SCIENCE, RESEARCH AND TECHNOLOGY IN NEPAL

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Table of Contents

LIST OF TABLES

Acronyms and Abbreviations

AIT	Asian Institute of Technology
APP	Agricultural Prospective Plan
AHW	Auxiliary Health Worker
ANM	Auxiliary Nurse Midwife
BPKIHS	BP Koirala Institute of Health Sciences
B.Sc	Bachelor in Science
CDB/TU	Central Department of Botany/Tribhuvan University
CDC/TU	Central Department of Chemistry/Tribhuvan University
CDCS/TU	Central Department of Computer Science/Tribhuvan University
CDES/TU	Central Department of Environmental Science/Tribhuvan University
CDFT/TU	Central Department of Food Technology/Tribhuvan University
CDG/TU	Central Department of Geology/Tribhuvan University
CDM/TU	Central Department of Mathematics/Tribhuvan University
CDMB/TU	Central Department of Microbiology/Tribhuvan University
CDME/TU	Central Department of Meteorology/Tribhuavn University
CDP/TU	Central Department of Physics/Tribhuvan University
CDS/TU	Central Department of Statistics/Tribhuvan Universtiy
CDZ/TU	Central Department of Zoology/Tribhuvan University
CFRL	Central Food Research Laboratory
CMA	Community Medical Auxiliary
CTEVT	Council for Technical Education and Vocational Training
DDC	District Development Committee
DFRS	Department of Forest Research and Survey
DHM	Department of Hydrology and Meteorology
DMG	Department of Mines and Geology
DNPWC	Department of National Parks and Wildlife Conservation
DOA	Department of Agriculture
DOF	Department of Forests
DOHS	Department of Health Services
DOI	Department of Irrigation
DOR	Department of Roads
DOS	Department of Survey
DPR	Department of Plan Resources
DR	Development Region
DSCWM	Department of Soil Conservation and Watershed Management
EIA	Environment Impact Assessment

ENPHO	Environment and Public Health Organization
EPC	Environment Protection Council
FRD	Forest Research Division
FSD	Forest Survey Division
GDP	Gross Domestic Product
GNP	Gross National Product
HMGN	His Majesty's Government of Nepal
HPPCL	Herb Processing Production Company Limited
HSEB	Higher Secondary Education Board
IPR	Intellectual Property Right
IAAS/TU	Institute of Agriculture and Animal Sciences
INGO	international non governmental organization
IOE/TU	Institute of Engineering at TU
IOF/TU	Institute of Forestry
IOM/TU	Institute of Medicine at Tribhuvan University
IOST/TU	Institute of Science and Technology at Tribhuvan University
I.Sc	Intermediate in Science
KU	Kathmandu University
MBBS	Bachelor of Medicine Bachelor of Surgery
MEST	Ministry of Environment, Science and Technology
MFSC	Ministry of Forest and Soil Conservation
MOA	Ministry of Agriculture
MOE	Ministry of Education
MOF	Ministry of Finance
MOH	Ministry of Health
MOI	Ministry of Industry
M.Sc	Master in Science
MWR	Ministry of Water Resources
NAMS	Nepal Academy of Medical Sciences
NARC	Nepal Agriculture Research Council
NCST	National Council for Science and Technology
NEFEJ	Nepal Forum of Environment Journalists
NFL	National Forensic Laboratory
NGO	Non-government organization
NHRC	National Health Research Council
NITC	National Information Technology Center
NPC	National Planning Commission
POU	Pokhara University
PU	Purbanchal University

R&D	Research and Development
R&D	Research and Development
RDL	Royal Drugs Limited
RDRL	Royal Drugs Research Laboratories
RECAST	Research Centre for Applied Science and Technology
Rs	Nepali Rupees
RHF	Resources Himalaya Foundation
RONAST	Royal Nepal Academy of Science and Technology
S&T	Science and Technology
SLC	School Leaving Certificate
TU	Tribhuvan University
UGC	University Grants Commission
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WECS	Water and Energy Commission
WHO	World Health Organization

EXECUTIVE SUMMARY

This is the Report on the Science, Research and Technology in Nepal commissioned to RONAST by UNESCO, Nepal. The Report reviews the status of Science and Technology (S&T) with specific goal to identify trends, constraints, and gaps wherein international collaboration may be fruitful to Nepal.

For source materials, RONAST used its previous work on the topic and updated them with recent literature review and questionnaire survey of major sectors to prepare a draft report. The report was presented before an expert group for input. This final draft is the result of this process.

For the purpose of this Report, science has been taken to include the traditional disciplines within the mandate of RONAST, the so-called hard sciences, and not behavioral sciences such as Economics and Political Sciences or the Social Sciences.

Technology has been defined as enhancements of human capacity, in this Report, those enhancements facilitated by sciences.

The Report is divided into a Historical Review, Review of Current Institutional Capabilities, Review of S&T Policies, Focus on Status of Different S&T Disciplines, and finally Policy Recommendations.

The Historical Review of S&T identifies two periods: Ancient History dominated by traditional science and technology before 1950 and Modern History dominated with the adoption of modern science and technology after 1950. The year 1950 has been used as a landmark year since it was after this that Nepal formally opened up to the outer world.

The review of current institutional capacities starts from S & T in schools, through vocational education and up to higher education in universities.

S&T education had a difficult time starting before 1950 but soon flourished as part of General Science education in from Grade 6 and expanding to Physics, Chemistry, Biology, and Mathematics to Grade 12. There has been a long drawn out effort to shift Intermediate level from University to schools to encourage more students to stay longer in school like in international school system and also to relieve the University from the 30% student overload so they can concentrate their resources to higher educations (Bachelors and up).

S&T in vocational education started early to provide technicians in revenue generating sectors like forestry, agriculture and engineering as well as health but with the establishment of the Council for Technical Education and Vocational Training (CTEVT), there are now 18 technical schools and 170 private technical institutes offering S&T trainings.

S&T in higher education reviews the status in the 4 universities. By far most of the teaching manpower (40%), students (75%), and resources are still concentrated with TU since it is the oldest, most resourced, and the cheapest because it is a public institution. The other universities are private and offer programs in high market demand such medicine and engineering at high fees and at better investment to student ratios.

Within TU, there is a disparity in investments in applied sciences such as Agriculture, Forestry, Medicine or Engineering and the Basic Sciences such as Physics, Chemistry, Biology, Mathematics and Statistics. The result is that well endowed S&T (Rs 5.7 billion in 15 years) institutes offer international quality education while funds starved departments just churn out numbers who are not easily employed.

Kathmandu University has been the first private university that offers quality education at high prices to 4% of the S&T students of Nepal.

Both Purbanchal and Pokhara universities have taken up the demand for high value S&T like Engineering, Medicine, Environmental Science and Pharmacology and IT, with 2218 S&T students in Purbanchal and 3596 S&T students in Pokhara.

Other institutes that have upgraded to university status are BP Koirala Institute of Health Sciences in Dharan and Nepal Academy of Medical Sciences in Bir Hospital, both catering to demand for high-level training in Medicines.

The main constraint in high education in S&T has been the lack of fund to upgrade physical facilities to accommodate the runaway demand for enrollment; consequently, quality is declining with higher student to professor ratios, student to lab or library ratios etc, stagnant curricula etc. There is an urgent call for massive increase in overdue investment in physical facilities to enable offering high quality S&T education at affordable prices.

Nonetheless, Nepal has over 28,000 manpower in S&T, the critical number necessary to make visible impact to Nepal's development, and this is an achievement despite the modest investment of less than 1% of GNP to S&T. As noted however quantity is not commensurate with quality. Still these manpower struggle to keep their professional societies going with periodic conventions and seminars but they are far behind in research.

A story with S&T human resource development is the astounding progress of women in numbers. There are some 922 women in S&T among the 8236 S&T personnel, so the percentage is still quite modest (13%) and this is worse in subjects considered unfeminine like engineering but the gender disparity is closing in urban centers. The gender disparity is attributed to cultural prejudices.

Besides the universities, there are several high level policy and research institutions such as National Council for Science and Technology, Royal Nepal Academy of Science and Technology, Ministry of Environment, Science and Technology, Nepal Agricultural Research Council, Water and Energy Commission, Environment Protection Council, National Health Research Council**,** Government Departments, Public and private initiatives. The National Council for Science and Technology was a precursor to RONAST, established for advisory policy making in S&T, and then seceded to the permanent function of RONAST established in 1982 under a Royal Charter.

All of these bodies have been set up for providing leadership in S&T policy but all have under performed relative to their expectations.

A review of actual S&T policy involves the review of relevant legal framework, the political manifestos and the actual development plans.

The legal framework consists of several related Acts promulgated under the Constitutional Article 26 (11): *the State shall adopt policies rendering due priority for the development of science and technology and the local technologies as well.*

None of the political parties proclaim explicit commitment to S&T but mention green revolution, irrigation, environment, and IT.

The development plans reveal that it took 25 years for S&T to be explicitly mentioned in the Sixth Plan (1980-1985). Although the total outlays have increased 575 times to Rs 189 billion by the Seventh Plan, S&T was a mere 1.1% in 1996. The Tenth Plan (2002-2007) proposed to formulate a 20-year S&T plan with RONAST.

UNESCO has been a major player in the formulation of a national S&T policy and policy implementation body beginning with Nepal's request in 1960s.

The Research and Development of S&T covers activities in government departments, universities, and autonomous organizations, private and non-governmental organizations.

Government departments have carried out the most research to come up with tangible technologies for immediate use as in agriculture and forestry. There have been some notable successes such as fisheries and dairy but the scale has not been high enough to make a brunt in total economic productivity. Government departments have the resources in terms of money and manpower but little publications

Universities have a plethora of highly trained manpower with virtually nil research opportunities for lack of investment yet they are productive with dissertation publications.
The research and development at other organizations have been scattered and of uneven quality and significance with some successes here and there and a lot of routine mediocrity for the most part.

There is a steady increase in research publications, some topics waxing and waning but peer review quality is not consistently high and stability is fragile.

The total investment in R&D has been less than 1% (0.11-0.48%) of the total budget, UNESCO recommends a minimum of 0.6%; India invests 0.4%. There is some hope from commercial investments in R&D as by Dabur Vatika on herbs.

The review of S&T status of different disciplines cover both basic sciences and applied sciences in both universities, government, and other private and ngo sectors.
For each discipline, a status of it history to date, the capacity parameters of the discipline to contribute to economic productivity of the nation, the actual delivery capacity, specific bottlenecks to efficient delivery and policy recommendations to relieve such bottlenecks are offered.

The disciplines covered include Agriculture, Chemistry, Physics, Plant Science, Earth Science, Forestry, Health Sector, Health Sciences, Engineering, Computers and IT, Mathematics and Statistics.

Based on the disciplinary status review, policy recommendations are offered regarding political commitment, public understanding of S&T, S&T Management, Mobilization of S&T Manpower, Role of Scientific bodies in policy making, Science education, Lasting S&T policies, Gap between Policies and Practices and R&D Policy and Investment.

Generally, a higher investment is called for with greater coordination among S&T institutions and explicit policy that is followed up with bureaucratic continuity to close the gap between policy and practices.

CHAPTER 1
RATIONALE & OBJECTIVES

With the advent of democracy in 1950, Nepal opened up to the outside world. This opening also marked the beginning of activities in science and technology (S&T). Six decades of effort have brought a number of S&T infrastructures into existence. Institutions for policy formulation, education and training, consultancy services, testing and standardization, research and development, extension services and promotion and dissemination at different levels have been set up. The S&T non-governmental organizations and professional societies of many disciplines have been set up. Publication and communication activities are flourishing. Most significantly, Nepal now possesses a sizeable number of S&T manpower. The country is continuing its commitment to the development of S&T to realize the significant contributions that S&T can make towards the social and economic transformation.

A benchmark document that the international donor and technical collaboration partners can refer to for developing pertinent policies is always essential. In an attempt to prepare such a basis in science and technology, the Royal Nepal Academy of Science and Technology (RONAST) prepared a discussion paper on *Scientific Research, Technology, Development, Transfer and Dissemination- Some Guiding Concepts* in 1983. RONAST also constituted 23 working groups of scientists and technologists from departments of the government (RONAST 1986), Tribhuvan University and various other organizations to improve on the draft paper and identify priority areas. RONAST continued to update the status papers. In 2001, it published a book entitled *Science and Technology in Nepal* prepared by the Vice-Chancellor of RONAST Professor Dayanand Bajracharya.

This report is an attempt to upgrade the information since 2001 and to present the status of science, research and technology in Nepal. Feasible areas where strategies could be developed to intensify the role of S&T are identified and suggested. This report will further serve as a reference for academic and research communities, educational institutions, government, international development partners, NGOs and INGOs that are collaborating in the development of S&T in Nepal.

The overall objective of this activity was to contribute to the national development through evidence based policy and program development in science research and technology in Nepal. The specific objectives of this report are:

1. To document the status of science and technology of Nepal
2. To measure the progress made in science and technology

3. To review the reports on policy measures and development plans
4. To come up with policy recommendations to develop national capacity for S&T

Methodology

This report is mainly based on available information covering a wide spectrum of science and technology in Nepal. The RONAST publications, mainly reports prepared by the 23 working groups, status reports and the *Science and Technology in Nepal (2001)* book provided the key basis for this report. Relevant annual reports, brochures and published articles from journals and magazines, sectoral reports and proceedings were collected from various sources. A questionnaire was also developed and circulated to various experts and organizations (Annex 1). A draft report was generated for expert review.

An interaction program was organized to elicit expert inputs for improvements of this draft report. Much of these expert feedbacks have been incorporated where possible in this final report. Other useful suggestions, however, need to be addressed separately due to the limitations of times and resources available for this project. The recommendations offered have been drawn from the authorial interpretation of available information.

Scope

The development in science and technology is taken as a measure of the development of any country. The status of science and technology in Nepal must be assessed to find out what we have so far: the sum of historical experience and assets in science and technology as well as the constraints limiting its optimum contribution to the economic development of the country.

Science is generally understood as the knowledge about the structure and behavior of the natural and physical world. Most understand "science" as the hard sciences that do not include the soft sciences such as Economics, Social Sciences and Political Sciences that deal with the behavior of Man.

Technology refers to any means that enhances the capacity of human beings. Often, technology is synonymous with the application of hard sciences to enhance human capacity like the invention of a motorcar. But the definition can also be expanded to include social technologies of enlisting public participation in community forestry technology or using economic principles to design micro-financing in agricultural enterprises.

CHAPTER 2

HISTORICAL TRENDS & GENERAL OVERVIEW

The Historical Legacy

The history of science and technology and its development in Nepal is yet to be traced back and studied systematically. Historical events have recorded the use of some advanced scientific knowledge and the adoption of some innovative technologies in areas such as agriculture, civil engineering, architecture, metallurgy, water management, medicine, textiles, paper manufacture, dyeing and food technology (Table 1). Ancient history started with the Gopals, regarded as the first dynasty, followed by Abhirs, Kirats, Lichhavis, Thakuris, Mallas, Shahs, Ranas and again the Shahs. As modern science and technologies were introduced only in the middle of the 20th century, the history described herein are of periods before and after 1950.

Table 1. Records of scientific knowledge and technological innovations in Nepal before 1950

SN	*Dynasty*	*Period*	*Knowledge*
1	The Gopals The Abhirs	Up to c 1000BC	Animal husbandry; Agricultural farming; Use of bamboo, hay, thatch and timber for construction; Dairy products
2	The Kirats	700BC-110AD	Brick firing; Woolen shawls
3	The Lichhavis	110AD-879 AD	Building construction; Water supply- construction of irrigation canals and stone spot; Architectural developments- Chityas and Stupa; Stone technology; Ponds for recharging water, sand filters; Street light by cotton and oil
4	The Thakuris	879AD-1200AD	Construction of Kasthamandap; Continuation of technologies developed before
5	The Mallas	1200AD-1768AD	Construction of Krishna Mandir, Nyatapola, Taleju and many palaces in Bhaktapur, Patan and Kathmandu; Metallurgical competence; Excelled in civil and architecture, textile; Knowledge in mining and extraction of iron; Ayurvedic dispensary; Technologies comparable to neighboring countries; Arniko to China to spread Neapli architect and technologies
6	The Ranas	1845AD-1950AD	Introduction of European technology; Construction of Sinha Durbar and other Victorian buildings, Clock tower; Allopathic hospital; Introduction of Motor car, Hydro electricity; Establishment of science education; Experimental station for agriculture

Note: The Shaha period begins after 1768, which was dominated by the Ranas for 104 years (1845-1950). The S&T development after 1950 is listed in Table 4.

Science and Technology Before 1950

The Gopals and Abhirs ruled Nepal up to c 1000 BC. Animal husbandry was the main occupation seconded by farming. They used temporary materials for building construction such as bamboo, hay, thatch and timber. From 700 BC to 110 AD, the Kirats ruled Nepal. The notable feature of this period was the visit by Emperor Ashoka to Lumbini. The technology of brick firing and production of quality woolen shawls were the notable technological achievements of this period.

The Lichhavis (110 AD - 879 AD) ruled Nepal from 2nd century onwards. Building construction and water supply technologies improved considerably. Stone spouts constructed around 600 AD continue to function to these days. Similarly, the Chaityas, Stupas and idols constructed during the Lichhavi period are still intact due to the sound stone technology. Other robust technologies are canals, self-recharging ponds and reservoirs for water supply complete with the provision of sand filters and street lighting with cotton-oil.

The Thakuri period (879-1200 AD) is known as a dark period in Nepal because not much is known except the construction of Kasthamandap, an imposing brick and timber public shelter, that gave the capital city of Nepal its name.

The Malla period extends from 1200 to 1768 AD. The Malla period witnessed remarkable growth in science and technology that demonstrated a level of technology comparable to the contemporaneous advanced nations. For example is *Nyatapola*, a five-storied, 30-meter tall temple in Bhaktapur has withstood at least three major earthquakes. The superb blending of robust architecture with religious aesthetic representations in structures of this period have won UNESCO recognition as World Culture Heritage for six sites of Kathmandu valley. Even in 1279 AD, the pagoda architecture was internationally recognized as evidenced by the White Pagoda of China built by Arniko of Nepal (Joshi 1987).

Furthermore, Gajurel and Vaidya (1979) have made a survey of traditional technologies of Nepal developed during this period. They compiled a list of 53 such technologies with illustrations (Table 2). Studies have revealed that Nepal had good technical know-hows in metallurgy, architecture, civil engineering, textile, paper manufacture, dyeing, printing, food technology, water management, terrace farming, agricultural input, terra-cotta, herbal medicine, terra cotta, textiles from cotton, wool and nettles, carpets, organic dying, onionskin paper, brewing beers and liquors, water management by mills and irrigation. Some of these technologies are still in use where modern technologies have not replaced them. The contribution of traditional technologies to the overall socio-economy has been significant even today. However, these technologies are not nurtured or improved.

Table 2. Some important traditional technologies of Nepal

SN	*Technology type*	*Estimated Time*
1	Idol casting	100 AD
2	Iron refining	
3	Copper refining	1500 AD
4	Metal utensils	1700 AD
5	Bronze utensils	1700 AD
6	'Dhusa' salvaging gold dust	
7	Gold plating	1000 AD
8	Pottering	500 BC
9	Tanning	
10	Paper	1100 AD
11	'Harital' paper	1000 AD
12	Ink preparation	1000 AD
13	Dying	1000 AD
14	Block prints	
15	Nepali weaving machine	
16	'Radi' woolen carpet	
17	'Pakhi' woolen carpet	
18	Woolen carpet	
19	'Nalu' rope	
20	Mustard oil	
21	Vegetable ghee 'Chiuri' Bassia butyracea	
22	Bees wax and other waxes	
23	Liquor	
24	Yeast cake	
25	Black rice 'Hakuwa'	1800 AD
26	Boiled rice 'Usina'	
27	Fermented and dried vegetable Gundruk	
28	Cucumber pickle	
29	Curd and drinking yoghurt 'Mahi'	
30	'Churpi' hard cheese	
31	Beaten rice	Ancient
32	Rice flakes	
33	'Khatte' flakes	
34	Molases and brown sugar	
35	'Masryora' dry lentil cakes	
36	Vinegar	
37	Plough	Ancient
38	Oxen cart	
39	Compost	1000 BC
40	Black soil fertilizer	
41	Brick and tiles	20,000 BC
42	Plaster and cement	1500 AD
43	Lime technology	1900 AD
44	Ghatta water turbine	
45	Hand Grinder Janto	
46	Lever grinder Dhiki	
47	Percussim instruments	
48	Fermented tobacco	
49	Coal and briquettes	
50	'Khayer' Acacia product	
51	'Pyanga' bamboo chest	
52	'Dhoop' herbal incense	
53	Medicinal mineral dusts	

Source: Gajurel and Vaidya 1979

During the period of 1800-1950 AD, Nepal remained isolated from the rest of the world for geopolitical reasons. Societal transformation wrought by the science and technology development of the Industrial Revolution in the West passed Nepal by (Singh & Bhuju 2001). A few examples of modern science and technology introduced to Nepal during this period include the White Clover (*Trifolium repens*) in 1853; the first S&T institution, the Agriculture Office, in 1924; the Civil Medical School for "Compounders" and Dressers (est. 1934); Technical Training School for Sub-Overseers (est. 1942); and the Forest Training Center for Rangers (est. 1942) (Sharma 1981).

Nepal did witness the import of a few western technologies for the services of then ruling class. They include a hospital (Prithvi Bir Hospital, est. 1890), a clock tower (Ghantaghar), a railway line, a jute mill and a ropeway line and a suspension bridge. The Pharping hydropower station built in 1911 was actually among the first of such power plants to be built in the entire South Asian region. The first automobile entered the country in 1916, on the backs of porters from across the hills. Similarly, a school for higher education (Trichandra College) including Intermediate in Science was started in 1919. The College, however, was limited to the members of ruling class and some influential families. In 1950, an airplane was chartered by then Rana Prime Minister for personal purposes (reportedly for a wedding) and made a first landing in Nepal. Thus, these institutions were established for consumption service purposes and for the ruling class.

Science and Technology After 1950

With the advent of democracy and the abolition of Rana regime in 1951, Nepal freed itself from the self-imposed isolation and began to embark on the path to modernization. With the implementation of the development plan in 1956, the Nepal Government took the initiative to develop infrastructure for S&T activities. The departments of Irrigation, Hydrology and Meteorology, Mines and Geology, Survey and Medicinal Plants were among the first government S&T institutions to be established (Table 3).

It is notable that many of these institutions were established within the Ministry of Forestry because this was a revenue generating sector for the government The Ministry has fostered the establishment of some pioneering organizations such as the Royal Drugs Research Laboratories, Royal Drugs Limited, the National Herbarium and Plant Tissue Culture Laboratory, the Forest Research and Survey Center, the Central Food Research Laboratory, the Herbs Processing and Production Limited and the Department of Drug Administration.

Table 3. Chronological order major science and technology institutions established in the country

Year	*Name of Institution*	*Type*
1890	Bir Hospital	Health service
1911	Pharping Hydroelectric Power Plant	Power supply
	Bijuli Adda/Nepal Electricity Authority (since 1985)	
1918	Trichandra College	Education
1924	Department of Agriculture	S&T Service
1939	Department of Livestock Services	S&T Service
1942	Technical School for Sub-overseer	Training
1947	Nepal Forest Institute	Education
1955	Department of Forest	S&T Service
1956	Department of Soil Sciences	S&T Service
1958	Department of Geology and Mines	Exploration and S&T
	Department of Survey	Service
	Central Bureau of Statistics	
1959	Tribhuvan University	Education
1960	Department of Medicinal Plants	Exploration, S&T Service
	Botanical Survey and National Herbarium	Workshop, R&D
	Balaju Yantra Shala	
1962	Department of Hydrology and Meteorology	S&T Service
1963	Butwal Technical Institute	Training, R&D
	Forest Survey Research Office	S&T Service
1964	Royal Drug Research Laboratory	R&D
1965	Postgraduate Departments of Natural Sciences, Tribhuvan University	Education
1966	Central Food Research Laboratory	Quality tests
1968	Lumle Agriculture Research Center	R&D
1972	Royal Drugs Ltd.	R&D
	Institutes of Medicine, Agriculture, Forestry, Engineering- TU	Education
1973	Department of National Parks and Wildlife	S&T Service
1974	Department of Soil Conservation and Watershed Management	S&T Service
1975	Nepal Telecommunication Corporation	Telecommunication
	Natural History Museum, Tribhuvan University	Exploration Research
1976	National Council for Science and Technology (NCST)	Coordination
	Nepal Bureau of Standards	S&T Service
1977	Research Center for Applied Science and Technology (RECAST)	R&D
	Butwal Engineering Works Ltd.	Industrial service
1980	Department of Drug Administration	Drug administration
1981	Water and Energy Commission	R&D
	Herbs Production and Processing Company Ltd.	Production Processing
1982	King Mahendra Trust for Nature Conservation	Conservation
	Department of Ayurved	R&D
	Royal Nepal Academy of Science and Technology (RONAST)	R&D, Tech. transfer, Science Promotion
1985	National Forensic Laboratory	S&T service
1989	Center for Technical Education and Vocational Training (CTEVT)	Training
1990	Center for Environmental and Agricultural Policy Research	Research, Policy
1991	Nepal Health Research Council	Policy making
	Kathmandu University	Education
	Nepal Agricultural Research Council (NARC)	R&D
1992	Environment Protection Council	Policy making
1993	BP Koirala Institute of Health Sciences	Education
1995	Ministry of Population and Environment	Policy making
1996	Ministry of Science and Technology	Policy making
	Purbanchal University	Education and research
	High Level Information Technology Commission	IT promotion
2004	National Academy of Medical Sciences	Education

The S&T activities increased significantly following the establishment of various S&T related departments and institutions. However, the activities of these institutions were limited to routine works and the provision of support services for their own sectoral development activities. Following the establishment of National Council for Science and Technology, the Sixth Plan (1980-1985) gave S&T its due place for the first time in the development plan. The Royal Nepal Academy of Science and Technology (RONAST) was established before the Seventh Plan (1985-1990). This Plan emphasized the endogenous S&T capabilities through the integration of S&T activities with the basic objectives of economic development.

So RONAST conceived the establishment of national laboratories for promoting R&D activities (Bhuju & Singh 1999). The National Forensic Laboratory was created in 1984. The others that followed are the National Instrumentation Repairs and Maintenance Center, National R&D Center on Alternative Energy, Nuclear Radiation and Monitoring Unit and the highest altitude international S&T research laboratory, the Pyramid, at Lobuche (5050 m) with the assistance of National Research Council (CNR) of Italy in 1991.

Nepal has no planetarium or science parks and few science museums. The only science related museums at present are the Natural History Museum in Kathmandu and the Forestry Museum in Hetauda Forestry Campus. The Ministry of Science and Technology is planning to establish an Information Technology Park at Dhulikhel, Kathmandu, while RONAST is planning to establish an informal Science Learning Center.

A Ministry of Science and Technology was established in 1996 and upgraded to the Ministry of Environment, Science and Technology in 2005. This followed nearly two decades of advocacy and thus raised high hopes despite allegations that such a ministry was created for political expedience. Nonetheless, the Ministry has prepared, with collaboration from RONAST, a preliminary draft of a 20-Year Perspective Plan for the development of S&T.

Agriculture has always been in a priority the development plans. However, the agricultural productivity has remained relatively low despite modest gains in fisheries, vegetables and fruits (MOAC/ADB 2002). In 1991, Nepal Agriculture Research Council was created to consolidate the R&D activities of the agriculture sector.

The private sector such as the Balaju Yantra Shala, Development Consulting Service, Butwal Technical Institute have in recent years also been contributing to the building of technological capability in energy sectors: solar water heaters, water turbines and Multi-Purpose Power Units (MPPU). More recently, private sectors have emerged in software development and Information Technology, telecommunications, cable technology.

The political upheaval of 1951 also brought mass awareness in education. Nepal's first university, the Tribhuvan University, was established in 1959. It was only in 1965 that TU started postgraduate programs in natural sciences. After the establishment of Institutes of Medicine, Forestry, Agriculture, Engineering and Food Technology in 1972, Nepal started producing its own high level manpower for technical fields. The stricture on offering higher education by private sector was relaxed after the re-institution of multi-party system in 1991, bringing several institutions for in engineering and medicine both in the private as well as public sectors. A few of them were commenced in affiliation with foreign educational institutes. Similarly, several universities have been added, including Kathmandu University, Purbanchal University and the Pokhara University.

An explicit Science and Technology policy statement was formulated by the government for the first time in the Sixth Five Year Development Plan (1980-1985) although planned development had started since 1956. The policy guidelines in this Plan envisaged the need for strengthening and coordinating the existing Science and Technology organizations, mobilizing the country's natural resources and manpower and the development and adoption of appropriate technologies.

Nevertheless, during the last 50 years, the country has created basic infrastructure of Science and Technology and produced a significant number of Science and Technology manpower. In the past, most of the Science and Technology institutions in Nepal had foreign advisors. Now all have indigenous expertise (Jequir 1988). Today, the country produces high-level manpower, including PhDs, in natural sciences, medicine, agriculture, engineering and forestry. However, there is a growing tendency of migration to developed countries. Similarly, with an average investment of less than 0.2% of GNP over the decades (Adhikary et al. 1998), the investment in Science and Technology is still too low for it to make a visible impact on national economic development.

CHAPTER 3
INSTITUTIONAL CAPABILITY

School Education

Nepal is intent upon improving her education, including that of science and technology. It has been running various national programs and planning for new comprehensive programs. Appropriate Acts and regulations have been enacted for legal foundations. Door-to-door campaign for enrolling all children of school going age have been launched recently to help include the 20% of school-age children still not in school and 46% of the population above six years of age are still illiterate.

The public schools of Nepal are of recent origin. Prime Minister Jung Bahadur Rana opened an English-type school after he returned from his visit to England in 1854 (Ministry of Education 1969). The school (estd. 1888), accessible only to the children of ruling class and their supporters, was known as Durbar High School ("Durbar" meaning palace in Nepali). Except for Dev Shumsher in 1901, no liberal attitude in education system was manifest during the Rana regime. In the 1940s, the pro-democratic activists defiantly and "illegally" set up educational institutes. It was only after the advent of democracy in 1950 that public and private access to modern education was permitted and supported by the government.

Education commissions constituted after 1954 have repeatedly emphasized the need for providing basic and primary education for all citizens and that school curriculum design and practice should be linked to the social and economic contexts to bring about effective development (Bajracharya 2003). The policy focus of education remained: universalized access to basic and primary education, scientific, technical and work oriented secondary level education and academically competent and economic development oriented tertiary education.

Nepal's education structure consists of Pre-primary (below 6 yrs of age), Primary (6-10 yrs), Lower Secondary (11-13 yrs), Secondary (14-15 yrs), Higher Secondary or proficiency certificate level (16-17 yrs), Higher Education at the University level (18-23 yrs). Primary education beginning at grade 1 include: English, Nepali, Mathematics, Social Studies, Environmental and Health Education, Physical Education, Creative and Expressive Skills and Language. General Science is compulsory from grades 6 to 10. In 2004, the total number of students in the schools (from grade 1-10) was over 6.6 million. The School Leaving

Certificate examination at grade 10 is the minimum pre-requisite for higher studies. In 2005, a total of 2,16,303 regular students appeared in the SLC examinations, out of which 38.7% matriculated.

In 1991, the government established the Higher Secondary Education Board (HSEB) to introduce the two-year post-secondary school education, called 10+2 (Plus 2), to bring Nepal's school education on par with international 12-year school education. Currently, there are 1,018 Plus 2 schools but only 214 such schools offer the science stream of Biology, Chemistry, Physics, Mathematics, Computer Science, Agriculture to about 13,000 students (Table 4). Over half (55.5%) of these students study in Kathmandu valley and the rest in urban centers of 32 districts (Table 5).

Table 4. Schools (science stream) affiliated with Higher Secondary Education Board

SN	*Name*	*District Address*	*Students Enrol*
1	Ace HS School	Kathmandu	28
2	Acme Engineering College HS School	Kathmandu	84
3	Adarsha English HS School	Kathmandu	20
4	Adarsha HS School	Ilam	28
5	Adarsha Vidya Mandir HS Boarding School	Lalitpur	49
6	Advance International Model HS School	Lalitpur	34
7	Aishwarya Vidya Niketan HS School	Kailali	54
8	Alpine International Model HS School	Sunsari	10
9	Amar Singh HS School	Kaski	82
10	Ambition Academy	Kathmandu	101
11	Amity HS School	Jhapa	42
12	Annapurna HS School	Morang	33
13	Annapurna HS School	Kathmandu	21
14	Apex Academy HS School	Chitwan	108
15	Ariniko Awasiya HS School	Morang	122
16	Asian College ff Hihger Studies	Lalitpur	13
17	Bagishwori HS School	Bhaktapur	68
18	Bagmati Boarding HS School	Kathmandu	114
19	Baijanath HS School	Kanchanpur	31
20	Bal Deeksha Sadan HS School	Lalitpur	27
21	Bal Jagriti HS School	Kanchanpur	22
22	Bal Kumari College	Chitwan	47
23	Bashu Hs School	Bhaktapur	49
24	Bhairahawa HS School	Rupandehi	42
25	Bhakti Namuna HS School	Lamjung	6
26	Bhanu Bhakta Memorial HS School	Kathmandu	57
27	Bharabi Science Academy	Dharan	30
28	Birat Science Campus	Morang	134
29	Birendra HS School	Baitadi	8
30	Birendra Vidya Mandir HS School	Kailali	21
31	Birgunj Commerce Campus	Parsa	55
32	Birta HS School	Birtamod Jhapa	29
33	Bishnumati Aawasiya HS School	Kathmandu	28
34	Blue Bird HS School	Lalitpur	44

35	British Gurkha Academy HS School	Kathmandu	38
36	Brook Field Academy HS School	Kathmandu	69
37	Buddha Jyoti HS School	Rupandehi	27
38	Buddhi Lal Vidhya Munar HS School	Saptari	7
39	Budhanilakantha HS School	Kathmandu	31
40	Cambridge HS School	Kathmandu	15
41	Campion Academy	Lalitpur	104
42	Campion Kathmandu HS School	Kathmandu	53
43	Capital H S School	Kathmandu	237
44	Caspian Valley H S School	Lalitpur	226
45	Centre For Innovative Technology HS School	Kathmandu	140
46	Chaitanya Multiple Campus	Kavrepalanchwok	14
47	Chaturbhujeshwar Janata HS School	Sarlahi	16
48	Chetana Vidhyashram HS School	Lalitpur	7
49	Children Paradse HS School	Lalitpur	8
50	Chitwan Science College	Chitwan	135
51	Classic Academy HS School	Kathmandu	33
52	College For Higher Education	Jhapa	64
53	Crimson International HS School	Kathmandu	62
54	DAV Rukmini Banasi Kedia HS School	Parsa	37
55	DAV Sushil Kedia Vishwa Bharati HS School		53
56	Damak Medel HS School	Jhapa	60
57	Damak Multiple Campus	Jhapa	112
58	Dang Valley HS School	Dang	13
59	Dedraj Sewalidevi Todi DVA Kediya Bishwo Bha	Morang	9
60	Devkota Memorial HS School	Morang	10
61	Dhanusha Science HS School	Dhanusha	162
62	Dharan HS School	Sunsari	51
63	Dipendra Prahari Awasiys HS Schoo9l	Kavre	59
64	Ed-Mark Academy HS School	Kathmandu	41
65	Einstein Academy HS School	Lalitpur	40
66	Emerald Academy HS School	Jhapa	8
67	Everest Awasiya HS School	Kathmandu	7
68	Everest HS School	Kathmandu	46
69	FW Taylor Management Academy	Kathmandu	63
70	Galaxy Public HS School	Kathmandu	36
71	Gandaki Boarding School	Kaski	72
72	Global HS School	Lalitpur	52
73	Glorious HS School	Rupandehi	141
74	Godawari Bidhya Mandir HS School	Sunsari	52
75	Gorakha International Public HS School	Dang	39
76	Gramin Adarsha Multiple Campus	Kathmandu	38
77	Gyan Jyoti H S School	Parsa	7
78	Gyanodaya Bal Batika H S School	Lalitpur	15
79	Hari Khetan Multiple Campus	Parsa	249
80	Harinagara HS School	Sunsari	9
81	Hill Town International HS School	Kathmandu	17
82	Himalayan White House HS School	Kathmandu	368
83	Intensiv International Academy	Kathmandu	39
84	Jana HS School	Surkhet	65
85	Jana Jyoti HS School	Nawalparasi	15
86	Janaki Awasiya HS School	Dhanusha	16
87	Janapriya Multiple Campus	Kaski	162
88	Janata HS School	Palpa	51

89	Janta Namuna HS School	Morang	43
90	Jaya Bageshwari HS School	Banke	36
91	Jiri HS School	Dolakha	8
92	Kamala HS School	Sinduli	36
93	Kantipur Academy HS School	Kathmandu	22
94	Kathmandu Bernhardt HS School	Kathmandu	174
95	Kathmandu Central HS School	Kathmandu	5
96	Kathmandu Community HS School	Kathmandu	21
97	Kathmandu Dondosco HS School	Kathmandu	196
98	Kathmandu Institute of Science & Technology	Kathmandu	155
99	Kathmandu Model HS School	Kathmandu	174
100	Kathmandu Valley College	Kathmandu	74
101	Kathmandu Valley HS School	Kathmandu	51
102	Khwopa HS School	Bhaktapur	152
103	Kumari Boarding HS School	Kathmandu	16
104	Lalitpur College	Lalitpur	37
105	Lincoln HS School	Kathmandu	12
106	Little Angels' HS School	Lalitpur	121
107	Little Flowers English HS School	Jhapa	34
108	Little Step Awasiya HS School	Kaski	32
109	Lord Buddha Academic Centre	Kathmandu	5
110	Loyola HS School	Kathmandu	16
111	Lumbini Adarsha HS School	Nawalparasi	29
112	Madan Bhandari Memorial HS School	Kathmandu	46
113	Mahamanju Shree HS School	Kathmandu	15
114	Maharshi Valmiki HS School		13
115	Mahendra Bhawan Girls H S Boarding School	Kathmandu	13
116	Mahendra H S School	Gulmi	26
117	Mahendra H S School	Banke	58
118	Makwanpur Multiple Campus	Makawanpur	143
119	Manakamana H S School	Kathmandu	67
120	Mani Mikunda H S School	Rupandehi	75
121	Manilek H S School	Baitadi	2
122	Manokamana Academy H S School	Morang	38
123	Millennium H S School		59
124	Mithila Institute Of Technology	Dhanusha	62
125	Model H S School	Dhanusha	88
126	Modern Public H S School	Banke	34
127	Monastic H S Boarding School	Dhanusha	1
128	Mount Annapurna Campus	Pokhara	125
129	Mount Everest H S School	Bhaktapur	10
130	Naast H S School	Sunsari	39
131	Nagarjun Academy H S School	Lalitpur	16
132	Nationa Academy H S School	Dhanusha	18
133	National Academy of Sci. And Tech. H S School	Kailali	21
134	National College For Higher Education	Kathmandu	27
135	National Institute of Science	Lalitpur	161
136	National Institute of Technical Sciences	Kathmandu	14
137	National Multiple H S School	Lalitpur	34
138	National Open College H S School	Lalitpur	5
139	National School of Sciences	Kathmandu	644
140	National Vision H S School	Kathmandu	27
141	Nepal Darsan H S School	Urlabari Morang	12
142	Nepal Institute of Management & Sci. H S School	Lalitpur	27

143	Nepal Nalanda Boarding H S School	Rupandehi	12
144	New Galaxy English H S School	Kaski	36
145	New Capital H S School	Chitwan	35
146	New Horizon H S School	Rupandehi	132
147	New Millennium Academy Hs School	Kathmandu	36
148	New Millennium H S School	Dhanusha	26
149	Nic H S School	Kathmandu	109
150	Nicholson H S School	Bhaktapur	20
151	Nightingale International Boarding H S School	Lalitpur	30
152	Nobel Academy Hs School	Kathmandu	264
153	Orchid Science College	Chitwan	288
154	Orient School of Science and Mgmt. Naraya	Kathmandu	13
155	Oxford English Boarding H S School	Rupandehi	60
156	Oxford H S School	Nawalparasi	46
157	Padmodaya Public H S School	Dang	136
158	Parashar H S School	Tanahu	12
159	Pasang Lhamu Memorial H S School	Kathmandu	18
160	Peoples Campus	Kathmandu	30
161	Pikhara H S School	Kaski	61
162	Pinnacle Academy H S School	Lalitpur	117
163	Pioneers H S School	Syngja	19
164	Prasadi Academy H S School	Lalitpur	114
165	Princeton College	Lalitpur	11
166	Progress H S School	Lalitpur	42
167	Public Youth H S School	Dhanusha	27
168	Radiant H S School	Kanchanpur	81
169	Rajarshi Janak H S School	Dhanusha	38
170	Rajbiraj Model H S School	Saptari	33
171	Rastriya Bigyan Tatha Banijya Pratisthan	Morang	57
172	Rastriya H S School	Kaski	31
173	Rehdon H S School	Kathmandu	61
174	Reliance International Academy H S School	Kathmandu	42
175	Roshani English Boarding H S School	Syngja	19
176	Royal Medel Academy H S School	Kathmandu	22
177	S.O.S. Hermann Gmeiner H S School	Bhaktapur	40
178	S.O.S. Hermann Gmeiner H S School	Kaski	39
179	Sagarmatha H S School	Kaski	82
180	Sagarmatha Multiple College	Kathmandu	33
181	Sanjiwani H S School	Kavre	25
182	Sann International H S School	Kathmandu	21
183	Sapta Gandaki Multiple Campus	Chitwan	29
184	School of Env. Mgmt & Sustainable Development	Kathmandu	21
185	Shakti H S School	Palpa	18
186	Shankarpur H S School	Darchula	1
187	Shree Nagar Science H S School	Palpa	67
188	Siddhartha Academy H S School	Kathmandu	27
189	Siddhartha Banasthali Campus	Kathmandu	68
190	Siddhartha Bording H S School	Damak, Jhapa	80
191	Siddhartha English H S School	Kavre	42
192	Small Heavan Awasiya H S School	Chitwan	28
193	Srijana Gyan Kunja H S School	Morang	73
194	St. Mary's H S School	Lalitpur	47
195	St'joseph H S School	Morang	35
196	Subhadra Makutdhari H S School	Dhanusha	81

197	Sukuna Multiple Campus	Indrapur Morang	22
198	Symbiosis Academy H S School	Lalitpur	20
199	The New Summit H S School	Kathmandu	212
200	Tilottama H S School	Rupandehi	190
201	Tulashi Mehar Memorial H S School	Makawanpur	12
202	Unique Academy H S School	Lalitpur	18
203	United Academy	Lalitpur	225
204	Universal Academy H S School	Kathmandu	12
205	V. S. Niketan H S School	Kathmandu	216
206	Vidhya Mandir H S School	Baglung	34
207	Vigyan Adhyayan Kendra	Dhanusha	4
208	Vijayapur H S School	Dharan	68
209	Vishwa Adarsha H S School	Sunsari	118
210	Viswa Niketan H S School	Kathmandu	48
211	Welhams H S School	Lalitpur	72
212	World Link Academy H S School	Kathmandu	51
213	Xavier Academy	Kathmandu	134
214	Xavier International H S School	Kathmandu	90

Source: Higher Secondary Education Board 2005

Table 5. Distribution of +2 schools (science stream) in and outside Kathmandu valley

SN	*Schools address*	*Number of Schools*	*Number of Students*
1	Kathmandu valley	104 (48.6%)	7196 (55.4%)
2	Outside Kathmandu valley	110 (51.4%)	5795 (44.6%)
	Total	214	12991

Source: Higher Secondary Education Board 2005

The objective of the Plus 2 system is relieve the load of Intermediate students in TU (nearly 30%) so it can concentrate on higher education and to retain the students in schools for 2 more years so students with no access to University are not deprived of higher education (Bajracharya 1998). This objective has not been realized since most Plus 2 education is offered by private schools of Kathmandu at higher fee structure than public Tribhuvan University so the load on the University has not really decreased.

Despite growing opportunities for higher technical education in Nepal, many students still venture abroad to India, China, Bangladesh, Australia and the USA.

Technical Education and Vocational Training

The history of vocational training include the Ayurved School in 1929; Civil Medical School for compounders and dressers in 1934; a Technical School for weaving, dyeing, agriculture1932; a Technical Training School for sub-overseer and Forest Training Center for rangers in 1942; a School of Agriculture in 1957, Butwal Technical Institute for

producing mechanics; and another institute, The Technical Training Institute in Kathmandu in 1965 to train technicians in the field of mechanical and electrical engineering.

In 1989, the Council for Technical Education and Vocational Training (CTEVT) was constituted as a policy formulation and coordination body for technical education and vocational training programs in Nepal. In particular, CTEVT formulates policies, ensures quality control, coordinates all the technical education and vocational training (TEVT) programs and provides services to facilitate TEVT activities to produce basic and middle level skilled manpower for the economic development. Currently, CTEVT operates 18 technical schools (Table 6) and has in affiliation than 170 private institutions in 20 various technical and vocational areas such as agriculture, construction, electrical, electronics, health, manufacturing, mechanical, sanitation and tourism.

Table 6. Technical institutions operated by CTEVT

SN	*Name of the Institution*	*Trade Areas*
1	Balaju Technical Training Center, Kathmandu	Electrical, Mechanical, Sanitation
2.	Training Institute for Technical Instruction, (TITI), Kathmandu	Instruction Related Training
3.	Panauti Technical School, Kavre	Automobile
4.	Lahan Technical School, Lahan	Agriculture, Construction, General Mechanics
5.	Jiri Technical School, Jiri	Agriculture, Construction, Health (ANM)
6.	Dhankuta Technical School, Uttarpani	Agriculture
7.	Vocational Training Center, Biratnagar	Health
8.	Karnali Technical School, Jumla	Agriculture, Construction, Health (AHW, ANM)
9.	Bheri Technical School, Nepalgunj	General Mechanics, Automechanics, Plumbing, Wielding, Electricity, Electronics, Computer, Office Management
10.	Rapti Technical School, Dang	Agriculture, Construction, Rural Mechanics, CMA
11.	School of Health Science, Bharatpur	Health (Health Assistant)
12.	Dhaulagiri Technical School, Mustang	Lodge Management, Agriculture, Construction
13.	Pokhara Tourism Training Center, Pokhara	Hotel Management, Travel and Tourism Management, Computer
14.	VTCD, Lamjung	As per Local Needs
15.	VTCD, Tanahaun	As per Local Needs
16.	Tansen Nursing School, Palpa	Health (Staff Nurse)
17.	Second Health Service, Bharatpur	Health
18.	Hetauda Polytechnic, Hetauda	Electrical, Mechanical and Industrial Skills
19.	Seti Technical School, Dipayal	Agriculture, Construction

Source: Council of Technical Education and Vocational Training

Higher Education

Nepal's first institution of higher education, Trichandra College, was established in 1918. The college introduced science teaching at the Intermediate level the following year. However, the college was not accessible to the general public. The main purpose of science

teaching at that time was to prepare the students for further studies in technical subjects such as medicine, engineering, agriculture, forestry in India. The science teaching was upgraded to the Bachelor level (BSc) in 1945.

The colleges were affiliated to the Indian Universities in the beginning. Trichandra College was affiliated with the Calcutta University. Later, all colleges in Nepal became affiliated with the Patna University. Most of the colleges conducted science teaching at Intermediate level but a few offered Bachelor program. Science teaching at the postgraduate level or the Masters level (MSc) began with the establishment first university in 1959, the Tribhuvan University. The first Masters program was in Mathematics.

By 1965, Tribhuvan University offered post-graduate teaching in Botany, Zoology, Chemistry and Physics at the premises of Trichandra College. Other subjects such as Statistics, Geology, Microbiology and Meteorology and Hydrology were introduced gradually. In 1967, the postgraduate programs were shifted to the premises of Tribhuvan University in Kirtipur. For many years, government teachers and visiting teachers from India under Colombo Plan, the USA under Fulbright Scheme and some teachers from the UK and the Soviet Union taught alongside Nepali faculty.

In 1972, the entire group of former affiliated colleges of Tribhuvan University was re-organized under 12 institutions: Agriculture and Animal Sciences, Science and Technology, Education, Engineering, Forestry, Medicine, Nepal and Asian Studies, Science, Humanities and Social Sciences, Business Administration, Commerce and Public Administration, Sanskrit and Law. Mahendra Sanskrit University was established in 1986 to strengthen Sanskrit teaching, which later introduced course in science and mathematics as well.

The re-instatement of multi-party democracy in 1990 brought liberalization in education. In 1991, a private university, the Kathmandu University, was established. It started its academic program in 1992 with an Intermediate in Science. In 1994, it launched Bachelor programs in Biology, Pharmacy and Engineering and by 1997, M. Phil and PhD programs were also offered. The University has granted affiliations to several private medical colleges. Since then, two more new universities, the Purbanchal University in the Eastern Development Region and the Pokhara University in the Western Development Region have been established in 1995 and 1997, respectively. These universities have also started offering courses in the subjects of Science and Technology.

By the late 1990s, university education in general science followed the scheme of 10 (school education) + 2 (Intermediate) + 2 (Bachelor) + 2 (Master's level), while in technical it was 10 + 2 + 4 or 5 + 2. In order to catch up with the world-wide practice of requiring at least 15

years of schooling for matriculation, the university education adopted the three tier system for general science as well with 10 + 2 + 3 + 2, some even has 10 + 2 + 4 + 2. The +2 component (after school leaving certificate) lying within the domain of the university is now in the process of transfer to the Ministry of Education administration. School science and Intermediate science, thus, now belong to one single canvass and the strengthening of the university program is pivoted around adding one more year to the BSc program.

Tribhuvan University

Till 1986, Tribhuvan University (TU) has been the country's only university offering for higher education in Science and Technology (TU 1999). Currently, three universities and two institutions at the university level offer higher learning in S&T. Still TU produces over three-quarters of S&T manpower with nearly 40% of the total high level (Master and PhD) professors of Science and Technology. Table 7 and Table 8 show the number of students and teachers under different institutes of S&T.

Table 7. Number of students in constituent campuses of different institutes of Tribhuvan University

Year	*IOST*	*IOE*	*IOM*	*IAAS*	*IOF*	*TOTAL*
1990	9384	1831	1512	742	577	14046
1991	10517	2039	1885	684	561	15686
1992	12113	2268	1777	721	454	17333
1993	12272	2080	1499	674	563	17088
1994	14109	2029	1098	675	541	18474
1995	11028	2052	1136	565	483	15264
1996	11182	1974	1036	520	404	15116
1997	12047	1998	1173	602	410	16230
1998	11700	2172	1212	598	353	16035
1999	13620	2369	1371	696	435	18491
2000	12619	3610	1605	745	405	19056
2001	12360	4077	1747	720	360	19264
2002	11533	4291	1667	564	358	18413
2003	18470	4321	1640	586	348	25365
2004	18891	4050	1543	643	437	25564

Source: Planning Division, Tribhuvan University

Table 8. Number of teachers in different science and technology related institutions of Tribhuvan Univeristy

Teachers	*IOST*	*IOE*	*IOM*	*IAAS*	*IOF*	*TOTAL*
Professors	53	16	26	10	-	105
Readers	171	52	42	25	4	294
Lecturers	511	143	177	76	43	950
Contract	61	78	36	15	2	192
Total	796	289	281	126	49	1541

Source: Planning Division, Tribhuvan University Today, 1999

There are several constituent and affiliated private campuses under Tribhuvan University that offer courses on different subjects of Science and Technology at different levels. The constituent campuses are administered and financed by the University itself whereas the affiliated campuses are financed privately and administered independently, but follow the curricula prescribed by the University. Most of the affiliated campuses of TU offer courses in the basic sciences, mostly up to the Intermediate level only. A few affiliated campuses also offer Master and Bachelor level programs in Botany, Zoology, Microbiology, Environmental Science, Computer Science, Mathematics, Statistics, Engineering and Architecture.

Tribhuvan University conducts academic programs in Science and Technology through its five technical institutes, they are: Science and Technology, Engineering, Medicine, Agriculture and Animal Sciences and Forestry. Altogether, the student admission in S&T fields constitutes nearly 16% of total student admission in Tribhuvan University. This figure in 2004 was 25,564 students or three-quarters of the entire of the total students in science and technology.

Mainstream science

Institute of Science and Technology at Tribhuvan University (IOST/TU) offers programs in Zoology, Botany, Chemistry, Physics, Mathematics, Statistics, Microbiology, Meteorology, Geology, Environmental Science, Computer Sciences and Food Technology (IOST/TU 2003). The student enrollment at different levels under the Institute of Science and Technology is given in Table 9.

Table 9. Number of students in constituent campuses of Institute of Science and Technology, Tribhuvan University

Year	*Intermediate*	*Bachelor*	*Master*	*Total*
1990	5797	2703	884	9384
1991	6419	2549	1549	10517
1992	7828	2972	1313	12113
1993	7751	2840	1681	12272
1994	8036	4513	1560	14109
1995	7226	2470	1332	11028
1996	6971	2746	1465	11182
1997	7366	3398	1283	12047
1998	7064	3218	1418	11700
1999	7100	4683	1837	13620
2000	6539	4921	1159	12619
2001	6362	4693	1210	12265
2002	9100	7364	1832	18296
2003	9052	7449	1869	18370
2004	8127	8671	1981	18779

Source: Planning Division, Tribhuvan University

Currently, the programs in Computer Science, Environmental Sciences and Food Technology are limited to the Bachelor level. The Institute is planning to introduce Master level teaching in these subjects. In addition, the IOST/TU is also planning to introduce Energy Studies and Technology, Material Sciences, Remote Sensing, Water Resources Studies, Biotechnology, Dairy Technology, Mountain Risk Engineering and Computer Applications. There are 75 campuses under the Institute of Science and Technology (Table 10).

Table 10. Constituent and private campuses affiliated with IOST, Tribhuvan University

Sn	*Name of Compus*	*Level*	*Region*
1	Amrit Campus, Lainchor	Certificate, Bachelor, Master	CDR
2	Bhaktpur Multiple Campus, Bhaktpur	Certificate, Bachelor	CDR
3	Birat Science Campus, Biratnagar[a]	Certificate, Bachelor,	EDR
4	Birendra Multiple Campus, Bharatpur	Certificate, Bachelor	CDR
5	Birendra Sainik Campus, Bhaktapur[a]	Certificate	CDR
6	Bishwo Niketan Science Campus[a]	Certificate, Bachelor	CDR
7	Butwal Campus, Butwal	Certificate, Bachelor	WDR
8	Campion College, Lalitpur[a]	Bachelor	CDR
9	Central Campus of Technology, Dharan	Certificate, Bachelor, Master	EDR
10	Central Department of Botany Kirtipur	Master	CDR
11	Central Department of Chemistry Kirtipur	Master	CDR
12	Central Department of Computer Sc & IT, Kirtipur	Master	CDR
13	Central Department of Environmental Science, Kirtipur	Master	CDR
14	Central Department of Geology, Kirtipur	Master	CDR
15	Central Department of Mathematics, Kirtipur	Master	CDR
16	Central Department of Meteorology, Kirtipur	Master	CDR
17	Central Department of Microbiology, Kirtipur	Master	CDR
18	Central Department of Physics Kirtipur	Master	CDR
19	Central Department of Statistics, Kirtipur	Master	CDR
20	Central Department of Zoology, Kirtipur	Master	CDR
21	College of Applied Science[a]	Master	CDR
22	Damak Campus , Jhapa[a]	Bachelor	EDR
23	Dhankuta Campus, Dhankuta	Certificate	EDR
24	Gautam Buddha Suchana Prrabidhi , Maitidevi[a]	Bachelor	CDR
25	Harikhetan Campus, Birgung[a]	Bachelor	CDR
26	Khwopa College, Bhaktapur[a]	Bachelor, Master	CDR
27	Mahendra Bindeshwori Campus, Rajbiraj	Certificate, Bachelor	EDR
28	Mahendra Morang Multiple Campus, Biratnagar	Bachelor	EDR
29	Mahendra Multiple Campus, Nepalgunj	Certificate, Bachelor	MW
30	Mahendra Ratna Campus Tahachal	Certificate	CDR
31	Makawanpur Campus, Hetauda[a]	Bachelor	CDR
32	Mechi Multiple Campus, Bhadrapur	Certificate, Bachelor	EDR
33	Mount Annapurna Campus, Pokhara[a]	Certifcate	CDR

34	National College of Technical Science, Balaju[a]	Bachelor	CDR
35	National Institute of Science and Technology[a]	Bachelor	CDR
36	National Multiple College, Lalitpur[a]	Bachelor	CDR
37	Nepal Science Campus[a] Putali Sadak	Certificate	CDR
38	Padmakanya Campus, Baghbazar	Certificate, Bachelor	CDR
39	Patan Sanyukta Campus, Patan	Certificate, Bachelor	CDR
40	Postgraduate Campus, Biratnagar	Master	EDR
41	Prithivinarayan Campus Pokhara	Certificate, Bachelor, Master	WDR
42	Ramshworoop Ramsagar Campus Janakpur	Certificate, Bachelor, Master	CDR
43	S. S. M Yadhav Campus, Siraha	Certificate	EDR
44	Siddartha Vanasthali Science Campus[a]	Cerficate, Bachelor	CDR
45	Siddhanath Campus, Mahendranagar	Certificate, Bachelor, Master	FWDR
46	Thakur Ram Multiple Campus, Birgunj	Certificate, Bachelor	CDR
47	Tribhuvan Multiple Campus, Palpa	Certificate, Bachelor	WDR
48	Trichandra Multiple Camupus, Ghantaghar	Certificate, Bachelor	CDR
49	Xavier's Academy[a] Lazimpat	Bachelor	CDR

Note: Superscript a are the affiliated private college, Abb. C= Central Development Region, EDR= Eastern Dev. Reg., WDR= Western Dev. Reg., MWDR= Mid Western Dev. Reg., FDR= Far Western Dev. Reg.
Source: Planning Division, Tribhuvan University

Most of the Master level programs in natural sciences are carried out at the Central Departments at Kirtipur, Kathmandu but some Master level programs in Zoology, Botany and Mathematics are also offered by other campuses. Central Departments are supposed to be the leading centers for teaching and research in natural sciences under the Institute of Science and Technology. Therefore, Central Departments conduct only Master and PhD programs. The existing central departments at TU: Botany, Chemistry, Computer Science, Environmental Science, Geology, Food Technology, Mathematics, Meteorology, Microbiology, Physics, Statistics and Zoology. While there has been a growth in the admission of students at the Central Departments over the years, enrollment for PhD is still very limited.

Over a period of five years (1995-1999), only 48 PhD students were enrolled under nine central departments or about one PhD student per central department per year. The actual number of students who were awarded PhD degree by IOST/TU over a period of 1990-1998 was just eight. This indicates that there are a great percentage of dropouts and that the research program is still very weak.

What could be the reasons for such lackluster academic vigor? One reason could be the lack of adequate research environment and infrastructure. A major reason, however, is also the shortage of fresh graduates who enroll into PhD. Most of the scholars who enroll for PhD are senior faculty members of TU or the government service holders. The majority of such

people enrolled for PhD are not serious about the research and they do not spend enough time in the laboratory everyday. For most, it is a part time and a leisurely business. For others, the main incentive for enrolling into a PhD program is to get the paid leave from their campuses or offices for the duration of enrollment. Quite often, the students and their supervisors do not have any regular consultations because they work in different campuses.

Table 11. Budget allocation in different institutes of Science and Technology in Tribhuvan University (Rs in millions)

Year	*IOST*	*IOE*	*IOM*	*IAAS*	*IOF*	*Total*
1990	38	15	49	11	11	124
1991	40	21	55	13	15	144
1992	55	34	66	18	23	196
1993	62	40	67	22	14	205
1994	67	44	108	23	23	265
1995	66	46	89	28	17	246
1996	79	50	103	31	12	275
1997	80	55	115	35	17	302
1998	84	58	124	38	18	322
1999	101	60	141	41	19	362
2000	117	81	227	52	23	500
2001	177	142	293	72	32	716
2002	168	120	283	69	32	672
2003	178	128	292	71	34	703
2004	174	127	295	71	33	700

Source: Planning Division, Tribhuvan University

In Nepal, little priority is given to higher education in basic sciences, compared to the higher education in technical subjects such as Engineering, Medicine, Agriculture and Forestry. The country has made huge investments for building necessary infrastructures for the Institutes of Medicine, Engineering, Forestry and Agriculture (Table 11). A total of Rs 5.7 billion has been spent on these institutes over a period of 15 years, with highest investment on IOM (40.3%), followed by IOST (25.9%).

Applied Science

Established in 1972, the Institute of Medicine at Tribhuvan University (IOM/TU) offers programs in Medicine, Nursing and Ayurved. The IOM/TU runs its academic programs in its own seven constituent campuses and seven affiliated private campuses (Table 12 and 13). The Institute started Bachelor program in Nursing in 1977 followed by MBBS in 1978. The first postgraduate program began in 1982 with the introduction of the three-year postgraduate studies in General Medicine. As the education quality is excellent and affordable fee structure, IOM/TU is the number one choice for the students. The enrollment capacity of the Institute has increased from 1212 to 1543 over a span of 15 years (Table 14). Today, the IOM/TU runs 29 different academic programs from Intermediate to postgraduate

level in Medicine, Public Health, and Paramedical studies, Nursing and Traditional Medicine and the Ayurveda Science. The Institute also runs the biggest hospital, its own 426-bed Teaching Hospital and the BP Koirala Lions Center for Opthalmic Studies in Kathmandu.

Table 12. Constituent campuses and academic programs under Institute of Medicine, Tribhuvan University

Campus	***Programs***
1. Medicine Campus, Maharajgunj, Kathmandu	Certificate in Medical Sciences (Health Lab, Pharmacy, Radiography) MBBS, B.Med.Lab.Tech., B.Optometry, B.Public Health Diploma in Anaesthesiology, Diploma in Child Health, Diploma in Gynaecology and Obstetrics Master in Clinical Physiology, Master in Public Health, MD (Anaesthesiology, General Practice, Internal Medicine, Obstetrics and Gynaecology, Ophthalmology, Paediatrics, Pathology, Psychiatry, Radiodiagnosis, MS (Surgery, Orthopaedic and Trauma, Otorhino-laryngology and Head and Neck Surgery)
2. Ayurveda Campus, Kathmandu	B.Ayurvedic Medicine and Health
3. Nursing Campus, Maharajgunj, Kathmandu	B.Nursing (Hospital Nursing, Community Nursing) Diploma in Psychiatric Nursing, M.Nursing (Women and Development)
4. Nursing Campus, Birgunj	Proficiency Certificate Level in Nursing
5. Nursing Campus, Biratnagar	Proficiency Certificate Level in Nursing
6. Nursing Campus, Pokhara	Proficiency Certificate Level in Nursing
7. Nursing Campus, Nepalgunj	Proficiency Certificate Level in Nursing

Source : Institute of Medicine, Tribhuvan University

Table 13. Affiliated campuses and their academic programs under the Institute of Medicine, Tribhuvan University

SN	***Name of Campus***	***Level of Teaching***
1	Universal College of Medical Science, Bhairahava	MBBS, BDS
2	Bir Hospital Nursing Campus, Kathmandu	Intermediate in Nursing
3	Lalitpur Nursing Campus, Kathmandu	Bachelor in Nursing
4	Janaki Medical College	MBBS
5	Mahendranagar Medical College	MBBS
6	National Medical College	MBBS
7	People's Dental College	BDS

Source : Institute of Medicine, Tribhuvan University

Asian Institute of Technology (AIT) has ranked the Institute of Engineering at TU (IOE/TU) as among the best three engineering institutes of the region. It has four constituent and five affiliated campuses (Table 15 and 16). Initially IOE/TU had program at Certificate (Diploma in Engineering) level. Bachelor programs were initiated in 1978. By 1996, the Institute offered Master's program in Urban Planning and later in Structural Engineering. It introduced Masters Degree in Environmental Science in 1997 and Water Resources in 1998. Three more Master's programs in Renewable Energy, Computer and Power System were introduced in 2001. Very recently it has offered ME in Geotechnical Engineering. The

Institute has been effortful in increasing its capacity to cater to more students' demand. In last 15 years (since 1990), the students' enrollment has increased from 1716 to 4036 (Table 17).

Table 14. Students number at various levels in constituent campuses of Institute of Medicine, Tribhuvan University

Year	*Intermediate*	*Bachelor*	*Master*	*Total*
1990	941	246	25	1212
1991	1044	381	48	1473
1992	1110	345	41	1496
1993	921	268	55	1244
1994	753	249	67	1069
1995	727	327	82	1136
1996	687	289	60	1036
1997	693	349	131	1173
1998	737	357	118	1212
1999	816	402	153	1371
2000	822	574	209	1605
2001	839	616	292	1747
2002	838	606	223	1667
2003	836	687	217	1740
2004	715	609	219	1543

Source: Planning Division, Tribhuvan University

Table 15. Constituent campus & academic programs under Institute of Engineering, Tribhuvan University

Campus	*Program*
Pulchowk Campus, Kathmandu	Intermediate level in Electrical, Electronics, Refrigeration & Air-conditioning, Architecture Bachelor level in Electrical, Electronics, Civil, Mechanical, Architecture Master level in Urban Planning, Structural Engineering and Environmental Engineering
Thapathali Campus, Kathmandu	Diploma in Mechanical, Automobile, Architecture
Dharan Campus, Eastern Nepal	Intermediate level in Electrical, Mechanical, Refrigeration & Air-conditioning, Civil
Pokhara Campus, Western Nepal	Technician level in Civil, Electrical, Electronics, Automobile, Mechanical

Source: Tribhuavn University

Table 16. Affiliated campuses and their academic programs under Institute of Engineering, Tribhuvan University

SN	*Name of Campus*	*Program*
1	Kantipur Engineering College, Lalitpur	BE
2	Kathmandu Engineering College, Kathmandu	BE
3	Advanced College of Engineering, Kathmandu	BE
4	Himalayan College of Engineeringm Kathmandu	BE
5	Janakpur Engineering College, Janakpur	BE

Source: Tribhuavn University

Table 17. Number of students at various levels in constituent campuses of Institute of Engineering, Tribhuvan University

Year	*Intermediate*	*Bachelor*	*Master*	*Total*
1990	1408	308	-	1716
1991	1524	357	-	1881
1992	1595	361	-	1956
1993	1645	358	-	2003
1994	1663	366	-	2029
1995	1727	325	-	2052
1996	1553	421	-	1974
1997	1384	614	-	1998
1998	1340	768	64	2172
1999	1388	884	97	2369
2000	2182	1318	110	3610
2001	2414	1487	173	4074
2002	2437	1612	227	4276
2003	2397	1701	209	4307
2004	2058	1749	229	4036

Source: Planning Division, Tribhuvan University

The Institute of Agriculture and Animal Sciences has three campuses. The Institute, however, is phasing out its Intermediate level programs. The academic programs under the Institute of Agriculture and Animal Sciences include both Bachelor's and Master's Degree (Table 18). As some of the Intermediate programs have been removed, the total number of students in the Institute has decreased from 742 in 1990 to 627 in 2004. The Institute is concentrating more on improving its B.Sc and M.Sc programs where the students' enrollment is in increasing trend (Table 19).

Table 18. Constituent campuses under the Institute of Agriculture and Animal Sciences Tribhuvan University

Campus	*Program*
Central Campus, Rampur	Bachelor in Agriculture, Veterinary & Animal Husbandry Master in Agriculture and Animal Science
Lamjung Campus, Lamjung	Intermediate in Agriculture (phase out)
Paklihawa Campus, Paklihawa	Intermediate in Agriculture (phase out)

Source: Tribhuvan University

With the establishment of Institute of Forestry, Tribhuvan University has been producing various level of manpower in forestry including graduates. The institute has two campuses: the Central Campus in Pokhara and the Hetauda Campus in Hetauda. Both campuses run Intermediate and Bachelor level courses in forestry. Recently, the Pokhara Campus has started the Masters program as well. The student enrollment under the Institute of Forestry is shown in Table 20. At present, there are 437 students in the Institute, over half of which is in Bachelor program. The institute is also paying more attention to Bachelor's and Master's degree courses.

Table 19. Number of students in constituent campuses of Institute of Agriculture and Animal Sciences Tribhuvan University

Year	*Intermediate*	*Bachelor*	*Master*	*Total*
1990	80	662	-	742
1991	-	684	-	684
1992	202	519	-	721
1993	227	447	-	674
1994	169	506	-	675
1995	161	404	-	565
1996	139	381	-	520
1997	138	464	-	602
1998	143	436	19	598
1999	130	509	57	696
2000	99	564	82	745
2001	101	536	81	718
2002	46	444	72	562
2003		511	70	581
2004		522	105	627

Source: Planning Division, Tribhuvan University

Table 20. Number of students in constituent campuses of Institute of Forestry, Tribhuvan University

Year	*Intermediate*	*Bachelor*	*Master*	*Total*
1990	460	117	-	577
1991	458	103	-	561
19192	343	111	-	454
1993	446	117	-	563
1994	424	117	-	541
1995	410	73	-	483
1996	283	121	-	404
1997	274	136	-	410
1998	204	149	-	353
1999	207	228	-	435
2000	176	229	-	405
2001	157	189	14	360
2002	168	176	14	358
2003	156	101	11	268
2004	161	240	36	437

Source: Planning Division, Tribhuvan University

Kathmandu University

Kathmandu University was established in November 1991 as a private university by an Act (KU 2005). This is the first private institution of higher learning. The predecessor of the University was the Kathmandu Valley Campus founded in 1985. The campus started as a private campus affiliated to Tribhuvan University and offered courses in science at intermediate level (I.Sc). The Kathmandu University started its academic program in 1992 with the Intermediate in Science program. In 1994, the University launched Bachelor programs in Pharmacy, Biology and Engineering (electrical and electronics, computer and

mechanical). Later, Environmental Sciences was included in its academic program. M.Phil and PhD programs were started in 1997. KU is strengthening its graduate programs while maintaining the intermediate level as well. In 2004, the highest number of students enrolled in MBBS program with 161 students in constituent colleges and 547 in affiliated colleges (Table 21 and 22).

Table 21. Number of students in School of Sciences, Engineering and Medical Science in Kathmandu University

Year	*ISc*	*BSc*	*BE*	*MSc*	*ME*	*MBBS*	*MD*	*NursCL*	*Nurs.BS*	*Total*
1992	189	-	-	-						189
1993	331	-	-	-						331
1994	324	29	92	-						445
1995	390	40	54	-						484
1996	361	43	104	-						508
1997	359	58	133	18						568
1998	369	56	121	8						554
1999	371	47	100	-						518
2000	240	66	117	7	7		3	47		487
2001		77	123			43				
2002		58	129			132		89		
2003	224	79	132	12		101	77	101		594
2004	225	74	124	17	12	161	128	101	15	857

BSc (Biology, Pharmacy, Environmental Science), B.E. (Electrical and Electronics, Mechanical, Computer) MSc (Science and Pharmacology) Source: Kathmandu University

Table 22. Number of students in the affiliated colleges of Kathmandu University

Year	*MBBS*	*B.Sc. (Environ. Science)*
1992	-	-
1993	-	-
1994	97	-
1995	89	-
1996	188	-
1997	401	36
1998	435	43
1999	456	45
2000	354	16
2001	495	
2002	497	
2003	324	
2004	547	

Source: Kathmandu University

The University has six affiliated medical colleges and hospitals. In the same year, the students' enrollment in Engineering was 136, which include subjects like Electrical, Electronics, Mechanical and Computer. Being a private university, the tuition fees are very high compared to state-financed Tribhuvan University. Table 23 is the annual budget of S&T related programs of Kathmandu University, which shows a gradual increment in budget from

Rs 46 million in 1992 to 70 million in 2003. There are 186 teachers (Table 24) and six medical colleges affiliated with the University (Table 25). However, KU shares only 4% of the total science students in the country.

Table 23. Budget allocation in School of Science, Engineering and Medical Science in Kathmandu University (in Rs. Million)

Year	*Sciences*	*Engineering*	*Medical Sciences*
1992	46.0 (100)		
1993	5.7 (100)		
1994	8.1 (100)		
1995	12.2 (100)		
1996	7.9 (100)		
1997	9.3 (100)		
1998	10.0 (100)		
1999	14.9 (27.9)	19.3 (36.2)	19.1 (35.8)
2000	22.6 (24.6)	28.5 (31.0)	40.7 (44.3)
2001	26.5 (32.4)	28.1 (34.4)	27.2 (33.3)
2002	26.5 (28.6)	24.8 (26.8)	41.4 (44.7)
2003	31.6 (45.1)	19.3 (27.6)	19.1 (27.3)

Values in parenthesis are percentage. Source: Kathmandu University

Table 24. Number of teachers in the School of Sciences, Engineering and Medicine in Kathmandu University

Teachers	*School of Sciences*	*School of Engineering.*	*School of Medicine*	*Total*
Professor	8	-	18	26
Associate Prof.	5	2	5	12
Assistant Prof.	33	16	11	27
Lecturer	13	8	19	40
Teaching Asst.	13	14	8	35
Research F/A	6	7		13
Total	78	47	61	186

Source: Kathmandu University

Table 25. Name of the campuses affiliated to Kathmandu University and their academic program

Name of the campus	*Program*	*Established*
Manipal College of Medical Sciences, Pokhara	MBBS	1994
College of Medical Sciences, Bharatpur	MBBS	1996
Nepalgunj Medical College, Nepalgunj	MBBS	1997
Kathmandu Medical College, Kathmandu	MBBS	1997
Nepal Medical College, Kathmandu	MBBS	1997
Scheer Memorial Hospital, College of Nursing, Banepa	BSc Nursing	2005

Source: Kathmandu University

Purbanchal University

Purbanchal University was established in 1994 in Biratnagar in the Eastern Development Region. The University began its academic programs in 1996. Besides Computer Science and IT, the University offers programs in Agriculture, Architecture, Civil Engineering, Electronics and Telecommunication through its constituent and affiliated colleges (Table 26). There are 19 colleges affiliated with the Purbanchal University offering Bachelor's programs of various disciplines of S&T. Altogether 2218 students are enrolled in various colleges of Purbanchal University. In a period of for years, a total of Rs 38 million have been spent for the University (Table 27). The major source of the budget is government grants and fees from affiliation.

Table 26. Students enrollment under the Institute of Science and Technology at various colleges affiliated to Purbanchal University

SN	*Name of the College*	*Program*	*2058-59 2001-02*	*2059-60 2002-03*	*2060-61 2003-04*	*2061-62 2004-05*	*Total*
1	Janata Adarsha Multiple Campus				2		
2	School of Engineering and Technology PU		18	22	27	32	99
3	Kathmandu Don Bosco	BCA	17	30	17		64
4	College of Information Technology		38	34	27	47	146
5	Kantipur City College	BCA	35	74	105	116	330
6	Campion Kathmandu College	BCA	12	25		31	68
7	Kathmandu Campus		10	12	10	3	35
8	International College of Technology		2	5	6	12	25
9	Himalayan Whitehouse International College		51	13	72	66	202
10	College of Software Engineering		15				15
11	Himalayan College of Agriculture Science and Animal Husbandary	B.Sc., Agriculture and Vet. Sc.	11	20	45	66	142
12	Gomendra Multiple Campus			6	3	9	18
13	Kist College of Information Technology			6	23	11	40
14	National College for Advanced Learning	B.Sc., Biochemistry		15	18	19	52
15	National Infotech College Birgunj					8	8
16	Khwopa Engineering College	B.E., Civil, Architect, Electronics,	48	87	143	158	436
17	Eastern Engineering College	B.E., Electronics, Telecom.	11	42	32	43	128
18	Acme Engineering College	B.E., Civil, Computer Sc.	41	85	78	174	378
19	Himalayan College of Science and Technology			17		13	30
	Total						2218

Source: IOST/Purbanchal University

Table 27. Budget of Science and Technology Campus, Purbanchal University

SN	*Budget Head*	*2057-58*	*2058-59*	*2059-60*	*2060-61*	*2061-62*	*Total*
1	Development	674966	1265000	1750000	1214400	2006000	6910368
2	General	3069377	6036500	7101900	7058000	8089622	31355400
	Total	3744344	7301500	8851900	8272400	10095000	38265146

Source: Purbanchal University

Pokhara University

Pokhara University was established in 1997 and is located in Pokhara in the Western Development Region. The major program of the university is focused into Computer and IT sector. The other programs are in Civil Engineering, Architecture, Electronics, Pharmacology, Natural Resource Management and Environmental Science (Table 28). The University has been running Master's degree program in Environment Management and Sustainable Development since 1999. It also has started Biochemistry teaching in one of its affiliated college. There are altogether 12 colleges affiliated with Pokhara University. The total number of students enrolled with Pokhara University during the period of last five years (1999-2004) is 3,596, including about 10% of the total number of students enrolled in science and technology.

Table 28. Program and student number in various colleges under Faculty of Science and Technology, Pokhara University

SN	*Institute*	*Program*	*Students No. 1999-2004*
1	School of Pharmaceutical and Biomedical Sciences, Pokhara	BPharm, MPharm, BMLT	146
2	Apex College, Kathmandu	BE Computer	185
3	Cosmos College of Management and Technology, Lalitpur	BE (IT, Computer, S&C)	314
4	Everest Engineering College, Kathmandu	BE (IT, Computer)	113
5	Gandaki College of Engineering and Science	BE (Software) BSc Computer Sc	127
6	Lumbini Engineering College, Butwal	BE (Civil, Computer, E&C)	288
7	National Academy of Science and Technology, Dhangadhi	BE (Computer)	48
8	Nepal College of Information Technology, Lalitpur	BE (IT, SE, Computer, S&C) MSc (Computer)	341
9	Nepal Engineering College, Bhaktapur	BE (IT, Civil, E&C, Computer) BArch	1273
10	Pokhara Engineering College, Pokhara	BE (IT, Civil, E&C, Computer)	435
11	School of Environmental Management and Sustainable Development, Kathmandu	BSc (Env.Mgt) MSc (Env Mgt)	249
12	Universal Science College, Kathmandu	BSc (Biochem)	77

Source: Pokhara University

Other Institutions

In addition to institutes mentioned above, the government has established two more institutions of university status, BP Koirala Institute of Health Sciences (BPKIHS) and Nepal Academy of Medical Sciences (NAMS). BP Koirala Institute of Health Sciences (BPKIHS) was established in 1993 and upgraded to a University in 1998 with a mandate to work towards developing socially responsible and competent health work force. The NAMS was established at Bir Hospital in 2003 and offers post graduation in medical science. Mahendra Sanskrit University, established in 1986, has also started Science *Uttarmadhyama* under which science courses on chemistry, physics, mathematics and biology are offered.

Constraints in Higher Education

Several educational institutions have been established after the advent of democracy in 1951, which have significantly contributed to the generation of required manpower in Science and Technology. However, there are several problems inherent in the higher education in S&T. Tribhuvan University is the single largest institution training of over 75% of S&T manpower. Being a state-financed University, it attracts the highest number of students. The role of private teaching institutions is increasing but still very limited.

One of the major challenges faced by the Tribhuvan University campuses is the ever-increasing number of students seeking admission. In 2004, a total of 25,564 students were enrolled in different subjects of S&T, the majority of them at the Intermediate level. TU attracts the largest number of students because it has the lowest tuition fees. Since it is beyond the capacity of most of the parents to afford high tuition fees in private schools and colleges the pressure for admission to TU is enormous. Therefore, most of the campuses are forced to admit more students than they can actually accommodate. Every year during admission time there ensues a confrontation between the campus administration and representatives of student unions, who pressure the administration to admit more students than the campus facilities can accommodate.

The available facilities and infrastructure are hardly adequate to meet the requirements of the students especially in campuses under the Institute of Science and Technology where basic sciences are taught. When it comes to investment in basic sciences, the University departments are always at a low priority. The overall percentage of investment in higher education has been declining while the cost of science education is increasing. This has necessitated the generation of internal resources by the University. One way of doing this would be to raise the tuition fees. For example, student tuition fee in TU is less than Rs. 100

per month for intermediate science students whereas it ranges at least from Rs. 1000 to Rs. 1500 in private campuses. Due to the objection of student unions, the university has not been able to raise the tuition fee even modestly. This has resulted in poor laboratory and library facilities in most of the science campuses. The products are, therefore, not properly trained to take up responsibilities in many Science and Technology institutions once they are employed.

The University professors perhaps belong to one of the most frustrated classes of the society in Nepal. Highly qualified professors earn far less than the teachers of private high schools. Many university teachers are involved in teaching in several campuses, including private campuses on a part time basis. So University professors take their jobs less seriously than their part-time job at other campuses. As a result, the university academic environment suffers. There is also an acute shortage of full-time teachers in many campuses. As a result, the classes are run with the help of part-time teachers who are employed on hourly basis.

Tribhuvan University has been unable to introduce new emerging areas of Science and Technology in its curriculum. This has been truer in basic sciences. This has led to overproduction of manpower in certain disciplines leading to unemployment and manpower shortage in others. Not only are new subjects not being introduced in time but also there have been few attempts to revise the existing curricula in basic sciences for decades. No serious assessments are ever made while revising curricula regarding the type of manpower that is required.

Following the introduction of the three-year Bachelors program to replace the two-year program in 1990s, TU has revised the curricula of its Bachelors program in sciences. In most of the subjects, this revision provided a good opportunity to modernize the curricula. However, there has been little improvement in the campus facilities to meet the new challenge that will be brought by the introduction of three-year Bachelor program. Already, most of the teachers involved in teaching at B.Sc level campuses are voicing their concern that they are in no way in a position to implement the new curricula successfully. It is, therefore, presumed that the instead of improving the standard of teaching the introduction of new 3-year B.Sc courses will lead to further problems.

While Tribhuvan University suffers among others from overpopulation of students, inadequate infrastructure, poor lab and library facilities, deteriorating academic environment and the static nature of the curricula, several private institutions of higher education in Science and Technology suffer from erratic academic norms and financial unsustainability.

There is no doubt that there are several private campuses that offer quality education. But most of these private campuses have a high tuition fee structure that is beyond the reach of majority of Nepali students and their guardians. This obviously limits the admission in such institutions to the students who are more financially sound than academically sound. This has created a situation where only a privileged rich class of people can get quality education whereas as financially modest but academically talented students have little opportunity for quality education. This has been more often the case in technical education such as medicine and engineering. In a country with a per capita income of less than US$ 270, a MBBS course in a private medical college costs anywhere between US$ 20,000 and 30,000. Obviously, rich, very rich parents can afford to send their children to such private colleges. It remains to be seen how the future products of such expensive private colleges will contribute to society.

Several private campuses in Kathmandu are providing quality education in Science and Technology. They are the first choice for many students. However, since the private institutions have to be financially sustainable, there have been cases where academic norms have been compromised for financial reasons. Monitoring and evaluations of such private institutions by the concerned authorities are not adequate. There are many private campuses and 10 + 2 schools, which are run within the rented buildings that are not meant for academic institutions. In several campuses many teachers are under qualified and the lab and library facilities are substandard. As a rule, all private campuses are required to hire teachers with a minimum qualification of Masters degree. But it is quite common that this rule is not strictly followed. There are many instances where teachers with Bachelor's degree area also employed by the private campuses. It appears that several private campuses have turned into business enterprises rather than educational organizations.

The significance of basic sciences in strengthening the overall Science and Technology capability has not yet been properly recognized in Nepal. This attitude has been largely responsible for the lack of development of adequate S&T capability even 30 years after instituting postgraduate programs and nearly 60 years after the beginning of Bachelor program in science education. The government sought development aid from USA to strengthen the Institutes of Agriculture and Forestry. Similarly, massive Japanese aid was accepted to develop the Institute of Medicine while British and Canadian aid was used to build up of the Institute of Engineering. The BP Koirala Institute of Health Sciences was built with the collaboration of India. Due to these efforts, all these Institutes are comparable to similar institutes in the region. However, the government did not demonstrate such commitment toward the development of infrastructure required to promote higher education in basic sciences.

At the suggestion of His Majesty's Government, Tribhuvan University had constituted in 1986 a task force of several senior professors to prepare a 15-year plan and program for strengthening higher education in the basic sciences with the intention of seeking German assistance (Bajracharya 2001). Following a series of appraisal missions of German experts, the proposal was redrafted and an input of about German Marks 16 million. There were positive indications from both Nepali and German sides that that the plan would be implemented. Some preliminary-grant assistance was made available by the German government. However, there was a change in the University leadership following the political movement of 1990 and this momentum collapsed.

In late 1990s, some efforts were made by the University through the Higher Education Project to improve the infrastructure and laboratory facilities for basic sciences in the postgraduate campuses at Kirtipur. Similarly, development budgets are being made available to strengthen laboratories in campuses running Bachelor program under the Institute of Science and Technology. However, relative to the investments in the technical institutes, the per student budget allocation for higher education in basic sciences is still quite low.

Human Resources & Professional Development

It is quite impressive to note that the manpower in various subjects of S&T in Nepal has increased by ten-fold within three decades. Thanks to the establishment of institutions at community and private level in affiliation with the existing universities. NCST estimated the number to be 2,377 in 1977; 8236 in 1995 (NCST 1995) and over 28,000 (Table 29) RONAST. By subject, Engineering showed the highest manpower with the highest percent (39.97%) followed by Natural Science (22.30%) and Medical Science (19.56%). The number of manpower in medicine (5496) may increase as the present data is mainly based on the information collected from institutions in Nepal.

It is, therefore, a matter of satisfaction that the S&T manpower has reached a minimum critical number of 1 per 1000 of population required for S&T to make a visible impact in the national development (Salam 1988). Moreover, the figure also includes personnel with a Bachelor level education, not all of them can be counted as scientists and engaged in research and development activities. Recently, several institutes including three universities have been producing high-level manpower. Therefore the total number of S&T manpower is estimated to have increased at least by 50 percent.

Table 29. Human resources in Science and Technology in Nepal

SN	*Subject*	*1977**	*1995**	*2005***
1	Engineering	739	2389	11234
2	Natural Science Natural Science (Botany, Zoology, Physics, Chemistry, Mathematics, Statistics, Geology, Meteorology)	450	1909	6266
3	Medical Science (Nursing, Pharmacy, Medicine and Surgery)	492	1658	5496
4	Agriculture	477	1396	3004
5	Forestry	155	719	798
6	Technology (Food Technology)	64	165	224
7	Computer and IT			782
8	Environment and Natural Resources			104
9	Microbiology			195
10	Total Number	2377	8236	28103

Source: * National Council for Science and Technology; ** RONAST

In the past most of the science and technology institutions in Nepal had foreign advisors to run these institutions. Now most of these institutions have become almost fully self-reliant in terms of professional expertise and capable of managing their affairs. Today, the country produces high-level manpower including PhD in natural sciences, medicine, agriculture, engineering, forestry, etc. One of the comparative advantages of the manpower of Nepal is the technological pluralism. Since 1950s to mid 1990s, most of the graduates and higher-level manpower were trained and educated from various countries including communist as well as the capitalist blocks of the world under the scholarship scheme. This has helped enrich Nepal with technological knowledge from different countries and systems.

The first remarkable activities of S&T professional society was noticed when the Nepal Science Association organized a seminar to promote scientific activities on September 27, 1956. The science association was formed by a group of young college science teachers, doctors, engineers, agriculturists, geologists, etc. Over 50 participants attended the seminar and discussed on three working papers. Since then many professional societies have been registered and are functioning with whatsoever meager resources they can generate. At present there are about 74 professional societies, which are registered with the different District Administrations. A list of 96 professional societies is given in Table 30.

The membership of the professional societies existing in Nepal is quite low; the majority of them have less than 500 members. By membership, the largest one is the Nepal Engineers Association and the Nepal Medical Association, which have memberships of 3578 and 2146, respectively. Professional societies with general disciplinary names have grown to such an extent that these societies have been regrouped and/or new societies by specialization have emerged recently. By general disciplines health and medicine includes the highest number of societies followed by engineering and technology.

Table 30. List of the professional societies in Science and Technology in Nepal

	Name of the Professional Society	***Established (B.S.)***
1	Agronomy Society of Nepal	
2	All Nepal Homeopathic Association	2006
3	Association of Clinical Pathology of Nepal	
4	Ayurved Doctor's Association of Nepal	2054
5	Cardiac Society of Nepal	
6	Computer Association of Nepal	2049
7	Council of Mathematical Association	2035
8	Ecological Association of Nepal	2048
9	Ecological Society	2049
10	Entomological Society	
11	Environment Conservation Association	
12	Epidemiological Society	
13	Ethnobotanical Society	
14	General Practitionars Association of Nepal	
15	Graduate Pharmaceutical Association	
16	Hemophilia Society of Nepal	
17	Microbiological Centre	2056
18	Mycological Society	
19	National Society for Earthquake Technology of Nepal	
20	Natural History Society of Nepal	2048
21	Nepal Agricultural Association	2017
22	Nepal Agroforestry Pratisthan	
23	Nepal Animal Science Association	2040
24	Nepal Association of Medical Lab. Sciences	
25	Nepal Association of TB and Chest Physicians	
26	Nepal Astroscience Committee	–
27	Nepal Ayurved Association	2023
28	Nepal Biotechnology Association	2049
29	Nepal Botanical Society	2038
30	Nepal Chemical Society	2036
31	Nepal Dairy Science Association	2050
32	Nepal Dental Association	2041
33	Nepal Ecology Group	
34	Nepal Engineers Association	2024
35	Nepal Engineering Technicians Association	2037
36	Nepal Environment Conservation Association	
37	Nepal Environment Conservation Group	
38	Nepal Fisheries Society	2052
39	Nepal Food Scientists and Technologists Association	
40	Nepal Forensic Society	
41	Nepal Foresters Association	2031
42	Nepal Forestry Teachers Association	
43	Nepal Geological Society	2036
44	Nepal Health Research Council	
45	Nepal Heart Foundation	
46	Nepal Horticulture Society	
47	Nepal Mathematical Society	2035
48	Nepal Medical Association	2007
49	Nepal Metallurgical Society	
50	Nepal Microbiology Society	
51	Nepal Molecular Biology Society	2051

52	Nepal Nature Conservation Society	2030
53	Nepal Natural Survey Association	
54	Nepal Oncologists Society	
55	Nepal Opthalmic Society	2042
56	Nepal Oral Health Society	-
57	Nepal Orthopedic Association	
58	Nepal Para Veterinary Livestock Association	
59	Nepal Pediatric Society	2038
60	Nepal Pharmaceutical Association	2028
61	Nepal Physical Society	2039
62	Nepal Public Health Association	
63	Nepal Radiologists Association	
64	Nepal Remote Sensing and Photogrametric Society	l2047
65	Nepal Science Education Society	2047
66	Nepal Science and Technology Teachers Association	2047
67	Nepal Society of Agricultural Scientists	2047
68	Nepal Society of Nephrology	2055
69	Nepal Surveyor Society	2047
70	Nepal Veterinary Association	2024
71	Nepal Zoological Society	2039
72	Nepal Society of Obstetrician and Gynaecologists	
73	Nepal Solar Energy Society	
74	Nepalese Society of Agricultural Engineers	2047
75	Nepalese Society of Gastroenteriology	
76	Nursing Association of Nepal	–
77	Paramedical Association of Nepal	
78	Perinatal Society of Nepal	2047
79	Pharmacists Society of Nepal	
80	Pschychiatrists Association of Nepal	
81	Science and Technology Association of Nepal	
82	Society of Agricultural Scientists	
83	Society of Anaesthesiologists of Nepal	
84	Society of Civil Engineers	
85	Society of Consulting Architectural and Engineering Firms	2041
86	Society of Dermatologists, Venereologists, and Leprologists of Nepal	
87	Society of Electrical Engineers of Nepal	2051
88	Society of Internal Medicine of Nepal	–
89	Society of Mechanical Engineers	2048
90	Society of Nepalese Architects	
91	Society of Neurosciences	
92	Society of Otolaryngologists	
93	Society of Public Health Engineers	
94	Society of Surgeons of Nepal	-
95	Soil and Water Conservation Society	
96	Women in Science and Technology	2049

The professional societies in Nepal are involved mainly in the promotion of S&T in course of practicing their respective profession and by disseminating information through their publications (Byahut 1999). Apart from publishing journals and literature, most of them are engaged in activities such as organizing seminars and workshops. Very rarely are they found involved in the issues dealing with S&T development. The professional societies have a

severe resource constraint. They generate little financial support from the annual fees, membership fees, donations etc. Most of them have to depend upon grants or donations from national and international organizations to run any program (Shrestha 2000). Except for the Nepal Engineers Association and the Nepal Medical Association, most of the professional societies do not have their own permanent offices buildings; their activities therefore are based on the teaching institutions or government organizations where most of the professionals work.

The establishment NCST, RONAST and the University Grants commission (UGC) brought some relief to the professional societies and professionals. These organizations have been providing grants to the professional societies, awards to individuals scientists and technical organizations, research grants, travel grants, grants for publications, grants for equipment, etc. Most significantly, RONAST Act 1991 has a provision to nominate three representatives from professional organizations in the Academic Assembly, the highest policy making body RONAST. Besides this, the facilities of the Academy are open for use to these societies and they can use the platform of RONAST to raise their issues. In this sense RONAST has been very instrumental in running activities of the professional societies.

Despite some of these supportive efforts, the professional societies themselves have not been able to play their role effectively. The societies have not been able to come up with comprehensive programs that could increase their role and intellectual contributions. Some of the journals of these societies are recognized abroad, but most of them are for national consumption. Besides these few activities neither the government, the politicians, the leaders nor the general public have been able to recognize the important role of the professional societies. This scenario of the professional societies makes some conclusions.

- No policy exists with the government towards the registration, performance, monitoring and evaluation of these societies
- No proper mechanism or system has been developed to properly utilize the strengths of these societies in the development issues
- No legal provisions exists for the development and application of S&T and scientific professionalism
- No incentives and motivation exists for the recognition, support and facilitation of professionals.

On the other hand the professional societies have to realize their weakness to attract the attention of the government and concerned bodies. They have to

- have a broad vision and multidisciplinary approach to S&T issues

- rise over personal and petty interests in the light of professionalism and institutional interests
- overcome the superficial, show business attitude and politicization of S&T
- meet the challenges offered by development of S&T
- take interest in national development issues and actively participate with a contributory approach

Nepalese Women in S&T

Background

In Nepal more than fifty percent of the total population are women. The economically active female population is 40%. The proportion of females in professional/technical occupation was only 15% (Population Monograph 1995). Characterized by rural farm based economy, 95% of the economically active female population is engaged in agriculture. The last decade had observed a marginal shift of female economic activities from agriculture to non-agricultural sector also. However, they are still confined to traditional forms of feminine jobs. These are tailoring, weaving and knitting. Some had ventured to jobs such as beauty parlor, travel agency, handicraft production, food processing and advertising and secretarial services. Among those involved in gainful economic activities, two-thirds are in manufacturing business and the remaining in the service sector (Shrestha et al 1999).

A large proportion of women do not get access to scientific and technical education that can help modernize their professions and increase their productive output. Despite these constraints, women with basic scientific and technical education are increasing over the years. These groups have entered technical carriers such as teachers, engineers, doctors, pilots and others.

The involvement of women in science goes back to 1950s. That period had witnessed only a single female student at the Intermediate level of science. The growth rate was not remarkable over the last three decades. The directory of "*Women Scientists and Technologists*" published by NCST (1996) revealed that among 8236 scientists and technologists only 992 were female. Among them, 433 were in natural science, 342 in medical science, 71 in engineering, 37 in agriculture and 17 in technology. Female scientists and technologists constitute below 13% of the total scientific manpower thus by demonstrating a persistent gender bias.

Gender disparity

Educational status within Kathmandu has dramatically improved after the restoration of democracy in 1950. Improvement was not observed in the rural areas. After two decades of democracy, intensive efforts were made to increase literacy level in the rural areas. The experiences in the adult literacy program had shown that beneficiaries were mostly male. Females had benefited little from this program. So female adult literacy programs were introduced. By 2001, the literacy rate among women had increased from 4% in 1971 to 40% in 2001.

At school, almost two-thirds of the girls drop out and this dropout and class repetition increases with grade increases despite the increase in female teachers. Nevertheless, female participation in schools is progressively increasing. The disparity between male and female students widen in higher education with only one female Masters student for every five male Masters student.

Male female student disparity increase in science and technology related faculties from 20: 1 in Masters of Engineering to 4:1 in Medicine. It is apparent that engineering is considered a male subject and medicine is considered a female subject.

Such disparities in male: female gender ratios are apparent in other universities that offer science and technology such as the Kathmandu University. However, one must note that both the absolute numbers of female students are increasing and the gender gap is also closing while the choices and opportunities are increasing.

The female manpower in Tribhuvan University involved in science and technology are 15 Professors, 47 Readers, 212 Lecturers and 72 Assistant Lecturers. Among them approximately 14 are PhD holders. The highest numbers are in Medicine, Chemistry, Botany and Zoology while lowest numbers are in Engineering. Kathmandu University has 13 female professors roughly in the same subject breakdown.

Capabilities

Nepalese women trained in science and technology have demonstrated extraordinary entrepreneurship in starting businesses that utilize their training as well as their business acumen. This generates important technology related services that increase the economic productivity of the country and also increases employment. At least 20 entrepreneurs have started over 10 businesses ranging from floriculture, tissue culture, alternative energy, fertilizers, biodiversity inventorying, medicinal herbs and computer services.

Even just literate women are involved in science and technology related business ventures relating to agricultural services such as nurseries, apiculture, vegetables and cash crops and floriculture outside Kathmandu.

Majority of science and technology institutions of Nepal below are located in the capital valley itself. In most of these institutions women as well as men are least involved in R&D activities. The reason could be due to the negligible amount of investment on S & T research and development (<1 % of GNP). Because of the budgetary constraints for research, it is difficult to single out female who are actually involved in research work. This is true for almost all the research institutions. The irony is that, about 95% of the women scientists who are said to be involved in S & T research are actually doing routine work of analysis and other service activities.

Women in institutions of higher learning and research number over 265 with nearly 160 in the medical sector and about 20 each in agricultural and forestry sectors. Generally the ratio of female researchers to male researchers range from 1: 30 or 50 in Royal Drugs and Herbal Processing to 1: 5 in Plant Resources Department.

The range of expertise of such highly trained women (M.Sc or higher) has are: Plant Sciences, Agricultural Sciences, Pharmacology, Chemistry, Zoology and the Health Sciences. The Engineering Sciences have only 71 female engineers, 3% of the total and they are usually misused in non-engineering jobs. But the great increase in engineering schools and the erosion of stereotypes against female engineering breaking down among urban middle class that can afford the 17-year education to be an engineer; more female engineers can be seen in the future.

Despite the above-mentioned positive growth, participation of women in scientific and technical works is only virtually nil. Women are forced to have lower scientific productivity than male scientists, which could be due to their lower status in their respective organizations.

Constraints

The present state of women in Nepal involved in science and technology including the other fields reflect the hardships that women have to face. They hold triple responsibilities of reproduction, household and employment. Nepalese cultural division of labor defines their primary role in society as to look after home and bring up their children. From their early childhood, girls are socialized into domestic chores whereas boys are encouraged to undertake adventurous and exploratory activities. A career in science and technology is considered a hard job and not suitable for girls.

Religious prophets both Hindu and Buddhist have projected women as recipients rather than active partners in science and technological development and its applications. This religious orthodoxy has been transmitted from one generation to other. The advent of democracy has made a shift from this attitude with the help of the then political and social workers. Knowledge transfer to females is now considered important. Since then girls' education center has been established. With the change of time, coeducation schools were also introduced. However, social and religious demarcation between girls and boys role still continue in the society. The political and social workers were also not completely free from this perspective. This prevailed in the choice of educational opportunities. Even among the so-called liberal and democratic persons, the field of education was gender segregated. For instance, engineering, agricultural science and forestry are not considered to be the subjects for female. This attitude continued for many years in many rural areas although the situation has been improving over the years. Women, these days, get equal opportunity in education especially in urban areas of Nepal. Gender disparity is slowly diminishing and most of the parents have a strong commitment to educate their daughters and wish them to be independent. With the knowledge in science and technology, women might contribute even more as they play a vital role in the positive development of home atmosphere, society and ultimately the nation. The traditional knowledge gained by women with their experience might be related to science and technology and the upgrading of their knowledge in that field would be the rewarding aspect for the upliftment of the Nation.

Participation of women in science and technology has encompassed two levels. They are premarital and post marital states. In pre marital states women live under the supervision and guidance of their guardians. The guardians hence need to have positive role towards the active participation of women. Marriage is almost universal in Nepal. Most of the women who are currently recognized as professionals are married. Both wife and husband hence should have equal level of understanding in home management and in their respective carriers.

Despite the above-mentioned problems, the situation is not frustrating for women; rather a positive trend is emerging for women scientists and technologists. The past attitude that technical fields such as engineering are only male bastions is disappearing now. Equal competition has been made for male and female in those areas. The only problem is that women had to compete equally with men but is brought up in different environment. This makes it difficult for them to demonstrate equal proficiency. This does not mean that women are less efficient than men.

Moreover, a number of private organizations (profit and non profit oriented) have emerged in the current decades. Women technologists are actively participating in their organizational

activities. They are fruitfully transforming their technical knowledge to the community. A gap between technician (donor of technical knowledge) and community (recipient of technical knowledge) is slowly decreasing.

Policy recommendations

1. For development process all sections of the society must be involved in the choice of science and technology, all must be aware of its limitations and all must enjoy its benefits (Duncan 1989). As gender imbalance and under utilization of women's skills and resources for science and technology constitute a serious draw back in the development process, it is essential for both men's and women's participation in the promotion of socio economic as well as technological development. Besides, with better opportunities for education offered to women, their passiveness would decline and be replaced with more self-confidence. Their participation should be encouraged and should be given opportunity to develop their skills and under take their research work based on such issues that might improve their status.
2. RONAST may contribute to the greater efficiency of women in science and technology by facilitating higher learning and research opportunities by access to funds, laboratories and foreign affiliations.

Science and Technology Organizations

The first organization established to formulate Science and Technology policy at national level was National Council for Science and Technology (NCST). It was followed by RONAST and the Ministry of Science and Technology. The organizational introduction, their objectives and activities are being briefly described below.

National Council for Science and Technology

As mentioned above, the National Council for Science and Technology (NCST) was the first national body that was established in 1976 to formulate a national Science and Technology policy and co-ordinate the activities of S&T institutions. The Council comprised exclusively of ex officio members. There was no provision for the representation of independent experts. The Vice-Chairman of National Planning Commission is the Chairman of the Council.

The main objectives of the Council were identified as the:

- Formulation of a national Science and Technology Policy.
- Promotion of scientific and technological research.

- Coordination in research programs of departments of His Majesty's Government and Tribhuvan University.
- Dissemination and popularization of scientific and technological knowledge among the masses through education and communication media.

Similarly, following functions were assigned to the Council:

- To formulate the national policy for Science and Technology.
- To coordinate Science and Technology research activities
- To support and promote research activities in the field of Science and Technology.
- To grant permission to foreign research organizations to conduct scientific research in Nepal.
- To promote professional development of scientific personnel.
- To develop and utilize research potential and resources.
- To identify and solve developmental problems through the application of Science and Technology.
- To promote dissemination and popularization of Science and Technology through mass media, radio programs, publication, talk programs, etc.

During its existence the NCST carried various programs such as S&T policy research, determining research priorities, identification and promotion of appropriate technologies, organization of seminars, workshops, exhibitions, essay competitions, etc., support for journals and S&T publication, providing research grants, strengthening S&T libraries and establishing international linkages with foreign S&T organizations. Since NCST was conceived was an advisory body, it had no independent administrative unit of its own. For this reason, RECAST was assigned to serve as the secretariat of the council. RECAST as established on in 1977 with an objective to undertake applied research in the field of Science and Technology. The government provided with the main source of budget to the council, totaling Rs 14 million in the span of 22 years beginning from 1976 (Table 31).

The National Council for Science and Technology mainly served as the national focal point for the development and application of Science and Technology It was felt in the S&T community that although the Council had a very good potential to promote S&T, it could not achieve its goals as expected. The main reason for the council being not as effective as it was expected was believed to be mainly due to its advisory role. The Council had no administrative and legal means and jurisdiction to implement its policy decisions (Bajracharya 2001). Implementation of its policy decisions rested with the government departments and the University.

Table 31. Annual budget of National Council for Science and Technology

Year	*Amount (in Rs.)*	*Year*	*Amount (in Rs.)*
1976	200,000	1987	7,00,000
1977	415,000	1988	660,000
1978	650,000	1989	4,00,000
1979	535,000	1990	100,000
1980	805,000	1991	200,000
1981	1,450,000	1992	827,000
1982	1,881,000	1993	1,085,000
1983	200,000	1994	1,350,000
1984	828,000	1995	1,275,,000
1985	600,000	1996	4,00,000
1986	638,000		

Source: National Council for Science and Technology

Both the government and Tribhuvan University were represented in the Council, the level of representation from these institutions, however, was apparently not adequate. Most of the times even the government departments represented in the council failed to implement the decisions their own department heads had made in the Council meetings. Similarly, Tribhuvan University's representation in the council at the Rector's level did not ensure that the University would implement the Council's decisions. The role of the Council was further undermined with the establishment of Royal Nepal Academy of Science and Technology (RONAST) in 1982.

After the establishment of RONAST, NCST's main activities were in supporting Science and Technology policy research. RONAST soon replaced NCST as the national apex body for Science and Technology. The objectives of RONAST were very similar to those of the NCST. Also the functions and programs of RONAST, at least in the beginning, were quite similar that of the Council. This sometimes led to the confusion in the responsibilities of the two institutions and to the repetition of their activities. Although the Council continued to exist, it became less and less active and its role remained ill defined. Ultimately, the Council was dissolved in 1998.

Royal Nepal Academy of Science and Technology (RONAST)

Royal Nepal Academy of Science and Technology (RONAST) was established on December 5, 1982 by a Royal Charter, as an autonomous body for the promotion of Science and Technology. Announcement of the establishment of RONAST had created a great sensation and expectation in the Science and Technology community. The original objectives of RONAST were defined as:

- Advancement of scientific and technological capabilities for all-round national development.

- Application of Science and Technology for the development of water and other available natural resources.
- Creation of conducive atmosphere for the advancement of Science and Technology
- Strengthening of scientific and technological capacity for the development of industry and other productive sectors.

The policies and programs of RONAST, at least in the beginning, were very much similar to those of NCST. However, the organizational set up of RONAST was different from the NCST. While the NCST was established primarily as the advisory body to His Majesty's Government, RONAST was envisaged to function as an independent institution with its own laboratories, administrative personnel, full time members and scientific staff. It enjoyed a much higher status than NCST. His Majesty the King was the Chancellor. The Prime Minister served as the Pro-Chancellor. The Executive Head was a full-time Vice Chancellor. The Academic Assembly, the policy making body, was composed of high-ranking officials and professionals.

Following the popular people's movement in 1990, the government promulgated RONAST ACT 2048 in 1992. The Act reestablished the role of RONAST as an autonomous institution for the promotion and development of Science and Technology. The new Act assigned following objectives for the academy:

- Advancement of science and technology for all-round development of the nation.
- Preservation and further modernization of indigenous technologies.
- Promotion of research in science and technology.
- Identification and facilitation of appropriate technology transfer.

In order to achieve these objectives the following functions were identified by the Act:

- Undertake and promote studies and research in priority areas,
- Advise His Majesty's Government on formulation of technology transfer policy and its implementation,
- Implement S&T programs in collaboration with national and international organizations,
- Collect and disseminate S&T information through a central S&T information system,
- Organize seminars and conferences on S&T topics and issues. Help facilitate S&T publications,
- Establish and strengthen linkages with regional and international institutions in order to promote mutual cooperation,

- Mobilize internal and external resources, both financial and technical, for S&T development as well as to carry out the activities of the academy,
- Give recognition to excellent individuals and institutional contribution for development, promotion and application of S&T,
- Increase public awareness of the importance and usefulness of S&T was well as to create conditions conductive for S&T application,
- Undertake studies and submit reports on the programs and achievements of S&T related national institutions,
- Advise His Majesty's Government on S&T development programs,
- Advise His Majesty's Government on the establishment of new institutions or laboratories for S&T related research and development,
- Provide financial and technical assistance for the establishment and development of new S&T institutions/laboratories,
- Set up exhibit centers for S&T related inventions and innovative models,
- Undertake all necessary measures to achieve the goals and objectives of the academy.

According to the new Act, His Majesty the King assumes the role of Patron. The Prime Minister and the Minister of Education are the ex officio Chancellor and Pro-Chancellor of the academy. The Academic Council, which is the highest policy making body of the academy, is chaired by the Prime Minister. Other members of the council included pro-chancellor, Vice Chairman of National Planning Commission, Vice Chancellors of Universities, Presidents of Professional Societies, representatives from the academy staff and academicians representing different fields of Science and Technology. Academicians shall remain life long members of the academic assembly. Provisions were made those four new academicians to be nominated by the Chancellor every two years. The Vice Chancellor and the Secretary are the only full time executives.

The present programs of RONAST include conducting research in some priority areas, carrying out promotional activities and providing certain support services. RONAST is conducting in-house research in the areas of Biotechnology, Natural Products, Environment, Alternate Energy and High Altitude Sciences. The promotional activities include Science Fair and other Popularization Programs, Seminars, Workshops, Conferences, Consultative Meetings, Talk Programs, Research Grants and Scholarships, Awards, Support to Professional Societies, S&T publication, radio and television programs

RONAST provides support services through its various units, viz. Research Laboratories, Instrumentation Center, Library and Documentation Center, Computer Unit, Radiation Monitoring Unit, Electronic Database and Information.

RONAST has developed academic linkages with the several regional and international S&T institutions. The major institutions are: National Research Council, Italy (CNR), Federation of Asian Scientific Academies and Societies (FASAS), International Council of Scientific Unions (ICSU), International Foundations of Sciences (IFS), International Atomic Energy Agency (IAEA), Information Network on New and Renewable Energy Resources and Technology for Asia and the Pacific (INNERTAP).

It serves as a national focal point for the following organizations Committee on Science and Technology in Develop Countries (COSTED), Center for Science and Technology of Non-Aligned Countries (NAM), Third World Academy of Science (TWAS), Association for Science Cooperation in Asia (ASCA) and Science & Technology Policy Asian Network (STEPAN).

Table 32. Budget of Royal Nepal Academy of Science and Technology from 1982-2005

Fiscal Year	*Year*	*Government*	*Foreign*	*Others*	*Total*
2039/040	1982	1,000			1,000
2040/041	1983	3000		179	3,179
2041/042	1984	5000		503	5,503
2042/043	1985	7700	680	1038	9,418
2043/044	1986	9000	500	1986	11,486
2044/045	1987	15000	135	1365	16,500
2045/046	1988	19000	2531	2969	24,500
2046/047	1989	21300	11570	5297	38,167
2047/048	1990	16000	5260	4740	26,000
2048/049	1991	10000	4848	5307	20,155
2049/050	1992	15078	44605	1088	60,771
2050/051	1993	25000	70152	7577	102,729
2051/052	1994	50000	76103	3514	129,617
2052/053	1995	24000	736		24,736
2053/054	1996	22000	14200	10000	46,200
2054/055	1997	26000	1150	20060	47,210
2055/056	1998	21300	4700	30000	56,000
2056/057	1999	56000	3425	5095	64,520
2057/058	2000	34500	4735	7920	47,155
2058/059	2001	24500	12295	5095	41,890
2059/060	2002	20000	10925	318	31,243
2060/061	2003	26500	3474	180	30,154
2061/062	2004	29000	2328	1382	32,710
2062/063	2005	32000	700	2520	35,220
Total in 24 years		512,878	275,052	118,133	906,063

Since the beginning of RONAST, there has been very little fundamental change in the activities of RONAST. In fact, most the activities initiated by RONAST were very similar to the activities of NCST. Even several years after the RONAST Act came into effect in 1992 there has been no significant change in programs and activities of the Academy. One of the main reasons for this was the continued lacking of stability in the earlier management of Academy since 1990. There is a general feeling in the Science and Technology community that the Academy has not been able to make a visible impact in the development and promotion of S&T even after nearly two decades of its establishment. The government has provided with a total of about Rs 513 million in its 24 years of existence (Table 32). In the meantime, RONAST has mobilized Rs 393 million for its programs, which constitutes 43.4% of the total budget. It is now high time to review and, if necessary, to revise the present programs of the Academy. It has become urgent for RONAST to set up new plans and programs to achieve its new goals as set by the Act and provide the academy with a new vision and direction. The Academy has to institute programs that would meet the aspirations and expectations of the people in general and the Science and Technology community in particular.

Ministry of Environment, Science and Technology

His Majesty's Government established the Ministry of Science and Technology in 1996 (MOST 1997). In 2004, the government renamed this as Ministry of Environment, Science and Technology (MEST) after the Ministry of Environment was merged into it. In fact, the First National Science Convention organized by NCST in 1978 had recommended for the first time the establishment of a science ministry.

The main objective of the MEST is to create conducive environment for the proper development of S&T and to make necessary arrangements for its application in the task of national development. The Ministry identified the following objectives to meet those goals:

- Identify new technology by exploring new investigation and innovation through the promotion and development of research activities in the realms of science and technology.
- Develop and promote traditional indigenous technology for the all-round development.
- Encourage the creative talents involved in various fields of science and technology by creating suitable opportunity.

There seems to have been no proper homework on the objectives, working plan, organizational set up manpower requirement etc. before the Ministry was established. Ever

since, the justification of a separate ministry for Science and Technology has been a matter of debate. Although the Ministry of Science and Technology is considered as a vital ministry in many other countries and headed by the Prime Minister or a senior minister, it is reportedly the least preferred portfolio among the cabinet ministers in Nepal. The Ministry has the highest turnover of ministers. In little more than three years there were 16 ministers. Some ministers have lasted no more than few days and knew very little about S&T.

The Ministry has also prepared, in collaboration with RONAST, a preliminary draft of a 20-Year Perspective Plan for the development of S&T. However, the Ministry is still in the process of identifying its future areas of engagement. There is a feeling that most of the activities initiated by the Ministry so far were very similar to those regularly conducted by other S&T institutions such as RONAST. The Ministry has prepared a draft proposal of Science and Technology Act to be enacted by the Parliament. The S&T community voiced strong reservations that such an Act could promote the development of S&T. There was a feeling in the larger section of S&T community that the proposed draft would make the Ministry more of controlling rather a promoter body in the affairs of Science and Technology.

At present, there are five institutions directly under the jurisdiction of the MEST, they are: National Information Center, Alternative Energy Promotion Center, Department of Hydrology and Meteorology, National Forensic Laboratory and BP Koirala Memorial Planetarium and Observatory Development Committee. For RONAST, it is a line ministry.

Nepal Agricultural Research Council (NARC)

Nepal Agricultural Research Council (NARC) was established in 1991 as an autonomous organization with the objective of carrying out research to increase the agricultural productivity and, thereby, uplift the socio-economic level of the people (NARC 1998). The Minister for Agriculture chairs the NARC. The main objectives of the council are to carry out high level studies and research on various aspects of agriculture, to identify and find out the measures for solutions to the existing problems in agriculture and generate technologies, knowledge and skills required and to assist the government in the formulation of agricultural policies and strategies.

The Council has been carrying out the following functions and strategies:

- Conduct high level research work on various prioritized field of agriculture required in line with the national agricultural policies

- Generate appropriate technologies specific to different agro-ecological zones and locations in Nepal
- Provide research and consultancy services to its clients
- Coordinate with other institutions for the agriculture research activities in Nepal, monitor and evaluate them
- Promote farmer's participation in technology generation
- Serve as the National Agricultural Documentation Center and focal point for regional and international information systems on agriculture
- Disseminate the generated agricultural technologies to the clients.

Through its own organs or in collaboration with other national, regional and international institutions, the Council conducts research programs on the areas of Cereals and Cash Crops, Horticulture, Livestock and Animal Health, Fisheries and Aquaculture, Fodder and Pasture, Agroforestry and Farm forestry, Soil and Irrigation Management, Botany and Biotechnology, Entomology, Plant Pathology and Plant Protection, Farming Systems, Agri Extension, Agri Economics and Marketing, Food Science, Agri Ecology and Environment, Socio-economics and Other fields related to Agriculture.

Water and Energy Commission

In 1976, the government to set up Water and Energy Commission to develop a functional approach to accomplish studies, surveys and investigations leading to policy recommendations relating to the development of the nation's water and energy resources. In 1981, a formal secretariat for the Commission was also established with six technical divisions: Institutional and Manpower Development, Energy Planning, Laws and International Arrangements, Water Resources Planning, Basic Data and Analysis and Economic Policy and Program Analysis. In order to include the participation of the private sector, the government reconstituted the Commission in 1992.

With the second reconstitution of WECS in 1999, a wider representation in the Commission has been accomplished (WECS 1999). The objectives and the functions under the new mandate are:

- To provide assistance to the concerned ministries in formulating policies and objectives to be included in the perspective/periodic plan relating to the water resources and energy sectors.
- To provide suggestions, recommendations and guidance with regard to the multipurpose (mega and medium scale only) projects' development as well as to

irrigation, hydropower, drinking water, industrial use of water, flood management and water navigation; and also regarding the promotion and development of such mega and medium scale projects and protection of environmental aspects relating to the above sectors.

- To formulate policies and strategies with regard to the water resources and energy sector.
- To render opinion, advice and recommendations on bilateral and multilateral issues relating to water resources and energy.

Environment Protection Council (EPC)

The Environment Protection Council was constituted under the chairmanship of the Prime Minister to formulate policies and plans related to environmental conservation and protection and coordinate environmental programs in 1992 (HMGN 1992). The Aims and Policies of Environment Protection Council are:

- To efficiently manage natural and physical resources.
- To maintain balance and coordination between developmental efforts and environmental conservation in order to meet the basic needs of the Nepalese people in a sustainable manner.
- To support sustainable development by managing, developing and conserving natural, cultural and physical and heritage resources keeping in view the social, economic and cultural needs and potentialities of the present and future generations.
- To identify and mitigate, to the extent possible, the adverse impacts on the environment caused, or likely to be caused, by human action and development projects.
- To utilize, manage, develop, conserve and recycle natural and physical resources in a manner that is not detrimental to their ability to yield long-term benefits.
- To give priority to the formulation and implementation of special protection and conservation policies and plans to safeguard important national heritage resources such as rare wildlife species, plants, biodiversity, genetic pools, environmentally sensitive areas and manmade heritage sites of aesthetic and cultural significance.
- To formulate acts and laws pertaining to various environmental issues as the needs arises and to carry out timely reform of existing legislations.
- To develop institutions for the effective implementation of environmental laws and policies.

The Environment Protection Council carries out the following functions to fulfill its objectives and duties:

- Determine national policy for environmental planning, pollution control, environmental impact assessment and national heritage conservation and management.
- Formulate environmental plans in accordance with national heritage conservation policies and prepare guidelines for monitoring and supervising environmental programs and establish procedures for environmental impact assessment.
- Investigate and acquire information about environmental plans, their effectiveness or potential adverse effects and prepare reports for public consumption on the basis of the information acquired.
- Asses the environmental and social impacts of projects likely to have significant effects on the environment in order to adopt required mitigation measures; these assessments will closely involve individuals, communities, agencies, or institutions most likely to be affected by such projects.
- Ensure inter-sectoral coordination within the ministries of His Majesty's Government with regard to environmental issues.
- Monitor international efforts being made for environmental protection and sustainable development.
- Review or carry out periodic studies of existing provisions in environmental law, make necessary reforms and enact new laws as and when required.
- Develop a national system for pollution control, establish environmental standards and ensure their implementation.
- Monitor the status of the environment for the purpose of assessing environmental trends and maintenance of environmental quality and standards.
- Implement the National Conservation Strategy with necessary revisions from time to time and
- Perform other necessary functions.

National Health Research Council (NHRC)

It is statutory and autonomous body established in 1991 to promote quality research in health sciences. The main objectives of the Council are to conduct studies and researches on problems related to health sciences, to provide consultancy services and information to health-related studies and activities and to collect information on health-related studies and researches being carried out around the world and make them available to the government.

Functions, Duties and Rights of the Council

- Conducting studies and researches on problems related to health sciences with as defined by the health policy of the government.
- Policy formulation for basic and applied research relating to health.
- Undertake research on health system, biomedical science and behavioral science.
- Carry out studies on prevention, diagnosis and treatment of diseases and ailments.
- Identify priority areas for health-related studies and research.
- Granting consent for study and research in subjects related to health.
- Dissemination of information on health-related research.
- Exchange of health-related information at national and international level.
- Supporting research at individual or organization level by providing prizes, scholarships and travel grants.
- Keeping record of research relating to health.
- Advise government on health-related study and research

Government Departments

There are over a dozens of departments related to science and technology that directly come under the government. Some of these had their existence since long, but most of them were created after 1960. Except a few, majority of these departments are service oriented with very little research activities. These departments even have their long-term management plans prepared by hired experts or consultants. A few of them, however, by their nature of function are involved in research and exploration activities.

Department of Agriculture: Established in 1924, Department of Agriculture is the oldest government office in Nepal. The broad objective of the department is to maintain food security and contribute in poverty alleviation through agricultural diversification and increased productivity. Realizing the population growth, limited land resource and environmental degradation, the department has undertaken strategies to implement geographic specific agriculture production program and to help set up agro based industries while giving special attention to small farmers and women. The department has developed wide programs covering crop improvement, vegetable production, fruit development, fisheries, bee keeping and apiculture, extension and training, crop protection, post harvest technology, soil management, marketing and promotion and agro-engineering. The department has its offices in all districts of the country.

Department of Forest Research and Survey: Department of Forest Research and Survey (DFRS) were initially established as Forest Resources Survey Project in 1963 to develop forest statistics and conduct research for maximizing forest productivity. The Department is the only government designated forestry research and survey organization in Nepal. It has two divisions: Forest Research Division (FRD) and Forest Survey Division (FSD). The FRD is engaged to develop and demonstrate appropriate technologies related to natural and manmade forest management, determining forest growth, identify suitable tree species for different site conditions and develop their nursery and silvicultural technologies. The FSD generates statistics and information necessary to plan overall forestry development at national, regional and district levels and keeps inventories.

Central Food Research Laboratory: Department of Food was created in 1960, which was renamed as Food Research Laboratory in 1965. Beside a central laboratory in Kathmandu, the Department has laboratories in Biratnagar, Hetauda, Pokhara, Dhangadhi and Jumla. It mainly provides services to test the food products and examine their quality.

Department of National Parks and Wildlife Conservation: Nepal embarked upon modern era of wildlife conservation with the enactment of National Parks and Wildlife Conservation Act in 1973. Prior to becoming a department in 1980, an office had been created in 1972 under the department of Forests. Department of National Parks and Wildlife Conservation (DNPWC) presently has a network of eight national parks, four wildlife reserves, three conservation areas and one hunting reserve, including five buffer zones, covering a total of 27,345 sq km or 18.14 percent of the total land area. The major objectives of the department are to conserve the country's major representative ecosystems, unique natural and cultural heritage and give protection to the valuable and endangered wildlife species. The DNPWC's present priority stresses a conciliatory approach with participatory management of biodiversity. The present activities of DNPWC include Annapurna conservation area project, Anti poaching operation, Bardia integrated conservation project, Kanchenjunga conservation area project, Northern mountains conservation project, Park people program and Veterinary services for domestic animals and wildlife.

Department of Plant Resources: Department of Plant Resources was established in 1959 to provide services in the field of research and development of plant resources in Nepal. The department has a collection of 250,000 herbaria. It has pioneered some research such as in tissue culture techniques in Nepal. Major research activities of DPR are in natural products and plants. The natural products research includes Phyto-chemical screening, pharmacological a microbiological tests, technology development for sustainable production, standardization and quality control. The plant research include conducting botanical survey

and collection, preservation of plant samples, anatomical and cytological studies, tissue culture techniques, maintaining living representatives of flora in botanical gardens.

Department of Mines and Geology: Department of Mines and Geology has a long history since its origin as Office of Irrigation and Geology in 1926. The DOMG is responsible for: 1. Conducting geo-scientific survey and research, 2. Mineral exploration, development and promotion of mineral based industries, 3. Engineering and environmental geological studies, 4. Seismotectonic studies and earthquake monitoring, 5. Petroleum and natural gas exploration development and promotion and 6. Administration of mining lease and implementation of mining rules and regulations. Some of the current activities are: Exploration for gold, limestone, polished stones; Promotion of cement grade limestone; Environmental monitoring of operating mines; Remote sensing studies of land slides; Monitoring of natural gases, Seismological monitoring; and Geological mapping.

Department of Soil Conservation and Watershed Management: Soil erosion and watershed degradation are major challenges in Nepal. The government initiated soil conservation and watershed management programs in 1974 through the Department of Soil and Water Conservation. Since its establishment, the Department has been planning, implementing and monitoring soil conservation and watershed management activities based on the principles of integrated watershed management. The long-term policies are: i. Maintain ecological balance to reduce occurrences of landslides, desertification and conservation of watershed resources and ii. Management of watershed resources to support the resource base of agriculture and hydrology. The Department is planning to provide services to all 75 districts within the 10^{th} Five Year Plan period. At present, it serves 55 districts of Nepal.

Public and Private Initiatives

There is encouraging participation of civil society in development programs including those related to science and technology in Nepal. Public understanding on science and technology could be rated low, but there has always been greater participation of public in science activities. In the rural areas, public assemble in big crowds for programs like exhibitions, quiz and film-shows, while in the urban areas they turn up in debates and conferences.

In a recent RONAST program in Jumla, a remote mountain headquarters of Karnali zone in western Nepal, students from all eight schools of the district hiked two days through conflict prone territory to reach the venue and actively participated in three-day science fair. In the fourth national conference on science and technology organized in 2004, over 1400 scientists and technologists participated, the number made the biggest gathering of such type.

Altogether 542 papers were received for presentation during the four-day mega meet in Kathmandu (RONAST 2004).

An example of how the civil society exerted pressure and forced the government and donors to abandon a mega proposal is Arun Hydropower Project in 1993. Professionals from various walks including engineers, economists, social scientists, academics and journalists formed what they called Alliance for Energy. The AE, on one hand campaigned against commission-driven projects, on the other, advocated for hydropower projects that the nation could handle itself. The advocacy not only terminated the donor driven project but also helped initiate more viable, national and economic project like Chilime in Rasuwa.
The Social Welfare Council of Nepal has published a list of 15, 043 non-government organizations registered with it from 1978 to 2003 (SWC 2004). Obviously, majority (54.7%) of these organizations are related to community development. However, there are encouraging number of organizations related environmental protection (926 NGOs), health services (339 NGOs), AIDS and drug control (48 NGOs). Some NGOs are making excellent progress and contributing towards conservation and pollution control. King Mahendra Trust for Nature Conservation (KMTNC established by an Act in 1982), Nepal Forum of Environment Journalists (NEFEJ est. 1983), Environment and Public Health Organization (ENPHO est. 1990), Resources Himalaya Foundation (est. 2004) are but few names that have come up as leading organizations in their sectors.

Community forestry is Nepal's success story of how sustainable development could be achieved through conservation of natural resources by local people. In Nepal, forests handed over to the local communities before and after 1990s were all degraded. These forests today have emerged as important carbon sinks. Thanks to 14,000 user groups that have mobilized 35% of the Nepal's population and managed 25% of the total national forests area as community forest to check the degrading state of forests (Karky 2005).

The private participation in science and technology related sector is more dramatic in education. Out of 214 higher secondary schools that are offering science courses, very few are government-supported schools (HSEB 2004). In fact, even these government-supported public schools manage their +2 programs themselves. Similarly, private colleges are providing higher studies in medicine and engineering. Private investment is also seen in industries specifically in IT sector, natural resources and agro-based settings.

CHAPTER 4

DEVELOPMENT PLANS & SCIENCE POLICY

Legal Framework for S&T Development

The Constitution of the Kingdom of Nepal 1990 requires the State to give due priority to science and technology. Article 26 (11) proclaims: *the State shall adopt policies rendering due priority for the development of science and technology and the local technologies as well*. The statement is made under the Directive Principles and Policies of the State, which constitute the main guidelines of state's activities (However, such articles are legally unenforceable. Section 9 in the National S&T Policy 1989 deals with administrative, financial and legal measures for the development and promotion of S&T, manpower development and utilization, research and development, so far no Acts or laws relating to these issues have been brought forward.

Thus, there exists no direct legal framework to facilitate the development and promotion of S&T in Nepal. There are some Acts which bear indirect relations with the development of S&T, such as the Nepal Industrial Development Corporation Act 1959, Patent Design and Trade Mark Act 1965, Industrial Enterprise Act 1981, Foreign Investment and Technology Act 1981, Industrial Enterprise Act 1982, RONAST Act 1990 and Water Resources Act 1992. Similarly, there are over half a dozen Acts and Rules/Regulations related to biodiversity and environment protection (Yonzon & Bhuju 2000). For examples are the Aquatic Animals Protection Act 1961, National Parks and Wildlife Conservation Act 1973, Soil and water Conservation Act 1982, Forest Act 1993.

Political Parties and Their Commitment to S&T

People’s movement in Nepal reinstated the multi-party political system in 1991 and introduced new Constitution. In the Part-III of the constitution, citizen’s equality, freedom, choice of religion, information and education have been mentioned as their basic rights. Beside these, the Constitution has included Directive Principals and Policies for economic growth and social uplift. The Part-IV of the constitution has included the issues of the augmentation of agriculture production, restoration of clean environment, utilization of natural resources, development of science and technology and extension of health services.

The last general election for the House of Representatives was conducted in 1999. Altogether 42 political parties participated in the election. The major parties in the run were: Nepali Congress (NC), Communist Party of Nepal- United Marxist Leninist (CPN-UML), Nepal Sadvawana party, Communist Party of Nepal- Marxist and Leninist (CPN-ML), Rastriya Prajatantra Party Thapa faction (RPP-T), Rastriya Prajatantra Party- Chand faction (RPP-C), Nepal Workers and Peasants' Party (NWPP), United People's Front (UPF) and Green Party of Nepal (GPN). The first six parties were also involved in government formation. Bhuju (1999) has analyzed the commitment of these political parties based on their election manifesto (Table 33).

Table 33. S&T issues and commitment of political parties in their manifesto

SN	*Program*	*NC*	*CPN UML*	*NSP*	*CPN ML*	*RPP-T*	*RPP-C*	*NWPP*	*UPF*	*GPN*
1	Agriculture production									
	Special priority in irrigation	√	√	√	√	√	√	√	√	√
	Establishing chemical fertilizer industry in the country	√	√	x	√	√	x	√	x	x
	Research and development	x	√	√	√	x	x	√	x	x
2	Natural resources: Conservation & use									
	Maximum use of hydropower	√	√	√	√	√	√	√	√	√
	Explore market for electricity export	√	x	x	√	x	√	√	√	√
	Importance of biodiversity	√	x	x	x	x	x	x	x	x
3	Environmental concern									
	Need of clean & balanced environment	√	√	√	√	√	x	√	√	√
	Forest degradation	√	√	x	√	x	x	√	x	√
	Environmental awareness	x	x	x	√	√	x	√	x	x
4	Development of science & technology									
	Increase investment on research	√	x	x	√	x	x	x	x	x
	Planning and infrastructure development	x	√	x	√	x	x	√	x	x
	Promotion (awards, conducive env.)	√	√	x	√	x	x	√	x	x

Source: Election manifesto of the political parties for general election 1999

Increasing agriculture production

All the parties have singled agriculture sector as the main economic backbone of Nepal. They mentioned the importance of irrigation with special emphasis. The Nepali Congress promised to deliver water supply to all irrigable land within 20 years, while CPN-UML and CPN-ML proclaimed to do the same within seven years of time. Both factions of RPP-T and RPP-C did not mention such time frame; however, they voiced support for the green revolution. The NC proposed to establish chemical fertilizer industry within five years; CPN-UML was in favor of feasibility study first, while CPN-ML even proposed a site in Dhangadhi of far-western Nepal. The NWPP also mentioned about the need of such an

industry. The rest of the political parties were all for providing chemical fertilizer at subsidy. On the issue of increasing budget for agriculture research, NC, RPP-T, RPP-C, UPF and GPN were found silent. However, NSP and CPN-ML proposed to establish an agriculture university in the country.

Utilizing natural resources

All political parties categorically mentioned about the rich natural resources of the country in their manifesto. There was no opinion conflict on the issues like: exploitation of water resources, distribution of electricity to all parts of the country and making economic benefits from hydroelectricity. The political parties also stated about national interest while utilizing the water resources. Nepali Congress had put special emphasis on export of electricity to India. It is noteworthy that the first government of Nepali Congress formed after the election in 1999 had to step down on the issues of Mahakali River. This led to the formation of at least four governments and dissolving the House of Representative finally in 2004.

The political parties did not fail to mention about medicinally important herbs, forests and forest products of the country. However, they were not much aware about the importance of biodiversity and its role in ecosystem. Except the Nepali Congress, the political parties have not mentioned about the issue and its conservation.

Environmental concern

Almost in a similar way, the political parties showed their deep concern about the environmental degradation. However, the RPP (Chand) missed to trumpet the tune. Nepali Congress and CPN (UML) had attractive slogans on the promotion of clean and balanced environment. The CPN (ML), RPP (Thapa) and NWPP were found to put special emphasis on upgrading environmental awareness. The manifesto of the parties gave importance of industries and transports for national development. However, only NC, CPN (ML) and NWPP cautioned about the pollution entailed with such development. On the issue of environmental degradation, majority of the parties (NC, CPN UML, CPN ML, NWPP and GPN pointed out the deforestation.

Science and technology

The directive principal of Nepal's constitution have mentioned about the role of science and technology in national development. Four political parties, viz. NC, CPN-UML, CPN-ML and NWPP were found to realize the spirit of this article. The CPN-UML showed its commitment to prepare tangible plan for the development of science and technology, while NWPP emphasized on the importance of strengthening agriculture research centers and science academy. These parties have also emphasized on the need to recognize the talents of the country and create conducive environment for them. Some of the parties have shown

their concern on the increased trend of brain drain especially in the field of science and technology. The NC and CPN-ML have also called for substantial increment in the investment for scientific research and development.

Development Plans

Since Nepal adopted the planned development, its development strategy has been in the socioeconomic growth with basic needs fulfillment, rural development, equity distribution, peoples' participation and employment generation. At present, the Tenth Plan (2002-2007) is in operation. The early efforts were focused on building the infrastructure such as roads and communication networks. Being an agricultural country, the agriculture sector has received due priority throughout the annual and periodic plans. The first five-year plan was prepared in the form of a draft by the Government of Nepal in 1956. The draft contained frequent use of phrases like scientific way of production, scientific basis, scientific research, use of scientific knowledge and technology indicating a realization of important role of science in the development process (Government of Nepal 1956).

The National Planning Council under the Ministry of Fiscal Planning prepared the second and third national plans. Later, the Council was reorganized as the National Planning Commission, which came under the Prime Minister. However, the succeeding plans till the fifth followed the basic principles of the first plan regarding policies, plans and programs. The emphasis given on industrial development by the fourth and fifth plans helped establish the Nepal Industrial Development Corporation (1959) and bring the New Industrial Policy (1974). For S&T sector, on the other hand, it took 25 years to be explicitly mentioned in the development plan.

Although the country initiated its planned development with the introduction of 1st Five Year Plan in 1956, it was only in the 6th Five Year Development Plan (1980 - 1985) that an explicit S&T policy statement was made by the National Planning Commission of His Majesty's Government. In this way, it took nearly 30 years after the advent of democracy that S&T sector was recognized as the vehicle of national development. Some major features of the plans (from Sixth) are briefly described here.

Sixth Plan (1980-1985)

It was in the sixth plan that an explicit S&T policy statement was made for the first time by the National Planning Commission of His Majesty's Government of Nepal. The newly created National Council organized a national level science convention in 1978 in

Kathmandu for Science and Technology (est. 1976). The convention recommended a science policy to be included in the Sixth Five Year Development Plan.

The special emphasis of the Sixth Plan, however, was on raising agricultural productivity, utilizing natural resources and expanding services such as education and health. The objectives of Sixth Plan were: to increase national productivity by linking the development of S&T with the socioeconomic development, to increase the national capability in S&T through manpower training, research and development activities, exchange of knowledge and appropriate management and to inform the people at large on the use and utility of S&T.

Seventh Plan (1985-1990)

The Seventh Plan stressed on meeting the basic needs of the people viz. food, shelter, clothing, education, health and security and quantified the basic requirements by the Asian standard. The key features were to meet the people needs on sustainable basis from the countries own resources, to increase economic growth through agricultural development, industrialization and natural resource utilization. On utilization of natural resources the plan aimed at making water resources as a strategic factor and utilize for irrigation, power energy and drinking purposes.

The seventh plan, while mentioning the importance of S&T development to fulfill the basic needs, stressed on the need of creating public awareness on the use of S&T. It also emphasized on continuous search for appropriate technology, including the development of indigenous technology. The objectives of the Seventh Plan were: to develop S&T in the same pace as economic and social development, to upgrade the capability of Science and Technology and to expand the use of S&T by bringing awareness to the people on its utility and value.

Eighth Plan (1992-1997)

The Eighth Plan admitted that there was a lack of coordination in the activities of different S&T institutions. Yet another concern shown was the inability to link development of S&T with the production and productivity in economic sector. The plan observed that there was neither sufficient import of appropriate foreign technology nor enough efforts to develop traditional technology. The economy could not benefit properly due to the lack of proper dissemination of information on the available technology.

The objectives of the Eighth Plan were: to develop S&T in a way that they could support the all round development, to support rural development sectors such as agriculture, cottage and

small-scale industries by enhancing the scientific and technological capabilities available, to encourage the import of foreign technologies that has a direct bearing on the country's economic development.

Ninth Plan (1997-2002)

The Ninth Plan came out with a few new features such as (i) preparing for the first time a long term 20 years S&T plan, (ii) according greater priority for developing alternate energy and promoting information technology, (iii) popularizing and creating awareness of S&T to urban as well as rural masses through informal means of education and (iv) stressing the importance of R&D in all the existing government as well as private institutions. The main goal set by the plan was to alleviate poverty through the application of S&T. It aimed at ensuring that the benefits of S&T will be made available to the rural and less privileged populace and that the S&T activities will not be confined to the urban elite but will also be initiated at districts, municipalities and village level. The objectives of the Ninth Plan covered following major points:

- S&T will be applied in achieving national objective and maintaining sustainability in economic, social, cultural and environmental perspectives.
- Traditional rural technology useful in agriculture, cottage and small industries will be promoted.
- Advanced technology with comparative advantage will be adopted to reduce foreign trade deficit.
- The message of usefulness of S&T to ordinary people will be propagated.
- Research will be encouraged in institution of higher education. Standard curricula of science and mathematics will be introduced in schools.
- Necessary encouragement will be provided to R&D agencies established in the government, the private and the non-government sector and to all scientists and technologists.
- Traditional energy sources will be supplied to the rural community to increase its income.
- New technology will be adopted to improve energy use efficiency and minimize negative environmental effect in rural community.
- Hydro and meteorological services will be expanded and upgraded.

Tenth Plan (2002-2007)

The ongoing Tenth Development Plan (2002-2007) emphasizes on the need to achieve GDP growth of seven percent during the plan period and the following consecutive two plans in order to reduce the number of people living below poverty line to 10 percent by 2017 from over 38% in 2004. It is envisaged that the tenth plan would pay a special attention in poverty alleviation by enhancing production and productivity through the maximum utilization of science and technology including the established infrastructures in the country.

The tenth plan will focus on mobilizing available physical and human resources, strengthening institutional and administrative sector to activate research agencies, attracting private sector in research activities; encouraging proper and qualitative researches; stressing in the development; and extension and use of information technology and bio-technology. Similarly, creating conducive environment for transfer of technology and foreign investments, disseminating information related with outcome of scientific researches and their uses, producing highly skilled manpower and enhancing local technology are other focus areas of the plan.

With the objectives of helping people to uplift their socio-economic condition, the Ministry of Science and Technology will play a role of promoter and facilitator and will provide necessary guidelines to ensure qualitative development of research institutions. It will also extend an effective cooperation to various institutions involved in research and development activities, like universities, councils and academies. It will help coordination between national and international research institutions, enhancing institutional capacity and effective mobilization of resources.

On science and technology sector the Tenth Plan has taken a Long Term Vision of uplifting the economic status of people through the development, improvement and utilization of science and technology in a sustainable manner and contributing in achieving the national goal of alleviating poverty through creative use of science and technology (physical, human and academic) via institutional development by making the science and technology sector timely and using it as an effective medium to increase national production and productivity.

On the development of science and technology the Tenth Plan aims at developing of science and technology and its use in achieving a sustainable and overall development of the country through maintenance and improvement of traditional technologies that can contribute in the rural development including the research and development of practical technology and to extend necessary contribution to make children, women and deprived section economically independent through science and technology.

Similarly, coordinate efforts to fulfill local demands and develop science and technology will generate additional income activities in the rural areas and it would be beneficial for the targeted group. In this regard, following are the major strategies of the sector:

1. Ensuring maximum utilization of available resources and means in the science and technology sector and to arrange additional infrastructures and institutions as per the need.
2. Developing and adopting appropriate technology through the mobilization of private sector in the development of science and technology and import of appropriate foreign technology.
3. Developing of a mechanism to conduct research and development activities in a competitive manner among individuals, communities and institutions engaged in science and technology.
4. Contributing in the socio-economic development of people through the development of knowledge and skills in the science and technology sector and sustainable use of natural resources and means.
5. Encouraging universities, concerned institutions and individuals in scientific researches and generating high-skill scientists by giving special priority to science and technology in the higher-level education.
6. Expanding and developing water and meteorological services.

Review of the Development Plans

Since Nepal initiated development plans in 1956, nine periodic plans have been implemented. The major objectives, policies and programs remain almost the same in the plans except some sectoral emphasis they have given according to the government's policy. All three development plans have emphasized on the need of coordination among S&T institutions, mobilization of human and natural resources, manpower training, information services, selection and transfer of appropriate technology and promotion of indigenous technology.

Table 34 presents the total budget of the development plans and their sectoral distribution. The size of the budget has increased substantially (nearly 575 times) from Rs. 330 million in the first plan (1956-1961) to Rs. 189,580 million in the seventh (1985-1990). Up to the fourth plan (1970-1975), the efforts were towards building up physical infrastructures particularly related to transportation. The shifting of emphasis towards basic needs took place from the fifth plan (1975-1980) and continued to the seventh plan. It was in the seventh plan that a separate budget allocation for S&T sector (Rs. 73.2 million or about

0.14% of the total outlay) was introduced. After the political upheaval in 1990, the priorities of basic needs continued in the name of poverty alleviation. With the establishment of the Ministry of Science and Technology in 1996, the S&T budget increased. But the budget shares only 1.1% of the total outlays.

Table 34. Total outlays and their sector-wise distribution in percent in development plans

Periodic Development Plan	*1st 1956-1961*	*2nd 1962-1965*	*3rd 1965-1970*	*4th 1970-1975*	*5th 1975-1980*	*6th 1980-1985*	*7th 1985-1990*	*8th 1992-1997*	*9th 1997-2002*	*10th 2002-2007*
Total plan outlay (Rs. in million)	330	670	2500	3540	9170	22300	54110	129565	189580	234029
Sectoral distribution in percent										
Agriculture, forest & irrigation	31.4	14.3	25.9	33.1	33.4	33.2	31.9	26.2	27.1	24.0
Transportation & communication	33.8	23.5	26.8	35.4	27.5	21.4	15.4	21.8	17.6	15.9
Industry, mining & power	16.7	30.9	27.9	20.3	19.5	24.6	22.5	15.1	19.5	16.1
Education, health & drinking water	17.1	17.4	16.6	10.8	18.5	20.8	30.2	33.3	33.3	38.7
Science & Technology	-	-	-	-	-	-	0.1	-	0.2	1.0
Trade & tourism	-	-	-	-	-	-	-	1.0	1.5	1.5
Land & housing finance	-	-	-	-	-	-	-	-	0.1	1.2
Miscellaneous	1.0	13.9	2.8	0.4	1.0	-	-	2.6	0.9	1.8
Total	100	100	100	100	100	100	100	100	100	100

Source: National Planning Commission, HMGN

As it was evident, the science and technology received its due place in the country's development plan for the first time in the Sixth Plan (1980-1985), which indicated the need of S&T for their application in development works. It was the seventh plan (1985-1990) that called for the enhancement of endogenous S&T capabilities through the integration of S&T activities with basic objectives of economic development. It is to be observed that the sixth plan came out after the establishment of National Council for Science and Technology (NCST) under the National Planning Commission and the seventh plan came after the establishment of Royal Nepal Academy of Science and Technology (RONAST) as an autonomous institution.

The Eighth Plan, which was implemented following the restoration of multi-party system, set the objectives of attaining sustainable economic growth, alleviating poverty and reducing regional disparity. It emphasized on the need of coordination among different S&T institutions of the country, mobilization of human and natural resources, manpower training, information services, selection and transfer of appropriate technology and promotion of indigenous technology. The Eight Plan also underlined several priorities especially in agricultural intensification and diversification, energy development and rural infrastructure development. During the period of this plan, Agriculture Perspective Plan was prepared. This Plan gave a clear direction to national development programs. Similarly, two new

universities Kathmandu University, Purbanchal University were established and Pokhara University was proposed for establishment.

The Ninth Plan was formulated in the context of growing people's aspirations following the restoration of multi-party democracy in 1991 and its main objective was poverty alleviation. The plan incorporated promotion of S&T education and traditional technology, import of appropriate and advanced technology management mechanism and a science information center as the major activities. Similarly, necessary measures to curb national brain drain by making the professions of scientists and technologists attractive and an incorporation of a separate program for the development of alternative energy were other major activities initiated in the Ninth Plan.

With an aim to raise the educational quality of S&T from primary level and to improve the quality of vocational and technical education up to the international level, various national universities launched information technology (IT) and the participation of private sector in the IT sector also increased during the Ninth Plan. In this regard, grant assistance has been extended to different universities to accelerate the development and expansion of IT education and Tribhuvan and Kathmandu universities introduced IT courses at the higher level. Similarly, with an objective to expand IT education in the high school level, computers along with Internet services were provided to them. RONAST formulated a 20-year national plan on S&T but remained unimplemented. Despite the initiation of some activities in conserving and promoting traditional technologies, no remarkable progresses were made in importing of utility-friendly necessary technologies.

The running Tenth Plan, being the first one leading to 21st century, is destined to enhance the concept of developing cultured, competitive, affluent and equitable Nepali society reflecting the ultimate aspirations of the people.

As the scientific indicators are lacking, it is hard to assess the impact of S&T on the development plan of Nepal (Shrestha 1996). While formulating the development plan, the sectoral S&T activities are collected from the sectoral ministries. These are then incorporated under the respective program of the sectoral ministries. This was the practice started in the inception of the development, and it still persists. Similarly, the monitoring and evaluating the S&T development activities are more from the techno-management aspects than from the impact and contribution of S&T results on the socio-economic development.

Science and Technology Policy

Arguments for the need of a National Science Policy began to be raised at different scientific forums during early 1960s. Although many politicians, planners and scientists were conscious of the need for a better co-ordination of national efforts in the scientific field, there were no legislative provisions or regulations nor any national institution to promote such co-ordination. The Ministry of Education tried to set up a suitable board to undertake some coordinating measures but this idea found little support from other ministries. Consequently, His Majesty's Government of Nepal (HMG) sought the assistance of UNESCO to advise the government on formation of a body for the formulation of a Science Policy (Bajracharya 2001).

In 1966, a detailed survey of scientific infrastructure was prepared under the commission of UNESCO. The report provided an up to date inventory of the scientific structures then existing and stressed their inadequacies. The Second General Assembly of the National Commission for UNESCO held in 1966 for the first time recommended for a long-term science planning on a national scale. During the assembly, the Science and Technology Sub-Committee also proposed the establishment of National Council for Scientific Research for the co-ordination and implementation of scientific research activities (NNC/UNESCO 1966). There were some opinions that it was necessary to strengthen the University's scientific potential before setting up such a National Council.

In 1968, UNESCO sent an expert, Dr C.Muller-Daehn to Nepal to investigate into the prevailing situation in Science and Technology and submit necessary recommendations. After consultation with local experts, he submitted a report recommending the establishment of a National Science Policy making body, the National Science Board (Muller-Daehn 1968). It was proposed that law to provide it with necessary authority and prestige as well as the material and technical means to carry out its functions properly should enact the creation of such a board. The organization and coordinating functions of the board should be integrated into the framework's science policy and National Development Plan. The following recommendations were made which should be taken into account while drafting the law for the National Science Policy-Making body:

- The National Science Board should be directly responsible to the Government through the Prime Minister.
- The National Science Board should work in close collaboration with the Ministry of Planning to ensure adequate allocation of resources for Science and Technology and advise on the role of science and technology in national development.

- Membership of the National Science Board should include senior scientists and technologists.
- National Science Board should allow for standing commissions where continuing problems of science policy and research are discussed. A series of temporary science research committees or special science policy committees should be set up whose membership would include individuals chosen solely on the basis of their professional qualifications.
- The National Science Board should be the focal center for scientific contacts with foreign Governments and international scientific organizations and responsible for ensuring the coordination's scientific activities at the national, regional and international levels.
- The National Science Board should have a Secretariat (Office for Science and Technology) with a Secretary-General who, by preference, should be a scientist or engineer. This secretariat should be accommodated in the Office of the Prime Minister.

During the third General Assembly of the Nepal National Commission for UNESCO held in 1968 in Kathmandu, the Science and Technology Sub-Committee again emphasized the urgent need for the establishment of a national body to promote and coordinate scientific research in Nepal. It also urged that the Science Policy should form an integral part of the overall national planning. For this purpose, it was suggested that National Council for Scientific and Technological Research be set up. The Sub-committee also urged that Nepali research should be concentrated, at least in the initial stage, on certain sectors of particular importance for the country's development, such as high-altitude ecology. Similarly, the national Science Policy should deal with the two following closely linked aspects. Firstly, a gradual development of the national scientific and technological potential for its own sake should be ensured. Secondly, the creative and assimilative forces inherent in that potential should be utilized to the fullest possible extent to attain the objectives of the general developmental policy. In addition, the Sub-Committee put forward following recommendations to the Nepal National Commission for UNESCO with a view to placing them before His Majesty's Government:

- Promotion of application of science by the common man through the full use of mass communication techniques, functional literacy programs, science clubs and fairs, cooperation with national and international organizations.
- Improvement of science education at all levels.
- Development of agricultural and industrial education.
- Establishment of an International Institute for Ecological Studies of the Himalayas.

- Establishment of polytechnic institutes.
- Establishment of a National Documentation Center

In the same year, UNESCO sent Prof. J. Ruffle to Nepal in order to communicate Dr.Muller-Daehn's report to the Nepali authorities and find out their reactions to the report. He carried out further consultations on the recommendations made by the Science and Technology Sub-Committee during the third General Assembly of the Nepal National Commission for UNESCO. At the conclusion of his visit Prof. Ruffle made the following recommendations:

- Setting up of National Science Policy Council under the administrative control of the National Planning Commission (and, consequently, of the Prime Minister) to advise H.M.G. on the preparation of a national science Policy and to supervise the implementation of the decisions taken in this matter. This National Science Policy Council would have a permanent Secretariat also under the control of the Prime Minister and directed by a Secretary-General.
- Setting up of a Nepalese Center of Scientific Research and Information to ensure scientific coordination of all the research activities in Nepal, to organize symposia and seminars, to draw up research programs in accordance with the National Science Policy Council and to draw up an annual report on the situation in regard to scientific research. The Center would be funded in part by the State budget and in part by foreign aid.
- Promotion of the research activities in the government institutions and the university in close collaboration with foreign research teams, in accordance with the science policy defined by the National Science Policy Council.
- A Nepalese expert should visit certain countries in order to study the organization of scientific research at the national level.

After careful study of the reports submitted by the UNESCO consultants, the Ministry of Education made following recommendations to His Majesty's Government regarding the establishment of a National Science Board:

- The Prime Minister should be the Chairman of such a board. The Education Minister, the Vice-Chairman of the Planning Council and the Vice-Chancellor of Tribhuvan University will be ex-officio members. Membership of the Board should also include famous scientific workers and also the Chief Secretary of HMG.
- The functions of the board should be:

  (a) To help and advise HMG in all matters concerning the plan and program in the field of Science and Technology.

(b) To recommend the names of the participants to different regional and international seminars and conferences dealing with science.

(c) To recommend training of scientists in different countries of the world in accordance with the need of manpower for the scientific activities.

(d) To advise the Ministry of Education, the University and other concerned Ministries for the development of science education, agricultural education and other technical training

(e) To publicize and disseminate scientific ideas and thinking with the help of the University and other scientific research organizations.

(f) To create a well-organized national Documentation Center.

(g) To advise the National Planning Council in matters regarding the short term and long term plans of Science and Technology.

(h) A top scientist should be nominated as the secretary-cum-member of the Board and should work directly under the Prime Minister. The Secretary should also be nominated as a scientific member of the Planning Commission.

This shows that the establishment of a national institution on Science and Technology to coordinate S&T activities and to formulate a National Science Policy was recommended as early as 1966. But it was only after nearly 10 years that such a body was indeed established. In 1976, the first such organization- the National Council for Science and Technology (NCST), was established. The NCST was constituted as an advisory body on S&T to the government. However, contrary to earlier recommendations that such a national institution should be established directly under the chairmanship of the Prime Minister, the council was constituted under the chairmanship of the vice-chairman of National Planning Commission. Nevertheless, it was a first step towards coordinating the S&T activities.

The main objective of the NCST was to formulate a national Science and Technology policy. The council contributed to the formulation of the first Science and Technology policy that was mentioned for the first time in the Sixth Five Year Development Plan (1980-1985). With the passing of time it was felt that the council, due to the nature of its leadership and the advisory role, lacked the necessary political authority as well as the resources to carry out its functions satisfactorily. In 1982, yet another body to coordinate Science and Technology activities was established – the Royal Nepal Academy of Science and Technology (RONAST). The Academy, which was also established as per the Royal Directives of the Late King Birendra, enjoyed the direct leadership of His Majesty the King as its Chancellor. The members of the academic assembly, the highest policy making body of the Academy, included as members, the Prime Minister, Minister of Finance, other top officials of the government and distinguished people from different walks of life including Science and

Technology. In contrast to the NCST, which had an advisory role only, the Academy was envisaged to function as a working academy with its own administrative unit, laboratories and full time researchers. Although both the Council and the Academy continued to exist together, RONAST gradually replaced NCST as the main national organization responsible for the coordination of Science and Technology activities.

The first comprehensive proposal of National Policy for Science and Technology was prepared in 1988 by RONAST and submitted to His Majesty's Government of Nepal for implementation. The proposal emphasized the need of development and mobilization of S&T to increase production and productivity in the areas specified as of strategic importance and value in achieving the socio-economic goals and targets for fulfillment of basic needs, rural development and human resource generation (Rana 1988). The proposal also defined aims and objectives, priorities, plans, programs, strategy, infrastructures, administrative, financial and legal measures, organizational framework and resource mobilization for the development of S & T. The policy was promulgated by His Majesty's Government of Nepal in 1989 through the Nepal Gazette (HMGN 1989). But the policy proposal could not be implemented, because shortly after there was a major political change. Necessary research and development in the field of S&T will be undertaken for attaining the goal of national development.

(i) Manpower needed for the development of S & T will be identified, developed and mobilized and efforts will be made to fill up the requirement.

(j) Necessary technology for the country will be imported and transferred and efforts will be made to adapt them steadily.

(k) Financial resources and means will be extensively mobilized for the development of S & T and the fields related to it. In this context, the end of the 9th Plan will make provisions for the investment of one percent of GDP in the development of S&T.

(l) Values and achievements of S & T will be protected, promoted and extended.

(m) In order to develop S & T and to mobilize, protect and encourage the manpower related to it, administrative and legal provision will be made for attracting a great number of skilled manpower.

In this way there were three major attempts to formulate national Science and Technology policy since the establishment of NCST. In addition, several working groups were formed in the past by the government, NCST and RONAST to formulate national policies and plans of action for Science and Technology. Similarly, several national conferences and seminars were organized by NCST, RONAST, Ministry of Science and Technology to deliberate on the issues of S&T and recommend the measures to implement the policies and programs. All

such deliberations have led to very similar recommendations. But these recommendations have failed to draw enough attention of the government and not necessarily adopted.

Long-term perspective plans have been prepared for the sectors like agriculture, forestry and energy. However, similar long-term plans have not yet been prepared for Science and Technology although the Ministry of Science and Technology has announced the plan to prepare a 20-year plan and program for Science and Technology. While several recommendations on policies, such meetings have made plans and programs, these efforts have met major difficulties in their implementation.

One of the main problems in the implementation of S & T policies is the lack of adequate political commitment and continuity in the government attitude. For example, while inaugurating the 2nd National Conference on Science and Technology in 1994, the then Prime Minister pledged to double the investment in S&T within the next fiscal year and bring it to the regional level within next five years (RONAST 1994). Being announced by the first popularly elected Prime Minister of the country after the restoration of democracy, the S&T community took it as a major and encouraging policy statement. But with the change of the government, the commitment was soon forgotten.

Similarly, there has been a big gap between the policies and practices and between the programs and performances. In 1989, late Prof. Abdus Salem visited Nepal to attend the International Summer School in Physics organized jointly by Tribhuvan University, RONAST and Third World Academy of Sciences. During this visit, he proposed the establishment of an International Center for Science and Technology. He assured his help in mobilizing manpower and financial resources at the international level to help establish and run such a center. Accordingly, the government set up a high level committee to prepare a proposal for the establishment of such a center. The proposal was submitted to the government in 1990 (Gajurel et al. 1990). Although late Abdus Salem showed personal interest in the establishment of the center, the proposal could never be implemented due to the lack of firm commitment from the government. Similarly, Tribhuvan University prepared a 15-year plan and program to strengthen S&T education (Gajurel et al. 1987). The Federal Republic of Germany, in principal, had agreed to provide with the financial and technical assistance to implement the plan and had even sent experts for project appraisal. With the change in leadership in Tribhuvan University, the project was soon forgotten.

In 2005, the Ministry of Environment, Science and Technology have promulgated a national policy on science and technology (MOST/HMGN 2005). Realizing the fact that science and technology plays a significant role in the overall development of each country and to attain the desired objective by harmoniously streamlining to a particular direction the activities of

governmental and non-governmental institutions and organizations involved in such activities as research and development, teaching, training, management and service delivery regarding the science and technology, His Majesty's Government has, therefore, issued this "Science and Technology Policy, 2061 (2005 AD)" with a vision to build the country as a developed, dynamic and prosperous state by raising the living standards through the appropriate development and use of science and technology.
The policy has taken three objectives as follows:

1. To enhance the national capacity through the appropriate development and use of knowledge, skill and efficiency in the field of science and technology;
2. To assist in the poverty reduction activities by utilizing natural means and resources in a sustainable manner through the use of science and technology and by promoting social and economic status of the people and protecting and preserving environment;
3. To elevate the country to a competitive position through the optimum development of science and technology.

With the issue of this new Science and Technology Policy, 2046 (1990 AD) has hereby been repealed. The Ministry had presented the draft of the policy at the Fourth National Conference on Science and Technology organized by RONAST in 2004. There was heavy criticism from the floor on the policy, specifically on the process that it followed. The ministry has not published or brought it for discussion on scientific forum before making it a final.

Research and Development

Research Institutions

There are three major sectors consisting research and development programs in Nepal: i. Government laboratories; ii. University departments of higher studies; and iii. Autonomous institutions. A few research laboratories at private initiatives have also emerged in recent years. While research works carried out in laboratories of government department focus mostly to their respective components, most of the research carried out in university departments is dissertation based academic works. Autonomous institutions like RONAST, RECAST and NARC have their own priority areas defined by the institutional objectives (Table 35).

A major contribution of research papers to the science conferences came from Tribhuvan University. In the last two conferences the contribution of Tribhuvan University far exceeded the contribution of government laboratories. Contribution of Tribhuvan University

in the field of biological and physical sciences is especially significant. Contribution to the national science conferences by the government laboratories is clearly on decline. While the contribution of government laboratories exceeded 50% in the first science conference held in 1982 it declined to less than 20% in the last conference held in 1999.

Table 35. Major research areas in some Science and Technology Institutions in Nepal

SN	***Institution***	***Major Research Areas***
1.	Central Department of Botany, TU	Plant Physiology, Plant Biotechnology, Plant Biochemistry, Cytogenetics, Plant Pathology, Mycology, Plant Taxonomy, Plant Ecology, Ecophysiology Plant Biodiversity, Ethnobotany
2.	Central Department of Chemistry, TU	Natural Product Chemistry, Electrochemistry, Radiation Chemistry, Sulfur Chemistry
	Central Department of Geology, TU	Applied Geophysics, Geological Mapping, Palaentology, Climate Change and Glaciology, Petrology, Hydrology, Chemical Modelling, Ground- and Surface Water
	Central Department of Mathematics, TU	Algebra, Fluid Dynamics, Special Functions, Classical Analysis, Complex Analysis (Univalent Function), Integral Transform,
	Central Department of Meteorology, TU	
	Central Department of Microbiology, TU	Medical Microbiology, Food Microbiology, Agricultural Microbiology, Environmental Microbiology
	Central Department of Physics, TU	Astrophysics, Environmental Physics, Condensed Matter, Polymer, Plasma Physics
	Central Department of Statistics, TU	Sampling Theory, Demography,
	Central Department of Zoology,TU	Parasitology, Entomology, Ecology, Wetland Ecosystem, Fisheries
	Research Centre for Applied Science and Technology (RECAST)	Solar Energy, Biomass Briquteting, Bio-fuel and improved cooking stoves, Natural Dyes, Natural Products, Crop Science and Medicinal Chemistry, Technology Testing and Transfer
	Institute of Agriculture and Animal Sciences, TU	Wheat Improvement, Rice Improvement, Orobanche Management, Biological Control, Irrigation Management, Agronomy, Pathology, Horticulture, Entomology, Animal Sciences, Veterinary Sciences
	Institute of Engineering, TU	Hill Irrigation, Air Pollution, Passive Solar Heating, Building Design, Renewable Energy, Urban Land Management, Urban Regeneration, Seismic Resistant Design
	Institute of Forestry, TU	Social Forestry and Forest Management, Forest Products and Forest Engineering, Wildlife Management, Silviculture, Forest Biology, Community Forestry, Ecotourism, Farm Forestry, Watershed Management, Environmental Science

Institute of Medicine, TU	Opthalmology, Obstretics and Gynaecology, Paediatrics, Orthopaedics, Radiology, Internal Medicine, Public Health, Pathology, Otorhinolaryngology, Anaesthesiology
School of Science, Kathmandu University	Chemistry, Mathematics, Statistics, Physics, Environmentla Science. Pharmacy
School of Engineering, KU	Computing projects, Online translation system, Hydro turbines, Solar water heater for highaltitudes, Micro hydro, Energy
School of Medical Sciences, KU	Occupational health safety
Central Food Research Laboratory	Food Technology, Quality Control, Nutrition,
Department of Forest Research and Survey (DFRS)	Natural Forestry Management, Plantation Management, Tree Improvement, Agroforestry and Fodder Trees
Department of Mines and Geology	Mines, Petroleum, Seismology
Nepal Agriculture Research Council (NARC)	Cereals and Cash Crops, Horticulture, Livestock and Animal Health, Fisheries, Aquaculture, Fodder and Pasture, Agroforestry, Farm Forestry, Soil and Irrigation Management, Botany and Biotechnology, Entomology, Plant Pathology and Plant Protection, Farming Systems, Agri Economics and Marketing, Food Science, Agri Ecology and Environment, Socioeconomics and other related Fields of Agriculture
Department of Plant Resources (DPR)	Medicinal Plants, Plant Chemistry, Flora, Plant Taxonomy, Tissue Culture, Cytology and Cytogenetics, Plant Anatomy
Department of Hydrology and Metereology	
Department of Wildlife and National Parks	
Royal Nepal Academy of Science and Technology (RONAST)	Biotechnology, Natural Products, Environment, Alternate Energy, High Altitude Sciences and Technology, Science and Technology Policy
Purbanchal University	Engineering, Agriculture, Animal Science
Pokhara University	Pharmaceutical, Biomedical, Environment

Source: Respective Institutions

Government Departments

At government level, major departments involved in R&D activities are in the sector of agriculture, biodiversity and plant resources, forestry, hydrology and meteorology and survey. Two new centers Alternate Energy Promotion Center (AEPC) and National Information Technology Center (NITC) have also been formed under the Ministry of Environment, Science and Technology. S&T related departments like survey, roads, building are mainly service oriented and in routine works.

Department of Agriculture (DOA) is mainly involved in increasing food production and maintaining food security of the country. Some of its programs, however, also include R&D activities. There are 12 Directorates under the department and nine of them have some kind of R&D activities. Such Directorates are: Crop Development, Vegetable Development, Fruit Development, Commercial Insect Development, Fisheries Development, Crop Protection, Post Harvest Management, Soil Management and Agri-engineering. Beside central laboratories on fisheries and soil testing, DOA has regional laboratories of seed, soil test and crop protection at regional development regions of the country.

The Department of Plant Resources (DPR) is a responsible government organization in conducting research activities on biodiversity and plant resources. The DPR carries out its activities through two divisions: Natural Products Development and Plant Research. The major research activities are: phytochemical screening, pharmacological and microbiological tests, research on medicinal, aromatic and other economically important plants to find out pharmaceutically and industrially important compounds and development of technology for sustainable production of plant products. The National Herbarium and Plant Laboratory of DPR is the lead institution in conducting botanical exploration in Nepal. The Laboratory conducts anatomical and cytological studies of Nepali plants while maintaining the samples of plant specimens collected from various parts of the country. The Laboratory is also credited to initiate and popularize tissue culture techniques for mass propagation of commercially important plants such as chrysanthemum, orchids, potato, onion etc. in Nepal.

The Department of Forest Research and Survey (DFRS) is the only government designated forestry research and survey organization in Nepal that works in close collaboration with various national stakeholders and international agencies. The Department has two divisions: Forest Research Division (FRD) and Forest Survey Division (FSD). The FRD is engaged to develop appropriate technologies related to natural and manmade forest management, determining forest growth to increase productivity, identify suitable tree species for different site conditions and develop their nursery and silvicultural technologies. Research is also conducted in the field of agro-forestry and fodder production, tree improvement, socio-economic studies, utilization of forest products. The FSD generates baseline data and information necessary to plan overall forestry development at national, regional and district levels. The FSD has forest survey and inventory as the major activities complimented with remote sensing, cartography and photogrammetry.

The Department of Hydrology and Meteorology has a mandate from the government to monitor all the hydrological and meteorological activities in Nepal. The scope of work includes the monitoring of river hydrology, climate, agrometeorology, sediment, air quality, water quality, limnology, snow hydrology, glaciology, wind and solar energy. General and

aviation weather forecasts are the regular services provided by DHM. As a member of the World Meteorological Organisation (WMO), DHM contributes to the global exchange of meteorological data on a regular basis. At present, DHM is engaged in River Hydrology Meteorology Weather Forecasting Flood Forecasting Snow and Glacier Hydrology and Tsho-Rolpa GLOF Risk Reduction Project.

The Department of Survey provides all kind of maps required for research and management plans. It has two branches: Geodetic Survey Branch (GSB) and Topographical Survey Branch (TSB). The GSB has set up control stations for cadastral mapping works. These stations are now in use also to study the crustal movements of the Himalayas and involved in Geodetic Leveling, Gravity Survey's Astronomical Surveys and GPS Survey works. The TSB has produced an assortment of Land resource maps, Topographical base maps, Administrative maps and Digital database.

Alternate Energy Promotion Center was established in 1996 with an objective to develop and promote alternate and renewable energy technologies in Nepal. It is involved in conducting R&D programs of biogas, micro-hydro power, solar energy, improved cook stove, wind energy, improved water mill and geothermal energy. The National Information Technology Center (NITC) is tasked to promote and develop information Technology, making it accessible to the general public and increasing meaningful employment.

University Departments

At the university, research activities are carried out as a part of dissertation works. At the science faculty of Tribhuban University, there are 11 Central Departments have already been established. These departments have Master's and PhD programs. Beside these, some of the TU constituent campuses and affiliated colleges have started Master's degree programs. Thus, researches are conducted as a part of dissertation works in these facilities. As the departments lack well-equipped laboratory facilities, most of research activities are field based description and survey type.

All the four institutes of Tribhuvan University, viz. Institute of Agriculture and Animal Science, Institute of Engineering, Institute of Forestry and Institute of Medicine have also been running graduate programs. These programs offer research facilities to its students at Bachelor and Master's level. Similarly, academic research activities are also carried by Kathmandu University, Purbanchal University and Pokhara University in connection with dissertation.

Research carried out in the various departments and institutions at the university is mainly limited to the M.Sc and PhD programs. There is very little research activity in the campuses/colleges where such programs are not conducted. Most of the science campuses/colleges do not have basic infrastructure and the necessary environment to conduct research works although there are some qualified teachers to conduct research works. In addition to the student-related research works, some teachers carry out their research works with grant received from different national and international organizations.

Autonomous Organizations

Nepal Agricultural Research Council (NARC) was formed by the government as an apex institution for policy coordination and implementation of agricultural R&D in the country in 1991. Beside its research facilities at Khumaltar, Lalitpur, NARC has a nationwide network of 18 research centers coordinated by four regional levels. The major research divisions are on: agronomy, pathology, entomology, soil sciences, agri-engineering, agri-botany, horticulture, animal nutrition, animal breeding, animal health, pasture and fodder and fisheries. Presently NARC is allocating its research resources in priority themes and commodities identified by the Agricultural Perspective Plan (1997-2016) and its 2-year vision.

Research Centre for Applied Science and Technology (RECAST) constitutes the main research and development wing of Tribhuvan University. It aims at optimum utilization of natural resources including plant products and develops and disseminates socio-economically viable technologies for Nepal. Some major research activities of RECAST are: Exploration and Utilization of Renewable Oil resources, Bioprospecting of Ethno-medicinal Plants of Nepal for Conservation of Biological and Cultural resources; Development of Gassifier Stove for domestic use; Dissemination of Programme of Appropriate Technology for Micro and Small Enterprise development in Nepal; and Dissemination Programme on Indigenous and Traditional Rural Technologies for Micro and Small Enterprise Development in Nepal.

The mandated objectives of the Royal Nepal Academy of Science and Technology (RONAST) are to carry on research activities and technology development for the all-round development of the country. The research activities are carried out through the Faculty of Science and the Faculty of Technology. The major research activities in scientific research are: Bioprospecting of medicinally important plants, ecology and environment, organic farming. mycorrhiza, vermicomposting and citrus diseases. It has introduced PCR facility for DNA characterization. In the technology sector, RONAST has been involved in alternate energy such as natural force ferryboat, photovoltaic water pump and biobriquetting.

RONAST, in collaboration with Ev-K2-CNR of Italy, has established an international laboratory, the Pyramid, at an altitude of 5050m ASL in Khumbu valley of Sagarmatha National Park to facilitate research activities of the high altitude. With its self-sufficient power supply generated from a renewable source, solar and water in specific, the Pyramid offers a unique opportunity to study climatic and environmental changes, physiology and human medicine in extreme condition, ecology, geology, geophysics and seismic phenomenon. With over 500 missions carried out at the Pyramid since its establishment a decade ago, the project has become one of the main international cornerstones of high altitude and remote area scientific research.

Nepal Health Research Council coordinates health research programs in the country. The NHRC has the mandate and authority to approve, modify in consultation with the party involved or disapprove health research projects. It promotes and also conducts health research in Nepal. Such research projects are funded through various agencies including UN and WHO.

Private and Non-Government Organizations

The involvement of private and non-government organizations is steadily growing in the R&D sector in Nepal. Such involvement is seen mostly in natural resources based industries. In the plant science, there are several nurseries and a dozen of private enterprises involving tissue culture and other production activities. Some of the major such enterprises involving small to medium scale production are Agro Enterprises Center, Botanical Enterprises, Cosmos Herbal Product, Green Energy Mission, Himalyan Flora-tech, International Quality Herbal Industries, Microplant Pvt. Ltd and Nepal Bio-tech Nursery.

Since the government made conducting environment impact assessment mandatory, private organizations have been conducting surveys. Such survey mostly requires preparing baseline data through field research. The Environment Division of Ministry of Environment, Science and Technology coordinate the EIA programs. The new economic policy of HMG/N has opened door to foreign investors as well, such as Dabur Nepal. Some self-governing organizations such as King Mahendra Trust for Nature Conservation, Research Laboratory for Agricultural Biotechnology and Biochemistry, Resources Himalaya, Biodiversity Study Center, Institute of Biodiversity of Nepal, Nepal Nature dot Com have also been quite active in research projects.

The participation of private and NGOs is also encouraging in alternate energy sector. The Biogas Sector Partnership – Nepal has set a successful example of promoting biogas plants in Nepal. It is estimated that 100,000 biogas digesters have been installed, mostly in rural

areas, in Nepal covering all districts of the country except those 11 in the high altitudes. There are 64 pre-qualified biogas construction companies in the country (AEPC 2002). In urban area, solar water heating systems are quite popular, while in the rural areas the solar photovoltaic systems. There are 18 private companies for SHS and solar thermal installation. For quality control of PV system, RONAST has established a Solar Energy Test Station.

Nepal has made success in micro hydro projects as well. There are over 1371 micro hydro units of electrification schemes and 804 of mechanical schemes installed in the country. These schemes produce a total of 14578.6 kW of energy (AEPC 2003). There are 19 pre-qualified consultancy firms for carrying our feasibility study of micro hydro project up to 100 KW, eight for 60 KW and 17 manufacturing and installation companies (AEPC 2005).

In medicine, at the initiative of Nepal Netrajyoti Sangh and other non-government organizations, Nepal has made admirable progress in eye care and operation. The eye camps are organized in various rural areas regularly. These camps have been attracting a large number of patients even from India. Beside eye care and operation services, the Tilganga Eye Center in Kathmandu have developed its capacity to produce 150,000 intra ocular lenses. The lenses are used for the cataract patients and supplied to over 40 different countries including Australia and other developed countries.

Research Trends

Till 1960, research and development were mostly that of exploration type initiated by foreign scientists. The first such exploration was on plant resources done by F. Buchanan-Hamilton in 1802. On faunal diversity, it was by B. Hodgson in 1826. As the country was in self-isolation for 150 years, it was only in 1950 that a nationwide geological survey was possible under the UN program of technical assistance. Dr T. Hagen led the historic survey. Thus, the R&D activities were started with natural history and the legacy continued as new departments under various ministries were established after 1960.

Table 36. Subject-wise breakdown of papers presented in national conferences on Science and Technology

Subject	***1982[x]***	***1988[xx]***	***1994[xx]***	***1999[xx]***	***2004***
Agriculture	8 (16%)	40 (24%)	33 (18%)	**70 (19%)**	**120 (24%)**
Biological Science	**21 (41%)**	53 (32%)	32 (17%)	**97 (26%)**	**154 (31%)**
Physical Science	**18 (35%)**	20 (12%)	27 (14%)	**41 (11%)**	**144 (23%)**
Forest and Environment	**2 (4%)**	-	33 (18%)	**43 (12%)**	**33 (7%)**
Engineering and Technology	-	14 (8%)	28 (15%)	31 (8%)	30 (6%)
Health and Medicine	1 (2%)	15 (9%)	10 (5%)	52 (14%)	44 (9%)
General	1 (2%)	**25 (15%)**	24 (13%)	38 (10%)	7 (1%)
Total	51 (100%)	167 (100%)	187 (100%)	372 (100%)	502 (100%)

x organized by NCST; xx organized by RONAST; Biological Sciences include botany, zoology and microbiology; Physical Sciences include Earth Science, Physics, Chemistry, Statistics and Mathematics; General Papers include Keynote Address, Policy Papers, Theme Papers, Special Papers and Papers of General Interest**.** Sources: Abstracts and proceedings of the conferences.

Table 36 shows that the interest of the S&T community in participating in national conferences is on the increase. While only 48 papers were submitted for presentation in the first national level conference on S&T held in 1982 the number of papers submitted for the last national conference held in 2004 rose to 502. This increase in the number of papers submitted to the conferences is quite significant in the sense that in addition to the national conferences several other conferences on specific disciplines are held separately every year. All this may be taken as an indication of the increase in scientific activities in the country. Research activities are found to be predominant in the field of agriculture and biological sciences. It also shows that the interest in environment-related research is on the increase. While not a single paper was presented in the field of forestry and environment in the first two science conferences their number has increased significantly in the last two conferences.

As observed in the national conferences organized by RONAST, biological science shared the highest percent of total papers presented except in the held in 1994. The biological research works were mainly ecology and taxonomy. In recent years, papers on microbiology and biotechnology are in increasing trend. In the fourth national conference, microbiology and biotechnology shared 10% each of the total papers (154 papers) in biological science.

The next highest number of papers was in agricultural science, which shared 24% of the total presentations in the conference held in 2004. Nepal has included agriculture is in its priority list since long. The research in agriculture is oriented towards the priority list identified by Agriculture Prospective Plan of 20 years (1997-2016) and NARC's vision (2002-2021). The priority areas identified by APP are: Major food crops (rice, maize, wheat and potato); High value crops and commodities (citrus, apples, off-season vegetables, vegetable seeds,

sericulture and apiculture); Dairy production (animal nutrition, high-value fodder crops); and Development of soil fertility and shallow tube-well farming system. The major research areas identified by the NARC vision are: Hybrid varieties and breeds; High value commodities; Post-harvest storage, handling and value addition; Comparative advantage technology; Biotechnology; Policy, socioeconomic and market research; and Gender-related research.

Papers on health related research are poorly represented in the conferences with less than 10% of the share except in 1999. This could be because of the fact that there are regular publications of journal. According to a study, out of 119 approved research proposals by Nepal Health Research Council in three years from 1997 to 1999, the highest was on reproductive health with 22%, followed by infectious diseases (19%) and nutrition (13%). Although Nepal has high child mortality rate, research on child health shared only 6%, while on high altitude and tobacco were <1% (Acharya 2000).

In contrary to the expectation, the number of papers on forest and environment presented during the conference was in decreasing trend. Similarly, there is no trend of increment in engineering and technology as well though the number of the colleges increased drastically on engineering field.

Research Publication

A list of 37 journals related to science and technology in Nepal is presented in Table 37. Most of these journals are published by various professional associations and specialized ones that cover a specific discipline. A few journals give space to all disciplines of S&T like Journal of Institute of Science and Technology, Tribhuvan University and Nepal Journal of Science and Technology launched by RONAST and Scientific World published by Ministry of Science and Technology. Though the journals send the articles for peer review, most of the submitted articles lack quality scientific writing.

Beside the journals, there are science magazines, bulletins, occasional and research paper series published in Nepal. Numerically over 60 such publications are on record, but in reality very few of them are regularly seen in the market. Most of them are sporadic and have very limited reach of clients. One encouraging part, however, is the publication of science bulletins at the initiative of graduate students. The publication of Himalayan Journal of Sciences is cited as a good example of such initiatives taken up by young graduates.

Table 37. List of some of the Science and Technology journals of Nepal

SN	*Name of the Journal*	*Publisher*	*Sector*
1	Banko Jankari	Forest Survey and Research Center	Forestry, biodiversity, ecology
2	Ecoprint	Ecological Society	Ecology
3	Education and Development	Research Center for Educational Innovation and Development, TU	Education
4	Geographical Journal of Nepal	Central Department of Geography, TU	Geography
5	Journal of Institute of Science & Technology	Institute of Science and Technology, TU	S&T multidiscipline
6	Himalayan Journal of Sciences	Himalayan Journal of Sciences	S&T multidiscipline
7	Journal of Nepal Health Research Council	Nepal Health Research Council	Health sciences
8	Journal of Natural History Museum	Natural History Museum, TU	Biology, Ecology
9	Journal of Nepal Chemical Society	Nepal Chemical Society	Chemistry, Environment
10	Journal of Nepal Engineers Association	Nepal Engineers Association	Engineering
11	Journal of Nepal Geological Society	Nepal Geological Society	Earth science
12	Journal of Nepal Pharmaceutical Association	Nepal Pharmaceutical Association	Health Science
13	Journal of Nepal Physical Society	Nepal Physical Society	Physics
14	Journal of Nepal Animal Science Association	Nepal Animal Science Association	Veterinary
15	Journal of the IAAS	Institute of Agriculture & Animal Science, TU	Agriculture & animal science
16	Journal of the Institute of Medicine	Institute of Medicine, TU	Health science
17	Journal of the Nepal Medical Association	Nepal Medical Association	Health science
18	Journal of Science	Science Association, Tri-Chandra Campus, TU	General S&T
19	Journal of The Nepal Research Centre	Nepal Research Centre	General
20	Kathmandu University Medical Journal	Kathmandu University	Health Science
21	Journal of Society of Agricultural Scientists	Society of Agricultural Scientists	Agriculture
22	Medical Journalof Shree Birendra Hospital	Birendra Hospital	Health science
23	Monal: Annual Journal of Forestry	Institute of Forestry, TU	Forestry

24	Nepal Journal of Science and Technology	Royal Nepal Academy of Science and Technology	S&T multidiscipline
25	The Nepal Journal of Forestry	Nepal Forestry Association	Forestry
26	Nepal Pediatric Society Journal	Nepal Pediatric Society	Health science
27	Nepal Population Journal	Population Association of Nepal	Demography
28	Nepalese Journal of Agriculture	Nepalese Agricultural Association	Agriculture
29	Nepal Journal of Plant Resources	Nepal Botanical Society	Plant sciences
30	Nepalese Journal of Animal Science	Nepal Animal Science Association	Animal science
31	Nepal Journal of Neuroscience	Nepal Neuroscience Society	Health science
32	Nepal Journal of Psychiatry	Nepal Psychiatry Society	Health science
33	NEC Journal	Nepal Engineering College	Engineering
34	The Nepali Mathematical Sciences Report	Central Department of Mathematics, TU	Mathematics
35	Renaissance	BP Koirala Institute of Health Sciences	Health science
36	Scientific World	Ministry of Science and Technology	S&T multidiscipline
37	Tribhuvan University Journal	Tribhuvan University	General
38	Water Nepal	Nepal Water Conservation Foundation	Hydrology

Problems

While the history of science teaching at higher level is less than 90 years, the history of scientific research in Nepal is still new. Till the initiation of post-graduate teaching at Tribhuvan University there was hardly any research activities in the teaching institutions of the country. Absence of research activities in the teaching institutions may be attributed mainly to the basic thinking at the time that the primary responsibility of the teaching institution was to teach, not necessarily to engage in research activity.

The lack of proper infrastructure and the environment may also have played a role. The teachers saw in themselves the science teachers not as researchers. The need of combining teaching activities with research was not appreciated. Even after more than 40 years after the beginning of post-graduate teaching, the postgraduate central departments, are still considered as teaching institutions. There exists no regular budgetary provision for research activities in any of the colleges, including the central departments, which have the responsibility of also conducting PhD programs. Whatever research activities are going on in the teaching institutions are due to the personal efforts of the concerned teachers.

The policy of separating teaching and research is also responsible for poor research activities in Nepal. On one hand, institution of higher learning like Tribhuvan University separates teaching from research, while RONAST is given a mandate of conducting research without degree oriented academic programs. This cause concentration of research facilities in the research centers, while the responsibility of producing research manpower rest with the departments without such facilities. This kind of policy of separating teaching and research has an adverse effect in the training of research manpower required in the country.

RONAST supports the researchers by providing grants and PhD fellowship. The number of grants has been less than four since its inception in 1985 though the number of aspirants is increasing. In last 20 years, it has supported 25 PhD candidates but only half of them have completed the work. Thus, the research programs are often fragmentary and inconclusive.

Investment on science and technology

With a per capita income of US $ 270, Nepal belongs to one of the poorest developing countries of the world. This is also reflected in the national investment in R&D related activities in the field of S&T. According to a study sponsored by National Council for Science and Technology (NCST), the R&D expenditure for the fiscal years of 1980s ranged from 0.13%-0.36% of GNP, with an average of 0.22% (Adhikary et al. 1998). Between the years 1990-1995, this figure ranged between 0.27 and 0.48%, with an annual average of 0.36%. The comparison of figures for 1980s and the first half of 1990s show a significant increase in R&D expenditure over the all time low 0.13% of GNP for several fiscal years in 1980s. However, according to the investigators of the study the increase in R&D investment observed for the 1990s is due to the input of foreign investment, which amounted to the range of 0.11–0.22% of the GNP invested in S&T. Deduction of this foreign contribution would place the national expenditure in the range between 0.11-0.22% of GNP over the years between 1990-1995, with an average of 0.15% which is close to the minimum of 0.13% observed for some of the fiscal years of 1980s. According to the authors, the foreign contribution to the total R&D expenditure in 1980s was insignificant (Table 38).

Table 38. Research and Development Expenditure in Science and Technology sector (% of Gross National Product) for Nepal

Year	*Total GNP (Rs in millions)*	*R & D Expenditure (Rs in millions)*	*R & D Expenditure as % of GNP**
1981	31 603	42	0.14
1982	34 458	125	0.36
1983	38 809	92	0.24
1984	42 384	55	0.13
1985	50 774	63	0.13
1986	56 763	76	0.13
1987	99 345	248	0.25
1988	111 580	290	0.26
1989	123 617	333	0.27
Average 80s	65 481	146	0.22
1990	135 480	377	0.28
1991	152 200	559	0.37 (0.25)**
1992	174 617	834	0.48 (0.37)
1993	203 079	822	0.41 (0.18)
1994	224 399	742	0.33 (0.16)
1995	254 349	686	0.27 (0.15)
Average 90s	190 687	670	0.36 (0.22)

Italics % etimated; **Figures in parenthesis indicate foreign contribution. In 1980s foreign contribution is insignificant; Sources: Adhikary and Ranjit (1987), Adhikary, Ranjit and Joshi (1998)

Even with the foreign contribution, at an average of R&D expenditure of 0.36% of GNP, the R&D investment should be considered as low even by regional comparison. For example, the ratio of average gross R&D expenditure and GDP (%GERD/GDP) for India and the Central Asian Countries stands at 0.6%. Since GDP is very low for Nepal, the actual R&D expenditure in Science and Technology in Nepal comes to very low in absolute terms. Moreover, since 1992 the R&D expenditure has been on the decline.

Table 39 shows the R&D activities in some selected sectors of Science and Technology carried out by the government. While only about 2% of the total budget allocated to the agriculture sector was set aside for R&D during 1981-1986 (Adhikary and Ranjit 1987), an average of about 13% of the total budget allocated for agriculture sector in the period between 1991 and 1996 were spent in R&D activities. Nepal Agriculture Research Council (NARC) carried out most of the R&D activities in agriculture. A major portion of the R&D expenditure in agriculture comes from foreign donor agencies. Inspite of significant investment, there has been only a marginal increase in the agricultural production. The combined R&D expenditure in the field of industry and mines looks quite impressive. However, most of this R&D expenditure is spent for the exploratory works on mining. Very little R&D activities are carried out that would contribute to the improvement of future industrial base. Although the government invests heavily in such sectors as water and energy and education, the share of R&D budget in these sectors is very low.

Table 39. R&D Expenditure in Some of the Science and Technology sectors (Average of 1991-1996)

Sector	*Total Budget (Rs. in millions)*	*R&D Expenditure As % of Total Budget*
Agriculture and Food	2356	13.3
Forest & Plant Resources	750	6.1
Industry and Mines	932	26.8
Health	807	1.9
Water and Energy	2992	1.5
Land Survey	152	5.8
Education	2782	1.8

Source: Adhikary et al.(1998)

It has been well established now that the economic well being of a nation depends upon its capability to apply Science and Technology and the R&D activities. The developed countries have accordingly invested heavily in R&D activities and reaped its economic benefit. But in developing countries like Nepal, investment in R&D activities does not fall under the government priority. The UNESCO has recommended a minimum investment of 0.4% of total GNP in R & D activities, which can easily be afforded by the developing countries without compromising investment in other important sectors.

The S&T community in Nepal has made several efforts to convince the politicians, government policy makers and planners on the need to increase R&D expenditure, with little success. In almost every meeting attended by the government planners and policy makers, the scientific community has repeatedly raised the issue. Although several assurances were given, they have not been properly implemented. Shortly after its establishment in 1996, the Ministry of Science and Technology had mentioned in its policy paper that the Ministry would try to raise the R&D expenditure to at least 1% of GNP within next five years. However, the actual R&D expenditure for the decade of 1990 is estimated to be around 0.33% of GNP, including the foreign contribution (Adhikary *et al*.1998).

Commercialization of R&D

In Nepal, the commercialization of R&D from the local S&T is not much encouraging. This has resulted due to lack of well-equipped R&D institutions and policy framework. Most of the industries are based on assembling the equipments, which do not need much of the R&D. Commercialization of R&D is also handicapped by the lack of coordination between the R&D institution and the production parties. At individual level, the R&D experts are mostly concerned about their academic career and are less aware about the problems of entrepreneurs. At the same time, the production parties have yet to realize the role of R&D and capabilities of S&T manpower. Thus, a regular interaction among the entrepreneurs and the R&D sectors is essential.

Many of the industries are based on imported technology, as there is minimum risk factor in such venture. The industries do not have large-scale laboratories for R&D. This reflects the fact that a need for improvement and strengthening of R&D institutions for the commercialization. Promotional institutions play an important role in the commercialization of R&D. Some of the active organizations in such efforts are: Agriculture Development Bank, Alternate Energy Promotion Center, Department of Industry and Department of Forests (Table 40).

Table 40. Potential institutions for technology commercialization

SN	***Organization***	***Area for commercialization***
1	Department of Agriculture Nepal Agriculture Research Council	Fisheries
2	Department of Plant Resources Nepal Agriculture Research Council	Tissue culture
3	Balaju Yantrashala	Multipurpose Power Unit
4	RECAST Private companies	Solar water heater
5	Herbs Production and Processing Company Singh Durbar Vaidyakhana Gorkha Ayurved Company	Herbs production and processing

CHAPTER 5

DISCIPLINARY DEVELOPMENTS

Overview of Science and Technology in the Disciplines

"Science" here is taken to mean the 'hard sciences': the range of disciplines that deal with the behaviour and properties of non-human phenomena. Included are the basic sciences such as Physics, Chemistry, Zoology and Botany as well as the applied sciences such as the Earth Sciences, Engineering Sciences, Health Sciences, Agriculture and Forestry. We include the Mathematics and Statistics as supports to these sciences.

Not included are the 'soft sciences' that deal with the application of scientific principles and methods to human behavior: the social sciences such as Economics, Political Sciences or the Management Sciences. However, these soft sciences are intimately implicated in the development and delivery of scientific technologies to the economy. An example is the successful community forestry 'technology' that Nepal has developed. This technology includes both elements of the hard sciences of silviculture, or the science of growing forests and the principles of behavioural sciences to get public participation in the efficient use of forest resources to enhance national economic productivity.

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Organizational Framework of the Science and Technology Status of Disciplines

The key question to address in this survey of the status of the science and technology of different disciplines is what is limiting their capacity to uplift the Nepali people?

The survey of science and technology will assess the current capacity of different disciplines and what bottlenecks constrain the efficiency of this capacity to deliver enhanced productivity to the nation. The proposed outline is: History to date, Delivery parameters and capacity of the discipline, and Bottlenecks to efficient delivery. Policy recommendations are made based on the published information such as status papers where available. Where possible these outlines will cover the current capacity of the discipline such as manpower, knowledge base and state of technology. Similarly, institutions, resource characteristics and policies, success stories so far and constraints are mentioned.

Agriculture

History to date

Agriculture occupies two-thirds of the population in Nepal. It represents the highest potential for growth and poverty alleviation, as the vast majority of people and especially of the poor, live in rural areas. Investments in agriculture and returns thereof affect directly the well being of most of the Nepalese countrymen. The State has recognized this and has allocated priority to its budgetary policy of successive national plans. At present, the agriculture growth rate is 2.3%, which is slightly above the population growth rate of 2.24%.

The institutional base in agriculture was created in 1924. The office, instituted to modernize the agriculture system in the country, constructed Chandra Nahar (canal) in the Terai and an experimental farm in Kathmandu. The Technical School (est. 1932) started training programs in agriculture and also a research center. In the same year, Agriculture Council was formed, which did some commendable works in horticulture, livestock and irrigation sector. By 1951, the Agriculture Office had evolved into a department with various activities. In 1967, five departments appeared, viz. Agriculture Extension, Fisheries, Horticulture, Livestock and Education and Research. In the same year, Central Food Research Laboratory was formed. In 1973, Department of Food and Agriculture Market was created.

The departments under agriculture have seen several structural alterations. Since 1990, the government has made four such re-structuring. The last reformation was in 2005. In its consistent effort to bring positive changes in agriculture sector, Nepal brought Agriculture Perspective Plan in 1995. APP emphasized on the agriculture-led growth strategy as the option for the country's broad-based economic development. Previously, the government created Nepal Agriculture Research Council (NARC) in 1991 giving importance to agriculture research and its contribution to national economy.

Delivery parameters and capacity

Agriculture accounts for 39% of the GDP and 66% of the employment. Crops, horticulture, livestock and fisheries share 41%, 31%, 26% and 2% in GDP, respectively. Crop coverage is dominated by rice (35%), followed by cash crops (10%), legumes (7%), minor crops (7%) and horticultural crops (5%). Area coverage by improved varieties of rice is 85%, by maize 86% and wheat 96%. The overall national production and requirement of cereals is more or less in balance (+80,022 metric tonnes). The total requirement is 4,463,027 metric tonnes. However, the production of cereal in different geographical regions has led to food deficiency in mountains (-73,560 metric tonnes) and hills (330, 908 metric tonnes) and surplus in Terai (484,490 metric tonnes) (MOAC/ABPSD 2003).

In the last 45 years of its efforts in research and development, Nepal has released 202 crop varieties of 43 crops. Achievements in fisheries, seasonal and off season vegetables and fruits are also remarkable. While some of the fruits have found market in neighboring countries, some fisheries technologies have been exported. Basic infrastructures for research activities have also been set up under various departments and research centers.

From a science and technology perspective, efforts to boost agricultural productivity to increase the wealth and well being of most of the Nepalese rural people have followed the Green Revolution model of high inputs of Knowledge (High yield crops from agricultural research and development), Fertilizers (Nutrients imported from forests and chemical factories), Irrigation (Water inputs from big and small dams and channels), Energy (to run irrigation, harvesting and agricultural processing), Organization (Extension and streamlining of agricultural services organizations) and Finance (Micro finance to state level budgetary allocation).

Through its long experiences, Nepal has developed substantial capacity in the development of agricultural science and technology suitable for the country as well as its delivery to the people. The country has a mature Ministry of Agriculture, full of agricultural professionals of various disciplines, an Agricultural Institute with faculty and students in the agricultural disciplines, substantial donor support and ancillary support organizations for delivering agricultural technologies of irrigations, fertilization, agricultural credit, farming systems to the rural populace.

The last structural changes in agriculture department in 2005, have created 12 program directorates and 14 national programs covering various sectors of agriculture such as Seed Breeding, Soil Testing Crop Conservation, Horticulture Vegetable Fisheries Plant Quarantine. There are 184 agriculture offices in all 75 districts and 378 agriculture service centers distributed in lowland, hills and mountains. The department has 1500 manpower (DOA 2005). Beside the department, there are independent research laboratories under Nepal Agriculture Research Council (NARC) and Institute of Agriculture and Animal Sciences (IAAS/TU).

Despite impressive gains in different sectors, the net effect is still modest in scale. Productivity of most of the crops is far below their yield potential. Though there is an increasing trend of rice, maize, wheat and potato yields, the national average is below 50% of the attainable yield. Two-thirds of the agriculture is under rain-fed conditions. Nepalese are still caught in the vicious circle of agricultural poverty.

One reason for this vicious agricultural poverty is the scale of land degradation of both agriculture and forestlands for which even the investments to date are modest by comparison. For instance, despite the years of expensive investment in irrigation and fertilization, the area of such agricultural land receiving this investment is a small fraction of the total agricultural lands. All the other lands continue to receive nutrient and energy input from forests in the form of fodder for livestock and fuel wood for rural populations. This large scale subsidy of low productivity rural agriculture is causing forest land degradation at a pace faster than the ameliorative effects of forest conservation in national parks, wildlife reserves, or general forest conservation.

The other explanations offered as causes of this persistent low productivity of agriculture is land fragmentation and the small size of land holdings. The rugged topography of the country, poor infrastructure (road, communication, electricity, market, etc.), limited arable land, low income and high commodity prices in hills and mountains are also seen as the root causes of this underdevelopment.

In order to deliver research input in augmenting agriculture production, NARC has developed its 20-year vision in 2001. The vision provides broad policy guidelines and direction for implementation of the program and activities of agriculture, livestock and natural resource research in Nepal for the period 2002-2021. However, there is a sharp decline in government's allocated budget for NARC. In 2001, the budget was NER 188,000,000, which has decreased to 83,000,000 in 2005. This has affected much in research projects including maintenance and repair of the equipments (Maskey et al. 2004).

However, there is also a contradictory view that increment in agricultural research alone is not an answer. They argue that during the latter half of the 1990s, when the national budgetary allocation to the agricultural sector was reduced from nearly 16% of the budget to around 11% of the budget, agricultural productivity was actually enhanced. This fact points to the possibility of agriculture sector generating more returns by investment more in social sectors like health and education that has directly benefits to all the populations including those that depend on agriculture versus investment in the agricultural services organizations an intermediary manned mostly by middle-class urban professionals with declining rate of return.

Bottlenecks to efficient delivery

It seems that the government has no specific policy and/or long-term vision in structural management of agriculture sector. In a short period of less than 15 years, agriculture department was restructured for at least four times. In 1990, the departments including the research laboratories and market were all brought under a single umbrella principal. The

principal did not work even for a decade that the departments were again given separate entity in 1996, followed by similar restructuring in 2001 and lately in 2005.

An anomaly is also observed in the manpower distribution. The Agriculture Department, for instance, has a total manpower of about 5000, where the low-level manpower of peon comprises 30% of the total. The research institution like NARC feels that they have acute shortage of specialist in agro-forestry, commercial crops such as tea, coffee and spices. On one hand, Tribhuvan University has enough intake capacity in agriculture science with adequate infrastructure and reasonable fees, on the other hand there is far less interest on agriculture subject compared to medicine and engineering.

The other problems, which are often pointed out, are gaps in yield, knowledge-information linkage and research. Generally, productivity of most food crops and livestock is low and falls below 50%. While knowledge and information gaps exist at different levels among scientific communities and between scientists and farming communities, research gaps are in livelihood of the people as much of the research focus have been on commodity and farming systems.

Increased agricultural productivity with less government inputs has also been attributed to the greater participation of the private sector and public (not government) in the fine-tuning of agricultural services and opportunities that the unwieldy organizations of the State Agricultural science and technology have difficulty capitalizing on. If 'technology' is defined as any means that enhances human capacity, including organization, then the State agricultural services organizations despite their heavy investment in manpower, research, experience, laboratories and organization are increasingly reaching a point of marginal return that does not justify additional investment.

Policy recommendations

1. The efficiency of agricultural science and technology to contribute to agricultural productivity is being constrained by the institutional context of the government structure.
2. Technical know-how now locked up or under-utilized in the State organizations from NARC to Agricultural Institutes must be released by more liberal State regulations or be motivated through better opportunities and incentives.
3. The State should also give easy access to the State assets of agricultural science and technology professionals and their resources such as laboratories, libraries, germ banks, experimental farms to private sector, public non-governmental sectors and the general public so they can generate more returns on the national investment.

4. The State should promote policy and market tools that enable the private sector to distribute fertilization, power and knowledge widely and efficiently at a profit and sustainable benefit. This "technology" of effective services delivery using non-governmental institutions must be nurtured and disseminated.
5. Demand-driven and appropriate technology is developed for priority client groups and research be conducted in marketing and socio-economic fields as well.

Chemistry

Historical to date

Several of Nepal's indigenous technologies are based on chemistry. The use of metallic ornaments has been recorded since ancient time. Nepali technologists excelled in metal works in 12th century, some even took the knowledge to neighboring countries. The Golden Gate of Bhaktapur and many idols, bells, utensils in Kathmandu and Patan are at least four hundred year old Masterpieces. Some of the technologies based on chemical knowledge such as extraction of iron, copper, preparation of ink, liquors, lime and coloring still prevail in Nepal.

Modern chemistry in Nepal was introduced in education with the commencement of I.Sc program at Trichandra College in 1921. It was upgraded to B.Sc level in 1947. In 1965, MSc in Chemistry was commenced when 20 students were enrolled for the program at the Tribhuvan University (CDC 2001). Newly established universities and colleges offer Chemistry in science and technology based courses.

Delivery parameters and capacity

Government sector: The activities related to chemistry are also found in the government department and other laboratories such as Royal Drug Research Laboratory, Department of Mines and Geology, Soil Science at Nepal Agriculture Research Council, Food Research Laboratory, Department of Hydrology, Department of Plant Resources, Forest Research and Survey, Department of Health, National Archives, Nepal Standard Bureau. The government has also taken initiatives in establishing medicinal plants based companies for production of essential oils and extractions.

Academic sector: Tribhuvan University is the only institution till date offering Master's degree program in Chemistry. The enrollment of the students in Chemistry is in increasing. However, upgrading the facilities within the departments to keep at par with the increasing trend of enrollment has been inadequate.

Despite a disparity between minimum required facilities and the number of the students, the Central Department of Chemistry at TU has maintained the quality of academic standard throughout these academic years (IOST/TU 2003). For the reason, the postgraduates from this department have excellent academic records, which enable them to get further opportunities to study/conduct research in reputed institutions of the developed world. The postgraduates of this department are currently working in various government and non-government offices as well as universities in and out of the country. Reputed chemistry related industries and some foreign universities have also approached the department for our postgraduates to conduct scientific and research activities.

The CDC/TU offers general courses in M.Sc. part I. In part II, however, students are allowed to choose areas of specialization from Inorganic or Organic or Physical Chemistry. The Degree of Ph.D. is offered in any of these three disciplines. The services of modern sophisticated instruments currently available at the department are: P-NMR (Proton-Nuclear Magnetic Resonance Spectrometer, 60 MHz.), FTIR (FT Infrared Absorption Spectrometer), GLC (Gas Liquid Chromatograph), HPLC (High Performance Liquid Chromatograph), Chromatron (Planar chromatograph), AAS (Atomic Absorption Spectrophotometer), TGA (Thermogravimetry), XFS (X) Spectrometer, UV-VIS Spectrometer, MPLC (Medium Pressure Liquid Chromatograph), Polarograph, Fluorimeter, Polarimeter and Flame Photometer.

The major fields of research at CDC/TU are: Synthetic Chemistry, Reaction Mechanism, Natural Products Chemistry, Solid State Chemistry, Electrochemistry, Analytical Chemistry, Radiochemistry, Applied Enzymology and Biotechnology, Chemistry of Clay Minerals, Environmental Chemistry and Organic Sulphur Chemistry.

There are some research programs carried out mostly in natural product chemistry at the laboratories of Royal Nepal Academy of Science and Technology, Research Center for Applied Science and Technology.

Non-government sector: Some of the organizations such as Environment and Public Health Organization (ENPHO) and Nepal Environment and Scientific Services Pvt Ltd (NESS) undertake monitoring of pollution and provide services as well. Similarly, some industries such as sugar, noodles, paper, cement and tanning also have chemical activities.

Delivery parameters and capacity

Chemistry makes an integral part of the laboratory service whether in research departments or service centers. Nepal has been fulfilling the required manpower for such service mainly through Tribhuvan University. The Central Department of Chemistry at TU enrolls 90

students every year. However, due to the lack of research facilities, only 15 students can offered the chance to do thesis.

Established with an objective to promote chemistry in 1978 the Nepal Chemical Society has over 700 members. The society has regularly been publishing the Journal of Nepal Chemical Society. NCS also organizes seminar and discussion forum in collaboration with national and international organizations.

Bottleneck to efficient delivery

Most of the chemistry related activities are being pursued under many constraints. It is also pointed out that the low level of research and inadequacy in the current status of chemical research in the country is due to the lack of support for almost every requirement such as chemicals and equipments. The department also lacks a good reference library.

Policy recommendations

1. To compile a comprehensive volume on natural and industrial resources of Nepal containing information about manpower, material and feasibility of potential industrial development through chemistry.
2. To modernize and strengthen of chemistry education and research activities to meet the latest developments in chemical science
3. To establish a national chemical laboratory and strengthen national capability in maintenance and repair of scientific instruments in order to render various types of services
4. To establish of a center for advanced study of natural products and to fully utilize the natural potentials of Nepal
5. To conduct a survey of all types of industrial chemicals consumed in the country and thereby work out programs for developing chemical industries with maximum indigenous input

Computer and Information Technology

History to date

Information technology (IT) can play a vital role for the socio-economic development of the country. Nepal, which has failed to take benefit from industrial and green revolution, can benefit from a lot form latest IT revolution. In order to tap benefits of information revolution, it is emphasized that Nepal should establish IT based industries and expand their services to become an active partner of global IT market and get maximum benefits from the

exports of IT related goods and services. Similarly, it is equally important to create a knowledge-based society by providing computer education to all through introduction of computer education in school curriculum and providing Internet services at the village level

Nepal entered into the computer age by introducing IBM computer to use in the population census in 1971. In 1975, His Majesty's Government of Nepal established National Computer Center to promote computer education and utilize its potentials. NCC's school program was quite popular among the school children (Chapagai 1981). However, the center could hardly celebrate its golden jubilee, it was dissolved.

Grant assistance was extended to four universities for the development and promotion of IT education. Tribhuvan University started BE program in electronics engineering in 1994 and computer engineering in 1998. TU is also offering M.Sc and PhD programs in IT. Since last few years, three other universities namely Kathmandu University, Pokhara University and Purbanchal University are also offering IT courses. At present the yearly intake of these universities along with their affiliated colleges is 3122. It is estimated that there are 300 private computer-training institutes. These institutes are playing a significant role in promoting IT awareness in the country. Besides conducting training programs, many of these private companies offer consultancy services, computer assembling and other IT solutions.

Delivery parameters and capacity

The development of IT sector in Nepal is in preliminary stage as compared to developed countries. Though more than 100,000 computers are in use nation-wide, the use of computers in the government sector is still nominal. Though some government and non-government agencies have been using computers to establish data bank and their process, smoothly run their activities and enhance performance, it is important to arrange a mechanism for the collection of information in an integrated manner nation-wide and use them as common assets.

With an aim to extend IT education in school level, the government has extended computer support and internet services to them. Information Technology Policy-2057 has been introduced and a draft of Cyber Laws has been formulated. The construction of IT Park in Banepa, Kavrepalanchwok district has begun. The Tenth Plan (2002-2007) has emphasized on expansion of IT in achieving a high economic growth rate through the quick dissemination and availability of necessary information. As such the plan has proposed to expansion of internet services to 1,500 VDCs across the country.

In order to enhance the IT programs, His Majesty's Government has established High Level Commission for Information Technology. Beside this, there are some IT related

organizations that are helping promote computer use and IT. In order to promote IT industries and also to streamline the efforts, the government has introduced IT policy recently.

At present, four universities are offering different types and levels of computer courses. Semi-skilled manpower is also generated by the Council of Technical Education and Vocational Training (CTEVT) and the local training institutes. It is estimated that there are about 1500 IT professionals and annually about 150 graduates of IT are produced. CTEVT has trained over 10,000 trainees with more than 6 months of training.

The Computer Association of Nepal was established for the promotion of computer and information technology in the Nepal in 1992. The association has involved computer and IT professionals, manufacturers, institutions and other related organization of computer and information technology in the country. More than 600 individual and 129 institutional members have registered with CAN. The association has been successfully organizing CAN Info-Tech, an annual technological festival regularly in Kathmandu. The Association of Computer Engineers Nepal has also been active since its establishment in 2001.

There are some success stories on how IT has been applied such 24 hour banking and countrywide branch office networking. Some government institutions where application of IT is successful are national pension and provident fund, telephone and electricity billing systems, VAT department and custom department.

In recent years, Nepali students have been developing robotics of different capacities. They have earned awards in various regional and international competitive exhibitions as well. Moreover, a Nepali language Unicode has been developed to enable use of Windows in Nepali.

Bottlenecks to efficient delivery

Nepal faces several challenges in the development of computer and IT. There is a lack of IT network and coverage because the telecommunication network developed is mainly to cater voice telephone services; sufficient bandwidth is not available for IT uses, computers are expensive for the general mass, the society is not sufficiently exposed to information technology and its benefits.

Though Nepal has introduced an IT policy, the country still a lacks legal framework for the development of IT based industry. Intellectual property right, trademark, copyright, patent and licensing are minimal legal prerequisites (Shakya & Rauniar 2002).

Nepal faces a major problem in labor management, as new technology demands new skill sets and training. The revision policy of Nepali institutions is very conservative. This has left most of courses in computer and IT out-dated.

Except for a few, most of the colleges lack proper laboratory facilities and infrastructure. This has created gaps in practical application of the theoretical knowledge. Due to the lack of fund, most of the students are compelled to use unauthorized source of software.

Policy Recommendations

1. It is suggested that Nepal should identify and understand the national strengths existed in IT and motivate this with incentives.
2. Introduce policies and programs to take advantage of the fast growing global IT framework.
3. Introduce cyber law at the earliest to handle issues like forgery, cyber theft, cyber crimes, intellectual property rights and online digital signatures.
4. Process of transformation for electronic payment, authentication of credit card, debit card and online authentication of card and security should be hasten while there should be special efforts in global alliances, partnerships and creation of local information infrastructure, national information and integrate to global information network.
5. Universities offering courses in computer and IT should constitute an IT Quality Control Team to monitor the overall quality of IT education provided by their affiliated institutions. It is also recommended that library and laboratory facilities be strengthened to upgrade the standard of IT education. For improving IT education and to maintain quality, a monitoring team and core faculty is also necessary.

Earth Science

History to date

The development of science and technology of the Earth Sciences in Nepal have been driven by the efforts to harness the mineral resources, the gem resources and the water resources of the country. All of these activities contributed to the increase in economic productivity of the country.

The existence of small but widespread mining activities using tradition technologies to extract metals for the religious art craft and daily home utensils underscore the historical contribution of this technology to the nation.

More systematic application of modern sciences of the Earth Science commenced with the effort to harness water resources for irrigation and later for hydroelectricity in the beginning of the twentieth century. This development began with the establishment of the Office of Irrigation and Geology in 1926, systematic geologic studies of the Himalayas for mineral and gem resources beginning in 1942 with the help of foreign experts and financial assistance. This effort has continued in sophistication under the Department of Mines and Geology established in 1976 (DMG 2003).

Delivery parameters and capacity

Department of Mines and Geology is undertaking various geo-scientific research programs. Special emphasis has been given to the area of high exploration potential for gold, lead, zinc, iron, petroleum, biogene gas, industrial non-metallic minerals and construction raw materials. Environmental and engineering geological studies at various stages from reconnaissance survey to detailed site investigation have been continued to support the infrastructure and mining related development activities. The Department has a wide range of facilities such as Atomic Absorption Spectrometry, Emission Spectrometry and Graphite Furnace for ultra trace level analysis and Fire Assay for gold determination. The geotechnical services such as cartographic drafting, remote sensing, photo geology, satellite images, core drilling, mineralogical, petrological and metallurgical tests are being strengthened to meet the present needs of services.

By now regional geological maps covering Lesser Himalayas, Sub-Himalyan and some parts of Higher Himalaya have been prepared. Covering the whole country, colored geological maps and mineral resources map of Nepal have also been published. Recently, a seismological network has been established to record and monitor the earthquakes in the country. The seismic hazard maps and microseismic epicenter map of Nepal Himalaya and adjacent regions have also been published.

The legal framework for administration of mineral resources in Nepal includes Nepal Mines Act 1966, Mineral Concession Rule (1961), Mines and Mineral Act 2050. Similarly, there exists the Nepal Petroleum Act 2040 and the Petroleum Regulation 2041.

Tribhuvan University is the only institution offering Geology courses in Nepal. It introduced course of Geology at Bachelor's level in 1967 and Master's in 1975. The course offers three different specialized areas Natural Resources, Environmental Engineering and Geological Mapping (IOST 2003).

With an objective to develop and promote the research and application of geological sciences to national development, a professional forum of geologists, the Nepal Geological

Society was formed in 1980. The society has over 500 members who are actively engaged or interested in the geological research of Himalaya-Tibet region. The members include the Nepalese geoscientists as well as scientists from different countries. Beside regular publications of the Journal of the Nepal Geological Society and News Bulletin, NGS organizes seminars and conferences at national, regional and international conferences. The society has also organized several training programs for Nepali professionals and lecture programs on contemporary issues of geo-scientific researches by inviting eminent national and international scientists.

Despite the limited resources and investment made, Nepal has achieved some remarkable performances in Earth Science. The country has prepared geological mapping of the entire country at 1:50,000 Scale, seismological database of over 20 years of seismic recordings and scientific information on the structure of the Himalaya. Studies have found reserves of many limestone deposits suitable for cement industries. The educational institutes are capable enough to produce of qualified manpower in the country. Similarly, Nepali geologists, both from government office and academia, have been publishing research articles in national and international journals.

In academic progress, Nepal is capable of producing high-level manpower in geology. Tribhuvan University started undergraduate course in geology in 1967 and M.Sc course in 1975. Majority of the geologists working in the country are the products of Tribhuvan University and are performing very well in their field of work. Nearly all the faculty has PhD degree and is highly qualified. The teaching quality is high both at undergraduate and postgraduate level.

Basic research facilities in earth science have also been set up such as the Geochemical laboratory and the Seismological laboratory at the Department of Mines and Geology, Geotechnical laboratory at Nepal Electricity authority and Paleomagnetic laboratory and Geology laboratory with X-ray defractometer in the Central Department of Geology. Two major academic publications, Journal of Nepal Geological Society (since 1980) and Bulletin of the Central Department of Geology, (since 1990) are published regularly.

Nepal has been effortful in exploiting the available mineral resources through small and large industries. Some notable industries based on geology are: Udaipur Cement Factory, Hetauda Cement Industry, Chobhar Cement Industry (closed recently), Godavari marble industry, coal mines in Dang, Kharidhunga Mine in Dolakha (presently closed), Ganesh Himal Zinc-lead deposit (under detailed investigation), Lignite (low quality coal) mining in Kathmandu and coal mines in Dang. Many small mining industries for gemstones, some gem

cutting industries, several large and small stone quarries are also in operation in various parts of the country (Amatya 1996).

Bottlenecks to efficient delivery

Nepal has spent in total only about US$ 7 million for its mineral resources development in the last 40 years. This includes administrative cost, salaries and developing physical facilities like buildings etc; no research funding and support for professional enhancement. The laboratory facilities have also not been improved or repaired due to lack of funds. Tribhuvan University is only institute to offer courses in Geology in the country. But it has neither been supported enough nor been allowed to fix fee structure that would help improve its quality.

There is a huge potential of geology. However, this career (for geology) is chosen only after engineering and medicine. Special programs have to be drawn to popularize and promote earth science in Nepal. Similarly, diversification of new sub-disciplines at post-graduate courses is lacking. Despite its huge scope and importance, earth science is getting very little priority in Nepal. However, this has yet to be realized as the earth scientists are poorly represented in decision or policy-making levels.

Policy recommendations

1. Keeping view the utilization of water resources of the country, establishment of a national laboratory on hydrology has been a long felt need by professionals and research organizations.
2. No development has been on the quaternary geology and tunnel technology in the country. Therefore, the State should give due attention in this direction.
3. Taking advantage of its high altitude, research organizations should take more interest on developing research project on global climate change and carry out through university programs.

Engineering

History to date

In the historical period, the art and construction had a prominent position in Nepal. The pagoda style of building construction was developed in 7th century in Nepal. Nepali architect Arniko established new history of architecture in China. The engineering technology developed during various periods of Lichhavi and Malla are still found in the water supply and sewage system, temples and palaces in Kathmandu valley. During the Rana rule (1844-1851), some engineering technologies developed in western countries were introduced in

Nepal. Pharping hydropower, Ghantaghar (clock tower), Dharhara and Rana palaces are some examples of such technology.

In 1942, a technical school was established to train sub-overseers. It was Nepal's first engineering school. At the recommendation of the national education committee formed in 1961, the technical school was converted into engineering college and put under Tribhuvan University later. In 1972, New Education System Project was launched, which emphasized much on vocational trainings. In the same year, Institute of Engineering was established under the aegis of Tribhuvan Univeristy. Initially, the institute produced middle level of manpower in various discipline of engineering such as civil, mechanical and architect. The BE programs were introduced in 1978. Similarly the ME was started in 1996, followed by the doctoral program in 1997.

Since 1990, engineering education has experienced remarkable growth. There are already 28 engineering institutes/colleges in Nepal. Engineering subjects offered are Architecture, Automobile engineering, Civil engineering, Electrical engineering, Computer engineering, and Mechanical engineering. Beside these, the Council for Technical Education and Vocational Training (CTEVT) also offer training of various levels in engineering such as automobile, civil, computer, electrical, electronics, mechanical, and refrigeration.

Since Nepal embarked on rapid development program to uplift the living standard of the people, a lot of building was considered necessary since infrastructure was considered the most important constraint to development. For most of the last half-century of development, investment in infrastructure was a major budgetary allocation of Nepal. Engineers were in high demand.

Delivery parameters and capacity

There is Ministry of Transport, Ministry of Communications and Ministry of Local Development that carry out various development programs related to engineering and technology in the country. The major government departments related to engineering existing are: Department of Roads, Department of Building and Department of Civil Aviation. Telecommunications and electricity have already come up as authority.

Nepal Engineering Council has prepared criteria of physical and academic infrastructure required for an engineering college. The promoters are required to fulfill to apply to the Council and fulfill the requirement to opening an engineering college. The Planning Division of the university and the Institute of Engineering also make periodic visits to the affiliated colleges to examine the state of the physical infrastructure and the academic performances.

It is estimated that vocational trade schools in engineering currently enroll some 8000 students and they produce 2500 graduates a year. Every year, Institute of Engineering of Tribhuvan University enrolls 48 students in architecture, 48 in automobile, 188 in civil, 96 in electrical, 144 in computer, 144 in electronics, 72 in mechanical and 24 in refrigeration. Because of the perceived demand for engineers and their money making potential as well as the social prestige attached to this profession, engineering education has been offered by other universities of Nepal too. There are 9 engineering colleges under Tribhuvan University, 9 under Purbanchal University and 11 under Pokhara University.

Master courses were also introduced in the Institute of Engineering at TU from 1996 first in Urban Planning and then in Structural Engineering followed by Environmental Engineering in 1997 and Water Resources Engineering in the year 1998, Renewable Energy Engineering, Computer Engineering and Power System Engineering were begun from the year 2001. Very recently, Master Course on Geotechnical Engineering has been offered. Khwopa College, affiliated to Purbanchal University, has started new course on Earthquake Engineering at Master level from 2005. Later Master Courses were also introduced in Kathmandu and Purbanchal University.

Kathmandu University offers Master Courses on Water Resources and Power Engineering, the Pokhara University offers on Construction Management, Natural Resource Management and Computer Engineering.

Doctoral courses were introduced in the Institute of Engineering from the year 1997. One scholar has already been awarded the PhD degree. There are twelve faculty members undergoing PhD research at the present. The total enrollment capacity of enrollment in Bachelor level is well over three thousand at the present. It is estimated that two thousand students are enrolled in Bachelor of Engineering every year.

Nepal Engineering Council has been set up in the year 1999 with an objective to enhance the level of engineering in Nepal. It carries out the inspection of engineering colleges and also hears of the default made by the Engineers to the clients. This is the largest association of engineers in Nepal with over 7,000 members. Set up in the year 1968, it carries out several programs of benefit to the engineering community, the most towering of them being the National Convention every two years. It has chapters in Nepal as well as abroad.
Engineering publications are contained in the journals published by the Engineering Colleges of which the journals of the Nepal Engineering College and the Institute of Engineering/TU are notable.

Bottlenecks to efficient delivery

The Institute of Engineering is the first choice of the students for engineering course in Nepal. The IOE has capability to raise enough resources through fees that can also be used in upgrading its facilities and increase research activities. However, it cannot apply such scheme of full fee without the approval of the university (TU).

In the private institutions, the attention is focused more on immediate problems than on the long-term development. These institutions though declared to be non-profit making, in reality are prompted to profit making. The cut throat competitions between different institutions to the extent of allegedly even sabotaging the competitor is one of the ills pervading the private engineering institutions in Nepal.

Policy recommendations

1. In order to maintain the quality of the engineering education and to give opportunities to the deserving students, single entrance examination system has been recommended. A joint committee involving Nepal Engineering Council, University Grant Commission (UGC), and the Universities may administer the examinations.
2. Students obtaining higher scores in the entrance examination should be provided loan to study engineering courses
3. There should be one inspection body for engineering instead of three that are existent at the present. The engineering council should form a central inspection team with the participation of the UGC, the affiliating Universities and the affiliated engineering colleges.
4. The council should fix the tuition fee of the engineering colleges based on their physical infrastructure and the academic performances. It should also bring out the relative standing of the different Engineering Colleges based on their research capability, out reach activity, institution industry interaction, performance of their graduates, the physical as well as the academic infrastructure.
5. There is a need for institutions to calibrate the supply and demand for engineering services in the Nepalese economy and to ensure mechanisms for quality control.

Forestry

Historical to date

The direction and degree of progress in the science and technology of forestry in Nepal has been dictated a) the historical perception of forests as a easy national treasure to be mined, b) the role of forests in environmental conservation, c) the role of forests in meeting the basic

needs of the rural poor and now d) the role of forests to generate wealth from global climate change amelioration (Bajracharya 1999).

In order to enhance the changing roles of forests to contribute to the national economy, investment in capacity enhancements have taken specific characteristics at different times.

From 1922 to 1978, the science and technology of Nepalese forestry was geared towards custodial role of guarding Nepalese treasury, the forests and devising efficient ways to extracting and exporting forest products, mostly lumbar. The custodial role was first started by deputing law and order provincial chiefs, the *Bada Hakims*, to oversee extraction of lumber by the British India for its railway sleepers along the Terai rivers. The science and technology was inventorying plant species, a task begun earlier by Brian Hodgson, the British India Resident Representative some 50 years earlier. This task gained more momentum with the more sophisticated survey of forest resources using remote sensing, more scientific harvesting and logging, the drafting of legislation to nationalize all forests and developing a forestry cadre that was trained in general forestry but whose job involved mostly custodial law and order persecution of forest trespassers.

Beginning the 1970s, the forests of Nepal came under international environmental scrutiny for its suspected role in exacerbating soil erosion and catastrophic flooding in Bangladesh. Money poured in to develop the science and technology of forest conservation for environmental services such as the slowing of land degradation and the slowing of biodiversity loss. Nearly three decades of investment here have produced a cadre of foresters honed in soil and water conservation as well wildlife and national parks conservation. Appropriate laws, rules and government institutions were also drafted as support contexts.

Nevertheless, by early 1980s, it was realized that the use of forests was not contributing significantly to the livelihoods of the Nepalese rural population. The government realized that it could neither discharge its custodial duties nor its environmental conservation responsibilities efficiently without greater participation of the rural communities that used the forests. Community Forestry as a successful technology was developed in Nepal to elicit greater participation of the people in forestry. This 'technology' involved the drafting of people-friendly regulations, the training of people-friendly foresters and the design and dissemination of people-friendly science and technology of community forestry

By the middle of 2005, the global environmental attention focused on Nepal's forest role in ameliorating global climate change by recycling atmospheric carbon dioxide. For this, Nepal would be eligible for compensation under the Kyoto Protocol to which Nepal signed on in 2005. The science and technology of this new role is at its infancy.

Delivery parameters and capacity

The technological know-how of forestry and forest-related services are distributed as follows:

I. The Government: Ministry of Forests and Soil and Water Conservation

1. Custodial technology:	Department of Forests
2. Survey technology including remote sensing:	Forest Survey Department
3. Forest improvement technology:	Forest Research Department
4. Plants inventory and tissue culture:	Plant Research Department
5. Soil and Watershed Conservation technology:	Soil and Watershed Dept.
6. Wildlife conservation technology:	Department of National Parks
7. Community Forestry technology:	Department of Forests
8. Drug manufacture and marketing:	Royal Drugs Department

II. Tribhuvan University: Institute of Forestry

This supplies manpower in the aforementioned specialties. Manpower levels are Certificate levels for Rangers, Bachelor level for Forest Officers and Masters Level for specialized subdisciplines within forestry. This Institute meets all forestry manpower under Masters. The demands for emerging disciplines for Masters and higher are met from foreign universities.

III. Non-Government Sector:

1. Environmental conservation: King Mahendra Trust for Nature Conservation.
2. Timber harvesting: Timber Corporation of Nepal
3. Resin extraction and production: Rosin and Turpentine Factory
4. Herb production and procession: Herb Production Company
5. Public participation in forest conservation: Community Forestry Users

Forest protection involved technology from the behavioural sciences. Nepal learned that she could not protect the forests by depending on the custodial powers of its forestry manpower alone, so it developed the community forestry technology that involved getting peoples' participation in forestry protection with the legal provision to award the benefits of such forests to the forest user groups. Nepal also invested in the design of a brand new curriculum in the Institute of Forestry to train new foresters to this task.

The forestry sector was the first to introduce state-of-the-art remote sensing technology to assess forest resources using field survey, aerial and satellite imagery analysis as well as geographic information system. Both machines and trained manpower were introduced and sustained with donor support.

The forestry sector has been keeping track of plant biodiversity and modifying tissue culture technologies for Nepalese species. It has also successfully managed the manufacture of drugs from forest herbs.

Nepal has successfully developed environmental conservation techniques in national parks with people's participation and military control. Examples are Royal Chitwan National Park and the Annapurna Conservation Area.

Nepal now no longer depends on friendly nations for the basic training of foresters. Nepal now has the capacity to train foresters of different specializations up to Masters levels and many private colleges are also producing environmental and natural resource managers. Still there is a demand for highly specialized forestry experts trained from abroad.

Bottlenecks to efficient delivery

The prime bottleneck impeding the efficiency of forestry sector to contribute to the economy is the State's tight hold on it as a premium revenue source. This attitude contributed to the failure of the 1957 Forest Nationalization Act or its ancillaries to protect forests from abuse by encroachers, loggers, or even common people who needed the forests to support their subsistence agriculture. Although, community forestry was designed as an antidote to this tight clasp of the government and significant amount of forests have been handed over to the communities, this attitude that the State and its foresters own the Nation's forests and have the know-how to manage it best inhibits the development of forestry technology outside the government sector. As a result, machinery, training, manpower stagnate in suboptimal situations while the private sector is constrained by the lack of legal guarantees for its investment, the shortage of know-how and the shortage of capital.

These conditions are being alleviated following the political changes of 1990 and liberalization that allowed for greater participation of both the private sector and the public in forestry. Private and leasehold forestry have been encouraged, private forest based non-governmental organizations now offer consulting, research, training and forest plantation services.

Policy recommendations

1. The forestry sector could use further liberalization of the private and non-government sector to invite investment, training and competitive forest services outside the government.
2. The State should relax the hold of forest professionals and its machinery assets that are currently underused overcapacity so private sector can use it and save on their capital investments to enhance forestry productivity.

3. The development of greater private sector investment in education and research should be encouraged to produce more specialized manpower and in-country forestry technologies.

Health Sciences

Historical to date

Nepal has a long tradition of non-western health care and learning, mainly Ayurvedic, meaning the science of life. It has been recorded that Ayurvedic hospital existed during Lichhavi period in 7th century. An Ayurvedic dispensary was established during the period of Pratap Malla (1641-1674). It is believed that the Singh durbar Vaidyakhana was set up during this period. The Ayurvedic concepts of diet, pathophysiotherapy and therapy are still prevalent in the Nepali society. Under royal patronage Royal Nepal Ayurved School was established in Kathmandu in 1928 and formal Ayurvedic education was started. Since then the education has been expanded and modified. At present, the Ayurved Campus comes under the umbrella of Tribhuvan University.

It is believed that King Pratap Malla introduced the Allopathic or the western system of medicine. King Prithvi Narayan Shah had his brother treated with western medicine when he was wounded in an attack to Kirtipur in 1760s. However, the institutional services of this modern health science and technology became available in Nepal from 1890 with the establishment of Prithvi Bir Hospital. Before 1950, several hospitals were set up in various parts of the country such as Birgunj, Jaleswor, Hanumannagar, Nepalgunj, Taulihawa, Bhaktapur, Bhadrapur, Dhankuta, Doti, Ilam and Parasi. At present, there are hospitals in all 75 districts.

In addition to the hospitals and health posts, vertical projects were implemented since 1950s. The malaria eradication project was introduced in 1959 followed by smallpox control project in 1962 and family planning in 1967. Specialized health services on tuberculosis and leprosy were already there since 1936. In 1972, a pilot project on integrated health plan was initiated with an aim to provide basic health services to the people. Similarly, Nepal successfully brought awareness about oral re-hydration therapy in 1980s. In the following years, campaigns on Vitamin A, HIV/AIDS, immunization such as BSC and DPT, TT, oral polio drops and measles vaccine were included.

On medical trainings, the first civil medical school was established in 1934 to train compounders and dressers. In 1956, training centers were opened to train lower level health manpower such as nurses and health assistants in Nepal. In 1962 an AHW school was started

under the aegis of the Ministry of Health. Till late 1970s, medical doctors were trained in foreign countries mainly India and then USSR under various scholarship schemes. The Institute of Medicine was established in 1972 under the aegis of Tribhuvan University. The Institute introduced MBBS program in 1978 and started producing trained doctors in the country. The Institute is now a Teaching Hospital that offers post-graduate courses. Many private medical colleges and teaching hospitals have been established over the last decade. Beside IOM/TU, there are 11 teaching institutions of health science (medicine and dental) in the country at present (Dixit 2005).

Beside these, various forms of traditional healing practices performed by Dhami, Jhakri and Jharfuke are also in practice in Nepal. In fact, they still exert a lot of influence regarding health matters among the Nepali populace especially in rural areas.

Delivery parameters and capacity

Nepal has signed the World Health Organization (WHO) Charter for Health Development and is also signatory to the WHO declaration Health for All by the year 2000. Nepal has set up basic infrastructure for health services. The infant mortality rate has slightly been improved, which is 64.4 per 1000 live birth. The life expectancies at birth for male and female are 62.20 and 62.50 respectively.

The per capita government expenditure on health sector is about NER 139.00, which is utilized mainly through the Department of Health Services. In Nepal, three-fourths of the investment in health sciences is in the human resources for health: doctors, health workers and the medical establishment. Nepal's expenditure on health sector is 1.3% of GDP.
The first long term health plan of 15 years was drawn in 1975, which was followed by the second in 1997. In the meantime several plans and policies on health related subject have been brought out, such as the National Health Policy 1991, National Drug Policy 1995, National Policy for Control of AIDS and STD 1995, National Ayurvedic Health Policy in 1995, Safe Motherhood Policy in 1998.

As such there are no laboratories on health science that are fully committed to carry out research works. The Institute of Medicine TU has established a health research laboratory at its premises, which carry out research in microbiology. The laboratories established by other institutes and government are also service oriented. Some of such laboratories are: 1. Nepal Public Health Laboratory, HMG, Ministry of Health, Teku; 2, Microbiology, Virology, Biochemistry and Hematology Laboratories at TU Teaching Hospital; 3, BPK Institute of Health Sciences: Microbiology, Virology, Biochemistry and Hematology Laboratories; 4. National TB Center, Sanothimi: Microbiology Laboratory; 5, National Vector borne disease research laboratory, Hetauda; and 6. Regional Public Health Laboratory, Pokhara

The health delivery system includes 3,132 sub health posts, 705 health posts, 15 family planning clinics, 193 primary health centers, 88 hospitals in the public sector and 118 hospitals in the private and NGO sector. This system delivers modern (western, allopathic) medicine. In addition, there are 287 Ayurvedic hospitals, 1 Homeopathic and 1 Unani health facility supported by the government. Other health care systems including Chinese, Korean, Tantric, Natural Healing and alternative therapies that are running on private demand.

According to a study of Nepal Medical Council in 2004, there are 4838 registered Nepali doctors. Of these, 1608 work in the public sector, the rest in private sector. There are 1133 specialists but there is a demand for additional 1435 specialists. Some of the specialists can come from the general physician ranks but after discounting for their natural attrition to foreign countries, there is still likely to be a deficit in specialists.

Nepal Medical Association is the first professional society in the country. It has about 2500 members. The association organizes conferences and seminar and also publishes Journal of Nepal Medical Association. Some other medical journals published in the country are: Journal of Institute of Medicine, Nepal Pediatric Society Journal, Kathmandu University Medical Journal, Renaissance: Journal of BPK Institute of Health Sciences, Journal of Nepal Health Research Council, Nepal Journal of Neuroscience and Nepal Journal of Psychiatry.

Some of the remarkable achievements made in health sectors by Nepal are:

- Successful eradication of smallpox eradication program and reaching near eradication of polio from the country through successful and effective implementation of public health programs.
- Popularization of the concept of oral rehydration salts and need for oral hydration during diarrheal illness has significantly reduced the illness and death rate from this disease.
- Rapid increase in the number of academic institutions in medicine so that the number of doctors has jumped within a very short period of time.
- Expansion in the number of facilities providing life saving medical services in the urban areas of the country. There is almost no need to travel abroad or leave the country for any kind of medical treatment in the country.

Bottlenecks to efficient delivery

The major bottleneck has been the government's management of health professionals through the Ministry of Health. Though the Ministry swears by its commitment to national health care to extend quality health care from urban centers to far away places of the country, they have not been successful in dealing with the economic forces of greater opportunity available to doctors in the cities and foreign countries.

Health practitioners in Nepal have easy access technology and drugs developed in the developed countries. This has discouraged them to look for own solutions to the problems faced in patient care.

Most of the health services are concentrated in the urban areas but the overall increases in health services due to greater participation of the private sector and the greater outlay of the State budget to the public health sector have yielded dividends in the steady increase in the Human Development Index values for Nepal from 0.333 to 0.499. This HDI incorporates indicators of health value increases such as life expectancy, infant mortality.

The government is now seceding its exclusive role to the private sectors and they have responded vigorously by increasing investment in the health sector such that there are now more beds in the non-government sector than in the government sector. A recent study commissioned by Ministry of Health regarding the status of equipment in government hospitals had come out with a startling revelation that more than 75% of equipment was out of order and malfunctioning. Such state of equipment was reported as a matter of serious threat to our health.

The basic type of research that can lead to new cure of diseases or explanations of disease process is beyond the scope of health professionals currently working or being produced in this county. Basic medical science disciplines such as physiology, biochemistry, microbiology and pharmacology are not popular subjects for postgraduate studies in the developing countries and the situation is worse in Nepal. Most of the researches in health sciences have been dominated by baseline status and identifying health problems, demographic health surveys. Attempt to conduct research in clinical subjects is of recent origin.

Policy recommendations

1. The private sector is more keenly responsive to the market signals of demand and supply. So on one hand we have an excess of supply in the cities and an excess of

specialists over general physicians while there are reports of a lack of quality control in the private sector. There is a need for some quality control and some planning.

2. On one hand, Nepal procures the medical equipments from foreign countries at huge foreign currency costs, while on the other such equipments are not being maintained or repaired properly. Therefore, the State should set up a national level instrumentation center and prepare required manpower.
3. Nepal's community based higher study in medicine has set a success model of teaching. The State should develop policies to disseminate this system to foreign countries through its own manpower and be benefited.
4. Many medical colleges have been established in the country. However, the fee structure of these colleges are out of reach to general Nepali people debarring many talents from taking medicine as profession. The State should create more reserve seats for talents from economically lower strata of the society.
5. Superstitions and taboos still prevail in Nepali society. Health awareness campaigns to save the lives from ignorance should be intensified.

Mathematics

History to date

The history of teaching mathematics is as old as the human civilization. In Nepal, mathematics teaching started with the beginning of Gurukul in ancient time. In the modern history of formal education, Mathematics was included as a part of curriculum at school level with the beginning of Durbar School in 1853 AD. The contents of mathematics were Algebra, Arithmetic and Geometry written in English. The first book of mathematics in Nepali appeared in 1883 (Tuladhar & Jha 2002, Jha et al. 2004).

Higher education in mathematics started from Intermediate of Arts (IA) at Trichandra College in 1926 AD and it was affiliated to Patna University, India. Science teaching at Intermediate (I.Sc) and Bachelor (B.Sc) were started in 1932 and 1942 respectively at the same college. Master level classes in Mathematics were started in 1959 with the establishment of the Mathematics department in Tribhuvan University. At earlier stages, both Indian and Nepali teachers had taught the related courses. Some of the well-known Indian professors had come to Nepal as visiting professors under Colombo Plan Scheme.

Delivery parameters and capacity

Mathematics constructs the basis of all sciences. As mathematics does not need sophisticated laboratory facilities, it could be the best science for a developing country like Nepal. At present, majority of the mathematics graduates are involved in teaching profession. Few

students are motivated to enroll in M.Phil and PhD programs and get involved in research activities. In order to encourage research activities in Mathematics, Tribhuvan University started PhD program in Mathematics in 1965. Similarly, Kathmandu University has also started M.Phil and PhD programs in Mathematics since 1997. It is estimated that there are about 35 PhD holders in Mathematics in the country, including those few who did PhD from TU and KU.

The University Grant Commission (UGC) Nepal, established in 1993, has been assisting the improvement of the quality of higher education in Nepal. It annually provides grants to those students enrolled in M.Phil and PhD programs. Similarly, RONAST has schemes of research grant and PhD fellowships for science students including mathematics. UNESCO is also working for the advancement of mathematics. Its regional office at new Delhi regularly organizes short-term training programs in mathematics. The International Centre for Theoretical Physics (ICTP) at Trieste, Italy has also been providing with scholarships and diploma courses in Mathematics for Nepali students.

The Council of Mathematics Education, established in 1991, regularly conducts training programs for the Mathematics teachers and brings out a journal entitled Mathematics Education Forum. Nepal Mathematics Society has been working in popularizing Mathematics in Nepal since 1970. The society also organizes conferences and publishes a journal The Nepal Mathematical Science Report.

Bottleneck in efficient delivery

The major set back in Mathematics is that the subject is treated as the most difficult subject amongst the students in Nepal. The average pass rate of students in compulsory Mathematics papers in School Leaving Certificate Board Examinations is about 40-50 percent. The results of Higher Secondary Education Board (HSEB) shows that the pass percent of students in class XI and XII have been below less than fifty. The situation is poorer at higher level. The results of the first year students of MA and MSc mathematics showed that only 10 students of were passed out of 153, while only 8 were passed in Med at Tribhuvan University in 2000. Thus, students are little motivated to study Mathematics as a major subject.

Policy recommendations

1. Mathematics should be made an interesting subject and the students made to feel that the subject is not as difficult one as that has been a general concept. For this Mathematics teaching must be improved drastically so that many students take interest on it and pass the examinations.

6. At present Mathematics is too theoretical and abstract a subject. It should be made more practical and its scope be elaborated accordingly. Regular workshops and seminars on Mathematics can help identify its problems and their way outs.
7. Formation of Mathematics clubs at the initiative of students and teachers can help popularize the subject. Academic institutions, schools must organize quiz, Olympiad on mathematics on regular basis.

Physics

History to date

Physics has been an integral part of science education since Trichandra College was established in 1919. The college offered science at Intermediate level with Physics as a major component. Physics at Bachelor level was introduced in 1948. Physics at Master level began in 1965 after the establishment of Tribhuvan University. The first Nepali graduate in Physics with Master's degree did appear in 1934 and the second in 1952. Few Physics graduates went abroad for PhD only after 1956. Till 1983, there were only eight Physicists with doctoral degree (KC et al. 1997). RONAST's recent source shows that there are 1160 Physics graduates in Nepal.

The number of students taking Physics as major subject has always been lower when compared with other faculties. The first batch of Physics at Tribhuvan University had only five students. The number even dropped to two in 1970s. However, in recent years Physics is attracting good number of students. There were over 400 students taking entrance examinations to get enrollment at M.Sc at Tribhuvan University. This is mainly because that Physics graduates are getting opportunities for higher education in the USA in recent years. It has been reported that about 30 Physics graduates from Nepal are going to the USA and other countries every year.

In order to promote Physics education and research, International Center for Theoretical Physics (ICTP), in collaboration with Royal Nepal Academy of Science and Technology and Tribhuvan University, conducted summer schools in Physics in 1980s (Bhattarai 1996). The school included Physicists from Bangladesh, China, Sri Lanka, Pakistan, India and Nepal. The school focused on theoretical physics such as condensed matter and particle physics. An international center for high-tech research was also proposed. However, neither the summer school program could be continued nor the proposed center was materialized.

Delivery parameters and capacity

In Nepal, activities related to physics are mainly limited in teaching. Tribhuvan University is the only institution in the country offering graduate courses in Physics. At present, the Central Department of Physics at Tribhuvan University offers a two-year Master's Degree program in physics. As special subjects, five papers are offered Solid State Physics, Cosmology and Gravitation, Optoelectronics, Bio-medical Physics and Plasma Physics. In addition, the department also has PhD program, three PhD degrees have already been awarded (IOST/TU 2003). The faculties in the department are involved in research project in collaboration with various national and international organizations. Extension of physics education into adjoining areas such as atmospheric physics and geo-physics were also initiated at the department to draw more interest in physics and create career opportunities in overlap area in applied science and technology.

Major research equipment currently available at CDP/TU are: Differential scanning calorimeter, Viscometer, Refractometer, Capacitance bridge, Ultraviolet- visible light intensity measuring cell, digital oscillospcope, He and Ne laser, Brewer equipment and UV spectrophotometer. Current areas of research activity in the department are in: solid state (experimental), polymer (experimental), radiation (experimental), plasma (theoretical), astrophysics and cosmology (theoretical), geophysics (data analysis), atmospheric physics (experimental) and computational physics (energy calculation, computer simulation).

Nepal Physics Society was established with the aim to promote and advance knowledge in Physics including research and its application in 1983. The major activities of the society are: organize seminars and other discussion forum; arrange colloquia and exhibitions assist in the development and refinement of Physics curriculum and improvement of teaching-learning situation. The society publishes the proceedings of its meetings and conferences. It has two major publications: Physics Newsletter and Journal of Nepal Physical Society.

Bottleneck in efficient delivery

The development of Physics in Nepal as a basic scientific pursuit has been far from encouraging. Within the community of sciences, Physics has stood to gain the least stature as well as in effectiveness. This has been so partly because routine studies and applications in Physics on purely regional basis cannot be extended. Physics graduates are mostly engaged in teaching in Nepal. Research activities in Physics are limited mostly in MSc dissertation works. Being normally considered difficult and too academic, appropriate attention and support for Physics are still to be formed (Pradhan 1996).

The weaknesses persisting with regards to physics is inanely concerned with an understanding of 'doing physics'. There is a kind of phobia with physics among the students,

and neglect experimental exercise. Doing physics is getting really involved in enhancing the body of knowledge in physics, needs an open mind properly assisted by theoretical knowphow, good experimental skills and mathematical ability. A good mix of all these factors is presently lacking even among the physicists (Pradhan et al 2002).

Policy recommendations

1. Priorities in program strengthening should include creation of ancillary service facilities, basically, repair maintenance and fabrication, inclusion of such practices for Physicists in training and the initiation of effective dialogues between Physicists and technologists towards cooperation in work and togetherness in thinking while addressing themselves to the country's problems of development in science and technology.
2. Perceived allergy for physics should be eliminated as soon as possible. Initiate a strong teacher orientation program. Learning and teaching should be conjoined in proper perspectives. Improve the present laboratory conditions at the university.
3. Strengthening the laboratory facilities of the schools to facilitate basic experiments of physics in schools and reviewing the present curriculum to narrow the gap between school and college level curriculum in physics.
4. Further develop collaborative activities with other national and international institutions and enhance the levels of expertise. Seek and establish avenues of growth in R&D pertaining to immediate benefits to industry and other technologies.
5. Embark on a national plan of setting up strong sustainable bases for theoretical and experimental research in recognized growth areas in physics.

Plant Science

History to date

In 1802, Hamilton Buchanin made the first systematic collection of plant species in Nepal, followed by N. Wallich in 1820. In 1853, Nepal introduced white clover (*Trifolium repens*) from the west. Plant Science as a specialized subject was realized in 1950 when Trichandra College introduced Botany in the curriculum of Intermediate level. Seven years later, the college introduced Botany in Bachelor's degree. Tribbuvan University started enrolling graduate students in Botany (MSc) from 1965. The first PhD degree in Botany was conferred in 1981, which was one of the first such degree in science faculty in Nepal (Bajracharya & Joshi 1981).

At the government level, the first R&D body of Plant Science was created in 1959 called the Department of Medicinal Plants. The other institutions, beside the universities, encompassing research activities and/or services in plant resources are: Central Food Research Laboratory, Royal Drug Limited, Department of National Parks and Wildlife Conservation, Research Centre for Applied Science and Technology, Herb Processing and Production Company Limited (est. 1981), Royal Nepal Academy of Science and Technology, Nepal Agricultural Research Council.

The involvement of private sectors is steadily growing in the field of plant science in Nepal. Beside several nurseries there are a dozen of private enterprises involving tissue culture and other production activities.

Delivery parameters and capacity

Plant Science is a basic science whose role in the contribution of S&T to the development of Nepal surfaces when one considers its role in enhancing the capacity of other applied subjects to contribute to the economic productivity of the nation. Examples are agriculture and forestry, two natural resources based economic sectors whose efficiency of contribution to the economic growth of the country depends on the quality and quantity of inputs from the plant sciences. Plant sciences also contribute indirectly to the economic sector by enhancing the capacity of environmental and ecological sciences to sustain the productivity of Nepalese ecosystems.

Basic plant sciences have also begun to contribute directly to the economic sector by developing and commercializing biotechnology of tissue culture of some economic species such as orchids and potato, floriculture and nurseries. Since the plant sciences are the major components of general sciences, there is a great demand for botanists in school teaching. More than half of the estimated 2000 botanists are found in teaching while the rest are distributed in government and private sector, conducting research and extension, or even manufacture of plant products such as medicines.

One reason why Plant Sciences bears such significance in Nepal is the astounding plant diversity of Nepal. The country holds only 0.1 percent of the total land area of the earth while harboring about 2 percent of flowering plants of the world's flora (Shakya 1999). Over half of Nepal's land area (54%) is covered with vegetation and nearly four out five Nepalese depends on plant-based livelihoods. The plant resources are not only immediate economic resources in terms of agriculture crops, medicinal plants, or plant products for industrial use such as Sal seed oil or banaspati ghee or resin or tannins but also of potential genetic germ plasm for genetic engineering of commercial crops or commercial products such as *taxon*, the anti-cancer extract from *Taxus baccata*.

The knowledge-base competencies within the plant sciences include: Taxonomy, Cytogenetics, Ecology and Environmental Studies, Plant Physiology and Pathology, Tissue Culture, Pharmacology and Drug manufacture (Rajbhandary et al. 1999). The plant scientists have been routinely productive at scientific conferences, contributing nearly a quarter of the total professional papers (RONAST 1989, 2000 and 2004).

The collaboration between RONAST, Royal Botanic Garden Edinburgh, the Natural History Museum London, and the University of Tokyo at international level, and signing of MOU between RONAST, Ministry of Forests and Soil Conservation and Tribhuvan University to advance the publication of Flora of Nepal is notable achievement.

Besides the assets of modern knowledge base in the plant sciences, there is also a wealth of indigenous knowledge regarding the country's varied plant resources and their uses in the oral memories and life patterns of the astounding variety of ethnic groups in Nepal. Shrestha (1997) has prepared a list of 314 citations published during 1955-1997 on ethnobotanical works in Nepal.

Nepal Botanical Society was established in 1981. The society organizes seminars, special talk programs, and conferences. In 1992, it organized the First National Botanical Conference. In 1992, NBS also opened the first channel of international cooperation by signing an MOU with the World Wildlife Fund, Nepal Program providing MSc students with grant support for the dissertation works. Beside the NBS, there are six more professional societies where the plant scientists are actively contributing, viz. Nepal Biotechnology Association (est. 1988), Ecological Society (est. 1992), Natural History Society of Nepal (est. 1992), Ethnobotanical Society of Nepal (est. 1997), Orchid Society of Nepal, and Floriculture Association of Nepal. All these professional societies have their publications, a few notable ones are: Ecoprint (journal), Nepal Journal of Plant Science, Botanica Orientalis and Plant Research Bulletin.

Bottlenecks to efficient delivery

The country seems to be doing fine with the production of teachers of plant sciences for the schools and universities. Despite the numbers and specializations, highly trained Botanists have little opportunity in terms of research funding or institutional environment to pursue in research that yield intellectual or economic dividends to the country except in narrow sectors such as agriculture, forestry, or the environment. Despite such bottlenecks, plant scientists have developed commercially viable tissue culture of economic species such as orchids and engaged in economically viable ventures such floriculture.

Policy recommendations

1. Preparation of flora of Nepal is yet to be completed. Keeping view the regulations of WTO and IPR, preparation of flora of Nepal should be given special priority, and completed at the earliest.
2. Nepal offers a huge scope in plant research. The basic research activities in plant science should be centered around plant utilization and sustainable development. A research center, which is entirely devoted to problems of utilizing hitherto unexploited or under exploited plants, if established will be a great asset for the country.
3. Conservation and perpetuation of endemic and endangered plant species is urgent and important to avoid any possible irreversible loss. Assessment and autoecological studies of these plants should be carried out.
4. The State needs to release the plant science assets in the government and university organization for research, development and commercial ventures using private sector investments. This will enhance the productivity of plant scientists who are otherwise under performing by limiting themselves to just teaching.

Statistics

History to date

Statistics is a mathematical discipline that is concerned with quality and reliability of data. This discipline is enables the science and technology sectors to contribute to the efficient allocation of scarce resources of time, money and materials for the development of the country.

The history of statistics as a discipline of science and technology started in 1940s with the establishment of *Janashankhya Goshara,* the precursor of Central Bureau of Statistics. Manpower development in statistics started in the 1950's under the Mathematics Department of Tribhuvan University and flowering to Statistics as an independent discipline from 1964. Statistics is now taught widely throughout the universities (Singh et al 1999).

Currently, the Central Department of Statistics in Tribhuvan University and the Central Bureau of Statistics are the largest repositories of statisticians, having about 100 each. The former is largely concerned with teaching and some research while the latter is concerned almost exclusively with population census. Statisticians are also scattered in financial institutions such as banks, some development related non-governmental organizations and different ministries. The total number estimated in 1999 was 368.

Delivery parameters and capacity

While higher level statistics course is offered in the Central Department of Statistics at TU and at Kathmandu University (KU), Bachelor level courses in Statistics are offered in many of its campus, either as a separate discipline or as a part of other disciplines such as Commerce, Humanities and Science. TU produces about 50 Masters degrees in Statistics annually and about 150 Bachelors degrees in Statistics. TU had nearly 15 statisticians with PhDs in 1999.

Almost all of the contribution of the highly trained statisticians in the University are limited to teaching; there is little budget or opportunity for research except for a very few. Similarly almost all the work at CBS is limited to routine analysis but there is little budget for research and higher-level contribution of statistics to national development.

Bottlenecks to efficient delivery

Two types of resource constraints are limiting the efficiency of the contribution that statistics can make to the economic productivity of the nation and they are *not* quality or quantity of manpower.

The first is the severe lack of resources for anything more than the salary of statisticians, severely limiting them to their narrow assigned tasks of either teaching or their routine analysis although they are capable of much more and the country needs much more from them. Driving this resource constraint is the lack of understanding and appreciation on the part of decision makers who control the purse strings on the importance of quality data since most of them are happy to make readily available data with no concern for their validity or reliability or how such decisions promote waste of valuable resources. So even urgent needs such as physical working space, textbook updating, computers and Internet access for statistical applications are not addressed.

In order to increase the contribution and efficiency of statistics to the economic productivity of the nation, the severe resource constraints of the Central Department of Statistics and the Central Bureau of Statistics much be immediately addressed since these two organizations contain the highest number of the most qualified statisticians and their physical assets. This includes direct budget grants should be provided for increased physical space and resources such as computer, photocopy, textbook revision, specialized library and funds for lateral linkages with development agencies that might better use their services.

An organization such as RONAST can begin and coordinate this task of arranging budget, foreign linkages and linkages to in-country users of statistics data so there is more lateral linkages for the demand of quality statistical services.

Zoology

History to date

Zoology is a basic science that contributes to the national development by enhancing the capacity of other applied disciplines to contribute to the greater productivity of the nation. These applied disciplines include Medical sciences, Veterinary Sciences, Wildlife, Live-stocks Sciences (Including Poultry), Entomology, Nematology, Parasitology, Limnology and Fisheries (Neupane et al 1999).

The history of Zoology science and technology in Nepal is limited almost exclusively to teaching at the university level with the minimum of physical facilities or research experience on the part of teachers. The manpower thus generated is consumed as teachers in universities, colleges and now the additional two years of high school science curriculum.

Zoologists involved in applied aspects of technology: Fisheries, Wildlife, Livestock and Animal Sciences, Veterinary Sciences, Pest control from rodents to insects and nematodes and the Medical science receive greater budgetary allocation because of their more direct potential to contribute to the well being of human population (medical sciences, parasitology), commercially useful animals (livestock, poultry and fisheries), or pest control of agricultural crops. Recently, some zoologists are finding opportunities in documenting faunal biodiversity and wildlife behavior studies of animals useful for biomedical research.

Zoologists have several professional bodies that promote the dissemination of knowledge.

Delivery parameters and capacity

There are over 150 Zoology teachers in Tribhuvan University Central Zoology Department, with smaller numbers in Kathmandu University and some 16 campuses with Zoology Instruction Committee. Zoology is offered as part of university teaching in Agriculture and Animal Sciences University, Teaching Medical College and the Forestry colleges.

The Central Department of Zoology has the bare essentials in the form of laboratory equipment but is constrained for physical space and funding for even syllabus review. Zoologists involved in teaching can deliver little else: no research and even the teaching is outdated yet the academic potential in terms of journal articles seem to be respectable.

On the other hand, Zoologists involved in the applied sectors and beneficiaries of government and donor largesse seem to have no problems of resources but they have delivered little academic output or noticeable technology that have increased agricultural productivity. Exceptions may be the growth of dairy industry, poultry and fishery industries.

In zoology, Nepal is producing required manpower including those in Masters degree. Doctorate program is also offered at the Tribhuvan University. Similarly, specialization has been expanded in various fields such as fisheries, entomology and parasitology.

Bottlenecks to efficient delivery

Zoologists involved in teaching need investment for physical space, laboratories, research skills and even syllabus updating if they are to remain relevant and useful for contributing to the economic growth of our country.

The State should make provisions for greater sharing of its physical assets: laboratory, budget and materials with university zoology professors so government can make useful contribution to economically productive services.

Zoology teaching is based on not-so dynamic curriculum, which has not much addressed the contemporary issues in biodiversity and other emerging fields of protected areas. This has made zoology not very attractive and useful in national context.

Policy recommendations

1. An organization like RONAST can facilitate this vital partnership between the universities and government agencies with zoology professionals so economically useful technologies are generated and disseminated.
2. RONAST can also encourage research and syllabus updating by channeling grant money from its own resources or from international linkages to university teachers.

CHAPTER 6

POLICY RECOMMENDATIONS & DEVELOPMENT TARGETS

The pretext

A visibly seen achievement that Nepal has made in the science and technology sector in last five decades is its increased capability to manage various S&T institutions in rendering scientific services to its different development efforts (Shrestha 1996). Facilitated by policy relaxation, a marked increment was noted in educational and training capability after 1990. While the R&D facilities have been improved in the country, the promotional and legal instruments are in progress. The S&T capability has also been manifested in decisions making and technical negotiations for better terms and conditions.

There has been a steady increase in the number of S&T institutions over every succeeding decade since 1950s. Nepal is now equipped with basic infrastructure covering all major fields of S&T. Some of them are even at par with international standards, specifically in technological delivery such as micro-hydro, natural resource management, eye operation etc. In 1990s a large number of institutions related to higher education were established, which enabled Nepal to train high-level manpower within the country in all major disciplines of S&T such as medicine, engineering, agriculture, forestry and natural sciences. Lately, there have been particularly great efforts to develop manpower in the emerging fields such as IT and computer sciences. This kind of efforts has contributed to the increase of S&T manpower in the country, which has reached over 28,000 as of the recent data published by RONAST.

However, it is yet to assess to what extent the S&T progress has contributed to bringing a comparative improvement in socio-economic indicators like GDP, per capita income, life expectancy, literacy rate, industrial and manufacturing contribution to GDP, communication and energy supply. In the lack of such visible impact of science and technology to overcome the problems of invigorating its economy and bringing prosperity for the people, there have been frequent questions about the achievements of S&T (Bajracharya 2001).

Table 41. Three-pronged policy recommendations for development targets of Nepal

	Development Targets	Implementing Agency	Remarks
1.	**Formulating Visionary S&T Policy and Planning**		
1.1	Develop visionary national policy of consensus on S&T and firm commitment to support its development	House of Representatives, Government, Advisory institutions including professional societies	Present S&T policy to be amended for consensus
1.2	Determine definite areas of national priority on S&T sector for R&D	National Planning Commission in consultation with and active participation of S&T communities	Plans and achievements made in S&T sector to be critically reviewed
1.3	Develop legal measures to motivate S&T community and industries, and utilize existing manpower and resources	House of Representatives	Review the existing rules and regulations, make them forward looking
1.4	Formation of S&T committee in the House of Representatives	House of Representatives	A separate committee on S&T is needed
1.5	Make adequate investments on R&D, at least 1% of GDP, and involve private sectors in R&D activities	Ministry of Finance, National Planning Commission, Industries	Present R&D investment is too meager
2.	**Strengthening S&T education and training system**		
2.1	Establish model science education institutions (+2 in all 75 districts, bachelor level colleges in all 14 zones, and master level higher learning in all 5 regions of the country	Ministry of Education/HMGN Local governments (DDC and Municipalities), HSEB, and Universities	Local governments be motivated and strengthen to manage educational institutions
2.2	Making the present technical and vocational training programs effective and geared towards self-employment	CTEVT, Banks, Private enterprises	CTEVT performances to be reviewed, and restructuring to include stakeholders
2.3	Make tertiary education research based and upgrade university departments of master level as centers of excellence on respective fields to support the national program	TU and other universities	Universities to be outward looking and curriculum be dynamic
2.4	Augment S&T awareness through more science exhibition activities, increased media coverage on S&T, and promote through more fellowships, research grants, and award	RONAST, Extension units of government departments, Media outlets and NGOs	Coherent messages to be flooded for demystifying superstitions and taboos
2.5	Develop interactive science centers and demonstration sites as means to educate general mass	RONAST, NARC	Such centers/sites will be self-sustaining type

	3. Building S&T capacity and management Development Targets	Implementing agency	Remarks
3.1	Establish national level research centers based on national strength such as high altitude sciences, hydrology, biodiversity, and indigenous knowledge	Government, RONAST, NARC, WECS	Existing research facilities be oriented towards building such centers
3.2	Organize more professional forum to increase peer-review activities, and boost morale of S&T communities	Professional organizations	S&T communities are highly frustrated and demoralized at present
3.3	Collaborate with international partners and Nepali expatriates for opening new frontier S&T, out-resourcing services in IT	Nepali embassies abroad, International institutions, Nepali expatriates	Collaboration only on specified areas of national priority
3.4	Commence result-oriented research, and transform their results from laboratories to land/industry for converting research results into marketable goods.	Research laboratories, FNCCI	Research area as specified by national priority
3.5	Structural adjustment to define roles of participating institutions and minimize redundant	MOEST as coordinating agency	Duplications in works and misunderstanding exist at present

The issues that underpin the challenges to be addressed for S&T are often raised in the workshops, seminars and discussions held under different occasions. Some of the way-outs suggested in such fora are typically vague such as enlivening of political commitments, while others are straight forwards and insist on re-orienting the approach (Gyawali 2000). Three-pronged policy recommendations are made here, viz. 1. Formulating visionary S&T policy and planning, 2. Strengthening S&T education and training system, and 3. Building S&T capacity and management (Table 41). Each recommendation is supplied with five development targets, and appropriate implementing agencies are also mentioned in the existing structure with remarks on the justification and/or importance.

Formulating Visionary S&T Policy and Planning

A visionary national policy of consensus to develop S&T is essential. Such policy makes sense only when there is a firm commitment from the legislatures (political parties), which form government accountable to the people. Such policy will determine areas of national priorities on S&T sector for R&D. The priorities are to be based on existing human resources and potentials such as increasing agricultural production through biotechnological

intervention and developing national capability in utilization of natural resources, hydropower and biodiversity.

One of the main problems in the implementation of S&T policies in Nepal is the change in the policies. Due to the political immaturity and the lack of consensus-building process, the S&T policy, like all other government policies, keep on changing with the change of governments. As a result there is no continuity in the government policy (Bajracharya 1998). Similarly, beside the government, the research organizations, industries, and S&T communities need to be motivated to fully participate in the process, for this existing rules and regulations have to be reviewed and relaxed accordingly. A science committee in the House of the Representatives will not only advocate for S&T development in the meetings but also caution during policy alteration.

With an investment of about 0.3 % of GNP, Nepal belongs to the countries where the investment in S&T is one of the lowest even by regional standard. The comparable figure for 1980s was 1.0 % for developed countries (Adhikary and Ranjit 1987). Unless there is an increase in the overall investment in S&T, the national S&T policy will be largely confined to written documents and its plans and programs cannot be implemented to meet its goals and objectives. The taskforce constituted by the Ministry of Science and Technology had also recommended that the level of investment should be increased to 1% of the GNP by the end of 2000 and to further increase the investment at the rate of 1% every five years (Suwal et al. 1996). But this has yet to be realized.

Strengthening S&T Education and Training System

The effective and efficient use of internal resources and for supply of industrial technologies as per the need of a country lies in S&T education and training system. Whilst the few public institutions of higher learning in the country are incompetent in quality, the private ones are competent to some extent but expensive and urban based. A network of model education institutions for S&T at three levels- higher secondary school (+2 level), college (Bachelor level) and university (Master level) is, therefore, justified. Such networks should open opportunities to the talents from economically weak strata of the society through study loan and assistantships.

As the technical education and vocational training programs are not entailed to self-employment generating scheme, many of the CTEVT graduates are left unemployed, when the country is flooded with semi-skilled hands from the third country. The CTEVT performance and structure, therefore, needs to be reviewed to accommodate stakeholders such as banks, investment companies and industries in the efforts.

Since Tribhuvan University started post-graduate programs in 1960s, there has been numerical growth in the student number that has not been matched by the simultaneous improvement in the infrastructure and facilities. There is no adequate investment in research activities in the university and their departments have always been at low priority when it comes to the investment in new scientific equipments. This has led to quality deterioration in the university products. Therefore, unless the government institutes a policy of strengthening S&T education in the country, government effort to apply S&T for the all-round development of the country will remain largely unsuccessful.

It has now been well recognized that adequate level of public understanding of S&T is necessary for the promotion and application of S&T in a country. In Nepal, social taboos and superstitions are deeply rooted, and need demystifying through scientific approach. Interactive science centers and wider coverage of S&T information by mass media will help build science awareness in the society and promote scientific temperament. In recent years, there has been encouraging number of incentives in sports and cultural activities in Nepal. Establishment of more awards and grants for S&T communities will encourage young graduates to devote more on S&T.

For many, scientific research is still a job done in sophisticated laboratories by white apron people. It has been reported that farm-level productivity of most food crops and livestock is low and fall below 50% of the attainable potential (Maskey et al. 2004). Development of demonstration sites for farmers and students will help bridge this existing gap between research laboratory and land practice.

Building S&T Capacity and Management

Most of S&T institutions in Nepal have specific confines of activities and function in isolation. For the lack of necessary authority and jurisdiction, the decisions of such S&T organizations like NCST and RONAST carried little weight and there was no coordination between the different S&T institutions in the country, leading sometimes to the confusion in the responsibilities of the institutions and to the repetitions of the activities. In the past, most of the S&T institutions suffered from conservative bureaucratic procedures and lacked minimum supportive services for their growth. There was a lack of appropriate knowledge in matters of S&T management at higher levels of decisions making. It was, therefore, felt that we had S&T organizations but no organized S&T (Pradhan 1997).

A need of an S&T body with necessary legal authority to coordinate the activities of different S&T institutions in the country was long felt, and as early as 1978 establishment of Ministry of Science and Technology with necessary advisory and executive bodies was proposed to take charge of the changing S&T scenario in the country. The Ministry of

Science and Technology was established in 1996. However, there are still some overlapping in the objectives and functions of MOST and RONAST. A well-defined demarcation of functions between these organizations is needed to avoid unnecessary confusion and duplication of works. Similarly, it is necessary to redraw organizational framework and strengthen linkages through a policy document.

There are several professional societies in the country, almost in every major discipline of S&T. But all these societies operate in isolation and there is hardly any mutual cooperation among them. So far, the involvement and input of professional societies in policy-making mechanism have been inadequate. There is also an inadequate representation of scientific societies and professionals in the formulation and implementation at policy levels. While the representation of professional societies should be enhanced in advisory bodies to assist in policy-making mechanisms, they should also increase their activities to promote peer-review culture and boost the morale of the S&T communities.

Nepal has its own specific problems related to its development that can be solved by new approach in scientific research. Most of the Nepali industries are either labor intensive (e.g. carpet) or assembling type (e.g. television) that demand little R&D inputs. For its geographical landlocked situation, a poor country like Nepal should take up mission-oriented research and give priority to light weighted but valuable products such as electronic chips, computer goods, and watch screw. For such a paradigm change, there needs to be revamping in thinking.

Sufficient national scientific and technological capacity is prerequisite for making proper choice of technology for an effective transfer of technology and for its utilization in the production of various goods and facilities. This is possible only if the government has a political will and is committed to developing S&T as an essential tool for national development (Dhaubhadel 2003).

Gyawali (2000) has identified three basic management styles in science: i. market science which is of an innovative and risk-taking nature, ii. voluntary science which is of a cautionary and risk-avoiding nature, and iii. government science which is a regulatory and risk-managing nature. Each science would counterbalance the other and provide a stability. Therefore, a coordinated effort is recommended in research ventures for the country.

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