

PROCEEDINGS

of

NATIONAL WORKSHOP

on

Promotion of New Technologies in Nepal

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"Promotion of New Technologies in Nepal"

24-25 March 1997
(11-12 Chaitra 2053)



Organised by

Science and Technology Policy Research Unit
Royal Nepal Academy of Science and Technology
Kathmandu, Nepal

in Collaboration with

Developing Countries Research Unit
University of Strathclyde, UK

Foreword

Technological advancement has brought revaluation in the western world, however, developing countries are far behind in this front. The prime cause for the developing countries to lag behind is the inadequate knowledge on transfer and promotion of appropriate and suitable technology in the country. While transferring or promoting a technology one should be aware of the an ambience and needs of the country. Hence, observing the urgency Science and Technology Policy Research Unit (STEPRUN) of RONAST in collaboration with the Developing Countries Research Unit (DCRU) of the University of Strathclyde, UK organised the workshop on "Promotion of New Technologies in Nepal" from 24-25 March, 1997.

STEPRUN finally succeeded to turn its dream into reality by publishing this proceedings. We believe that the proceedings will provide valuable information on promotion of technologies and will still be able to prove its value.

Science and Technology Policy Research Unit (STEPRUN)
April 1999

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**National Workshop on
Promotion of New Technologies in Nepal
March 24 - 25, 1997**

March 24, 1997, Monday

Time	Programme
10:00 - 11:00	Inaugural Session
11:30 - 12:15	Promotion of Technology in Industrial Sector in Nepal: Policies and Practices, Amar Manandhar, Ministry of Industry
12:15 - 13:00	Transfer of Advanced Technologies to Developing Countries, Dr. M M Huq, University of Strathclyde, UK
13:00 - 14:00	Lunch
14:00 - 14:45	Potentials and Problems of Biotechnology in Nepal, Dr Kayo Yami, RONAST
14:45 - 15:30	Technology Transfer to Nepal, Dilli Raj Joshi and Junelee Pradhan, RONAST
15:30 - 16:15	Use of Internet in Nepal: Present and Future, Sanjeev Rajbhandari, Mercantile Office Systems
15:15 - 17:00	Promotion ELC for Reliable and Sustainable Development of Micro-hydro Schemes in Nepal, Surendra Mathema, NMHDA/ Indira Shakya, RONAST

March 25, 1997, Tuesday

10:00 - 10:45	Promotion of New Technologies in Transport Sector in Nepal, G. B. Banjara, SIPP
10:45 - 11:30	Promotion of New Technologies in Telecommunication Sector in Nepal, Sugat R. Kansakar, NTC
11:30 - 12:15	Promotion of Alternative Energy Technologies in Nepal, Gyani Shakya, RONAST
12:15 - 15:00	Field visit and Lunch at Bode, Bhaktapur
15:00 - 16:00	Workshop Evaluation
16:00 - 17:00	Closing Session

**National Workshop on
Promotion of New Technologies in Nepal
March 24-25, 1997**

Inaugural Programme

Date	:	24 March, 1997 Monday (Chaitra 11, 2053)
Place	:	RONAST Meeting Hall
Time	:	10:00 A. M - 11:00 A. M.
Chief-Guest	:	Prof. Parasar Narayan Suwal, Sr. Advisor to the Ministry of Science and Technology
Chairperson	:	Prof. Dhruva Man Singh Amatya, VC, RONAST
Introductory Address	:	Dr. M. M. Huq, Associate Director, DCRU University of Strathclyde, UK
Inaugural Address	:	Chief guest
Address	:	Mr. Hugh Moffatt, Asst. Director
Chairmanship remarks	:	Prof. Dhruva Man Singh Amatya, VC, RONAST
Vote of Thanks	:	Mr. Chandra B. Khadka , Secretary, RONAST
Refreshment		

A Brief Report of the National Workshop on Promotion of New Technologies in Nepal

Introduction

It is widely recognized that Science and Technology has considerable potential for accelerating the pace of economic growth in developing countries. Moreover, the fulfillment of socio-economic goals set by the society will be promoted through the application of right kind of technology which supports improved resource allocation. Hence, there is a strong case of examining closely the promotion of Science and Technology in a developing country like Nepal.

Link Programme

The Royal Nepal Academy of Science and Technology (RONAST) has established a "Technology Policy Link" with the Developing Countries Research Unit (DCRU), Economics Department of the University of Strathclyde, UK. Under this programme sponsored by the British Council, workshop on "Technology Policy and Evaluation", Indigenous Technological Capability at Industry Level" "Assessment and Evaluation of Technology" and "Technology Promotion in Nepal" were held at RONAST in March 1990, April 1993, June 1994 and March 1996 respectively.

Objective of the link Programme

The overall objective is to develop indigenous capability for Science and Technology promotion through a programme of joint research and workshop.

Workshop

As a continuity of the link programme, a two day workshop on the "Promotion of New Technologies in Nepal" was held on March 24-25, 1997 (Chaitra 11-12, 2053) jointly conducted by STEPRUN, RONAST and DCRU University of Strathclyde, UK which was co-sponsored by the British Council. The workshop was held in the meeting hall of RONAST.

Objectives of the Workshop

1. To familiarise the importance of new technology for development.
2. To create awareness about the importance of sectoral technology policy in Nepal.
3. To strengthen further in-house capacity of RONAST for technology policy research activities.

4. To ensure continued cooperation of all concerned agencies in the research programmes.

Participants

The workshop was participated by 45 middle and senior level managerial staff, from government and non-government organizations. For the continuity of the programme, participants of the previous workshop were given preference.

Programme

Inaugural Ceremony

The workshop started at 10 AM with the arrival of the chief guest. Dr. M. M. Huq, University of Strathclyde, UK, delivered the introductory speech and highlighted on the workshop.

The workshop was then inaugurated by the chief guest Prof. Parasar Narayan Suwal Senior Advisor to the Ministry of Science and Technology with the inaugural speech. In his speech he stated that there are abundance of new technologies we can pick up from within the country and abroad but the main thing is which technology is to be picked who is going to use it and adopt it to our condition.

Mr. Hugh Moffatt Assistant Director of the British Council enlightened on the link programme between RONAST and DCRU of the University of Strathclyde, UK. Prof. Dhruva Man Singh Amatya the Vice Chancellor of RONAST and the chairman of the ceremony, in his chairmanship remark stated that the best way to introduce the appropriate technologies in the country is through the lunching of joint ventures and enterprises as they are doing on massive scale in India. Mr. Chandra Bahadur Khadka Secretary of RONAST thanked everyone for attending and adjourned the inaugural programme of the workshop, wishing it to be a success.

Sessions

The entire workshop was divided into four sessions. Altogether nine papers were presented during the three sessions. On the second day, a field trip to Bode, Bhaktapur was organised for the participants to familiarize themselves with the "Photo Voltaic Water Pumping System" installed by RONAST. This project is successfully supplying about 400 Cu. m/day to the local community of Bhaktapur, i.e. the system provides about 30% of the total water which they receive. The participants were briefed about this by the Project Liaison Officer of NEDO/ RONAST Mr. Promod Pyakurel.

The fourth technical session embodied discussion and evaluation of the workshop which was presented by Mr. Shekhar Shah of RONAST during the closing ceremony.

Closing Ceremony

The closing ceremony of the workshop took place on the 25th March (12 Chaitra) at 5 P. M. The session was chaired by Prof. Dhruba Man Singh Amatya, Vice Chancellor of RONAST.

Dr. Huq in his remark gave his impression on various aspects of the workshop. Likewise, Assistant Director of the British Council, Mr. Hugh Moffatt stated that he was happy to know that the Ministry of Science and Technology will take the lead and play a key role in defining the functions of various institutions working for the promotion and upliftment of science and technology in the country.

The chairman, Prof. Dhruba Man Singh Amatya, distributed certificates to all the participants.

Eventually, Mr. Shekhar Shah, thanked all the participants and the organiser for making the event successful.

Introductory Address

Dr. M. M. Huq
Associate Director, DCRU
University of Strathclyde, UK

Honourable Chief Guest Professor Suwal, Vice Chancellor of RONAST Professor Amatya, Mr Hugh Moffatt, RONAST Academicians, Fellow Participants, Ladies and Gentlemen,

Please allow me to express on behalf of Strathclyde University, our sincere greetings. Please also accept apologies from Professor Jim Love for his inability to join us.

This is a very happy occasion for me, especially as the progress of the Link Programme has now enabled us to go deeper into the promotion of technologies in developing countries.

In the National Workshop which is being inaugurated this morning, we will study - rather closely - over the next two-day period the problems and prospects of the transfer of new technologies to developing countries with particular reference to Nepal. This will enable us, hopefully, to take the discussion to the frontier of knowledge in the field. I would, obviously, have been happier only with this. But there is more for all of us. Thanks to the bold decision taken by Mr Hugh Moffatt and also strong support given by him, we are fortunate that immediately after the National Workshop, we will be deliberating in the company of some distinguished experts from a number of neighbouring countries, the issue of the promotion of technological capability in the South-East Asian Region. What an opportunity to take things forward.

I hope you won't mind my saying that the institutional building which we have been able to achieve under the Link Programme is undoubtedly praiseworthy. See, I am beating my own drum! As you all know, STEPRUN is not a large unit. You are also aware that because of a number of adverse factors - most of these beyond our control - we had to pass through some difficult periods - not once but several times. In spite of all these, we have been able to make some modest progress. And this makes me proud indeed.

I am grateful to the British Council for the support they have given from the beginning and, in particular, not taking a decision to abandon the programme following the occasional crisis and uncertainties we have experienced.

The outcome is there for everybody to see. Here we have got a group of dedicated staff working under STEPRUN, feeling assured - following interactions between the two partner institutions of the Link. As I mentioned in the beginning, this is a very happy moment for me. When we started the programme I could not imagine that we were ever going to reach a stage when we would be bold enough to venture to discuss the transfer of new and emerging technologies, an area which takes us beyond the promotion of conventional technologies, which itself is a difficult area to cover. Ladies and gentlemen, I can assure

you, this is what we will be doing over the next two days, with inputs from RONAST and from outside bodies within Nepal. I am, therefore, eagerly looking forward to the exchange of ideas. As many of you know, John Maynard Keynes - undoubtedly the most influential economist of the 20th century - has said it is not individuals but ideas that is very important. Hence appropriate skill development and institution building is of utter importance.

My heartiest congratulations go to the staff of STEPRUN - Mrs Indira Shakya, Mrs Junelee Pradhan, Mr Dilli Joshi, Miss Luna Vajra and all others who have worked so hard to bring it to this stage.

Thanking you, ladies and gentlemen.

Inaugural Address

Prof. Parasar Narayan Suwal
Senior Advisor
Ministry of Science and Technology (MOST)

Vice Chancellor of RONAST Professor Amatya, Dr Huq, Mr Hugh Moffatt, RONAST Academicians, Participants, Ladies and Gentlemen

First of all I would like to thank the organisers for giving me an opportunity to deliver an inaugural address in this inaugural ceremony of the National Workshop on "Promotion of New Technologies in Nepal".

The word 'technology' is a vague term. It embraces the simplest technologies to highly sophisticated ones. Technology can be a permanent component for the development of a nation, provided the selection of technology is done in a proper way, provided the appropriate technology suitable to the nation's context is done.

So, the choice of technology is one of the most difficult task mankind is facing. It is simply amazing that the technology which you think good in one situation do not get transferred or do not get packed up easily by even other parts of the country. Two very interesting discussions have come to my mind. For the last 15-20 years the water mills which we find common in most of the hilly parts and even in the Tarai districts of Nepal, are not found in the eastern part of Nepal, is very strong. The crop pattern between them is same though the water mills did not travel far to the east. Another one is the churning of rice or traditional "Dhiki" that we can find mostly in all parts of the country but this is not found in the western part of Nepal. So transfer of technology is very difficult. But at the same time I sometimes wonder, that some of the technologies and some of the products that come in the market are taken up or lapped up easily by our communities. Take the case of foot wear, latest technologies in terms of cosmetics etc. they are taken up easily. But other areas, the taking up of new technologies becomes very difficult. One of the greater difficulties I had in one time, was the introduction of the kerosene stove in the household instead of wood, maybe 30 or 40 years back.

Even that was very difficult. But now fortunately this kerosene stove technology or even the gas stove technologies have been kicked up. So, it is not actually only the promotion of new technology. We can go on promoting new technologies. New technologies are in abundance we can pick up from within the country, we can pick up from the world wide business. But the main problem is who is going to use it adopt it to our conditions. That is the major thing that should be considered in transfer of technology. Dr. Huq has been working in this business, for quite a long time and I hope he may be able to enlighten us with his experiences. With these few words I inaugurate this session on "Promotion of New Technologies" jointly organized by RONAST and University of Strathclyde. I wish this workshop a very much success.

Thank you very much.

Address

*Mr. Hugh Moffatt
Assistant Director
The British Council Nepal*

Prof. Suwal, Prof. Amatya, Dr. Huq and Mr. Khadka

I would like to talk a lot to you about new technologies in Nepal. But I am afraid that it is not my subject area. I think I mentioned to you last year also. Over the year, however, I have learnt a few things, so hopefully by the time I leave I would be an expert in this subject.

What I would like to focus on today is promoting the exchange of ideas through workshop such as these and allowing people to come together. This link programme which is ongoing now for two years has provided much contact between RONAST and Strathclyde. Prior to that we have been able to encourage practical dialogues and the council has been able to support the development of RONAST in various fields. This workshop again is the further extension of that development of RONAST. I would like to point out that the workshop has been entirely organized by RONAST, with very little support from the British Council in terms of funding.

We have, of course, been able to bring here Dr. Huq again. We are pleased to have him back and his presence adds to the workshop and its outputs. Obviously we are also very happy for being able to support the Regional Workshop which will be following this National Workshop. That for me is another very good sign that RONAST will be on march in the Asia Region. So that is the sign itself and the reason for continuing support of the council with the British Government money to continue the link programme. What I would want to point out is that, the effort has been put into this workshop and the regional workshop and have the link going has ensured the British Council and the British Government support.

Indira Shakya, Junelee Pradhan, Dilli Joshi, Luna Vajra, these four people have certainly put in an awful amount of efforts to keep things going and to make this workshop happen. So I would like to say thank you very much to those people and of course the continued support of the management of RONAST for allowing this to carry on.

I hope you will enjoy the workshop. I hope you expand and exchange the ideas as suggested by Dr. Huq and summarize for me in simple terms later on this afternoon; It will be very grateful because sometimes it goes over my head. I hope to see some of you later today and tomorrow at various points and I hope that all of you will be at the regional workshop. Once again thank you very much.

Chairmanship Remark

Prof. Dhruba Man Amatya

Vice - Chancellor

RONAST

Distinguished Guests, Ladies and Gentlemen

I thank the organizers of this workshop for giving me the opportunity to speak a few words at this inaugural session.

As acting Vice-Chancellor of the Royal Nepal Academy of Science and Technology, I welcome you all to this workshop on "Promotion of New Technologies in Nepal". I hope that the presentation of papers at the workshop and the ensuing discussions to-day and tomorrow will be fruitful. I hope that the workshop will be successful and the resulting exchanges and interactions among the participants will lead to the formulation of a set of recommendations, for the promotion of new technologies in the country. I hope it will create an intellectual ferment among you all who are engaged in the highly important area of development of technology and industrialization in Nepal. I believe that our respectable visitor from University of Strathclyde, the United Kingdom Dr. M. M. Huq, will contribute significantly to the success of the workshop by fully bringing to bear their expertise in the subject and guiding and stimulating the participants to make an effort to study hard, discuss and exchange views and experiences in the spirit of healthy co-operation and collaborative endeavor. I am sure that if you sincerely work hard with dedication and determination something good and beneficial will come out of the workshop and it will not be a barren intellectual exercise - just one more workshop in the unending chain of workshops and seminars that are being held in Kathmandu regularly.

In fact the research environment in the field of science in the country is very poor, our laboratories are ill-equipped, and the devotees of science and technology are struggling under adverse living and working conditions, being severely deprived of proper incentives for work study and research. Being just an inorganic chemist, and that too retired, you can very well appreciate my difficulty in speaking meaningfully and effectively about technology and its applications for the amelioration of the plight of the poor masses. However, I shall be bold to throw in a few statements concerning my views about technological and industrial development in our poor country .

I firmly believe that the best way to introduce the appropriate technologies in the country is through the launching of joint ventures and enterprises as they are doing on a massive scale in India. The appropriate industrial projects, capable of implementation within the country should be spotted out on the basis of proper surveys of raw material resources and a vigorous campaign should be launched by the government and local enterprising businessmen and industrialists to attract foreign capital to invest in those industries providing adequate incentives in the way of security and profits. In my opinion, this is the only way to bring about rapid industrialization in Nepal, creating plenty of job opportunities and leading to improvement in the living conditions of the vast majority of

the poor people, when local and foreign entrepreneurs open new factories in the country, the required technologies will be introduced, requisite machines will be imported, necessary training and skills will be imported for the workers and industrialization will move ahead, with hubs of industrial activity here and there.

Ours is the age of machines. There are all sorts of machines in the world today. Some help relieve the drudgery of labor, manufacture all sorts of consumer goods, facilitate the means of transport and communications, facilitate the process of education and dissemination of knowledge and information, provide recreation and entertainment, help fight illnesses and diseases and promote health and well - being, in a word, help advance human progress, culture and civilization. Other machines help destroy what we have laboriously built up, aggravate our sufferings and misery, and even destroy human beings by the millions. Such are the machines that the ingenuity of homosapiens has helped invent and they are here to stay with us, whether we like it or not. Co-existence of humanity with machines, good as well as bad, calls for the exercise of great prudence, judgment and dissemination a spirit of detachment, great character, discipline and wisdom which only strong faith in GOD and the future of humanity can foster. If Science and Technology have come for the material advancement of civilization, religion is indispensable for steering man through the intricate of his mechanized existence.

Thank you all.

Vote of Thanks

Mr. Chandra Bahadur Khadka
Secretary, RONAST

Respected Chairman, Hon'ble Chief Guest, Respected Academicians, Participants, Scientists of RONAST, Prof. Huq from University of Strathclyde and Assistant Director Mr. Moffatt from the British Council and Ladies and Gentlemen.

This is a great opportunity for me to be here with you in this National Workshop on "Promotion of New Technologies in Nepal". I would like to thank Prof. Dr. Suwal for kindly inaugurating this session. I would like to thank Dr. Huq who has traveled from so far to be amidst us. It is a pleasure that due to the link programme this seminar has been able to be conducted here and Dr. Huq has been very helpful to us. I equally would like to thank Mr. Hugh Moffatt for his kind support and cooperation.

This workshop has taken its existence with the help of the University of Strathclyde. I hope this workshop will be a success and fruitful to all of you. I know and everyone knows that technology transfer problem is a problem which has to be dealt on seriously. I am sure this subject will be discussed in detail during the workshop and will come out with a concrete solution and suggestion at the end of the workshop. I would once again thank all of you for being here today and wish the workshop to be a success.

Thank you.

TECHNICAL SESSIONS

March 24, 1997

10:00 - 11:00

Inauguration

11:00 - 11:30

Refreshment

11:30 - 13:00

Technical Session I

Chairperson: Dr. Ramesh Man Singh	
Paper Presentation Mr. Amar Manandhar (MOI)	Paper Presentation Dr. M. M. Huq (University of Strathclyde)

13:00 - 14:00

LUNCH BREAK

14:00 - 17:00

Technical Session II

Chairperson: Mr. Shekhar Shah		Chairperson: Dr. M M Huq	
Paper Presentation Dr. Kayo Devi Yami (RONAST)	Paper Presentation Mr. D. R. Joshi / Ms. J. Pradhan (RONAST)	Paper Presentation Mr. S. Rajbhandari (Mercantile Office System)	Paper Presentation Mrs. I. Shakya / Mr. Surendra Mathema (RONAST)

March 25, 1997

10:00 - 12:15

Technical Session III

Chairperson: Mr. Amar Manandhar	Chairperson: Mrs. Indira Shakya	
Paper Presentation Mr. G. B. Banjara (SIPP)	Paper Presentation Mr. Sugad R. Kansakar (NTC)	Paper Presentation Mr. Gyani R. Shakya (RONAST)

12:15 - 15:00 **FIELD VISIT AND LUNCH AT BODE SOLAR-SITE, BHAKTAPUR**

15:00- 17:00

Technical Session IV

Discussion	Workshop Evaluation	Summary Preparation	Closing Ceremony
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**** Tea was served during the Technical Sessions (No Break)**

EXERCISE 1

1. Introduction

2. Objectives

1.1	1.1.1	1.1.2
1.2	1.2.1	1.2.2
1.3	1.3.1	1.3.2

3. Methodology

3.1. Description of the methodology used in the study. The methodology used in this study is a combination of qualitative and quantitative methods. The qualitative methods include interviews, focus groups, and content analysis. The quantitative methods include surveys and statistical analysis.

4. Results

4.1. Description of the results obtained from the study. The results of the study show that there is a significant difference between the two groups. The first group showed a higher level of performance than the second group.

5. Conclusion

5.1. Summary of the findings and conclusions.

5.2. Implications for practice and research.

Promotion of Technology in Industrial Sector in Nepal

Policies and Practices

Amar B. Manandhar
Environment and Technology Transfer Section
Ministry of Industry

I. Technology and Economic Development¹

The gap in the state of economic development between the industrialized and the low income countries is ever widening. The World Development Report, 1996 notes that in 1994 the per capita GNP of USA and Japan were US \$ 25,880 and \$ 34,630 respectively, while that of low income countries like Rwanda and Nepal were US \$ 80 and \$ 200 (IBRD, 1996).

Technical change has now been recognized as one of the main factors accounting for the progress of the industrial economies (Robert Solow, 1957; Kuznets, 1966). However, the low income countries suffer from high growth rate of population compared to the rate of growth of production, and the technology used is inefficient and often primitive. The wide gap in the level of technology being used in the industrialized and the low income countries provides the potential, as well as opportunity, for borrowing the advanced technology. The successful borrowing of advanced technology can result in a higher rate of growth, as seen for late starters in industrialization in Europe (Gerschenkron, 1962, pp. 44) and Newly Industrialized Countries (NICs) of Asia (Hayami, Ch. 10), but there still is a need of institutional innovation for the successful transfer of technology. The institutional need, however, varies according to the state of development and also depends on the culture of the society where the borrowed technology is to be utilized.

The following sections present Science and Technology in National Plan, Industrial Development Scenario, Provisions for Technology Transfer, Status of Technology Transfer, Institutional Arrangements, Problems in the Promotion of Technology in Industrial Sector in Nepal and some recommendations for future development.

II. Science and Technology in the National Plan

Although Nepal started planned economic development in 1956, Science and Technology policy was absent in earlier plans (Pradhan et al, 1981, pp. 74). Sixth five year plan for the period from 1980 to 1985 focused on strengthening of science and technology organizations, development and adoption of technologies (RONAST, 1987). Science and technology was given a sectoral status only in the seventh five year plan and this is continued in the eighth five year plan too. The objective of the development of science and technology in the eight plan has been specified as: development of science and technology to support overall development of the country; support agriculture, cottage and small industries sector by improving existing science and technology capability; and encourage transfer of foreign technology, which can contribute directly for the economic

¹ views expressed are entirely personal

development of the country. Science and technology policy has been spelt out in the eight plan document as follows (NPC, 2049):

1. Promote appropriate technology in sectors such as agriculture, industry, energy, transport, communication and rural development;
2. Give priority to research activities for solution of problems faced by the country and emphasize adaptive R&D for crop development, horticulture, husbandry, rural industries and energy development;
3. Emphasize on scientific research and development of technology for the mobilization of natural resources of the nation. Basic research on snow hydrology, crops resisting cold and dry climatic conditions and bio-diversity will be encouraged;
4. Encourage Government, non-government and private sector for import of foreign technology;
5. Promote foreign investment for transfer of technology;
6. Encourage adaptation of imported technology to make it suitable to local conditions.
7. Coordinate various agencies involved in science and technology development. Establish an agency for this purpose;
8. Enhance technical manpower both in terms of quantity and quality for the overall development of the nation. Develop science and technology by encouraging universities, academies, non-governmental and private agencies to be involved in studies, research and training;
9. Disseminate achievements of science and technology. Involve information centers and libraries in this regards;
10. Stress on the development and modification of existing traditional technology in the country especially for those being used in the rural areas;
11. Mobilize non-government and private sectors for the publicity and for the effectiveness of technology; and
12. Improve the performance of agencies and institutions involved in science and technology development - involve them in R & D of national need - mobilize national as well as international resources in this regard.

Research institutions of Nepal have very limited capability of research and innovation (RONAST, 1987). Research are carried out in medicinal plants, renewable energy, various crops, some appropriate technology, fertilizers and plant protection. The total budget allocated for R & D is only 0.13 percent of country's GNP and this is well below average research expenditure by developing countries, which is 0.5 percent, whereas, the

developed countries allocate two to three percent of their GNP for R & D (Adhikari and Ranjit, 1987).

III. Industrial Sector

Nepal is still in an early stage of industrial development, that has received prioritized attention only in the late seventies. Manufacturing units, which numbered 15 in 1950/51 increased to 3633 in 1986/87, to 4230 in 1991/92, and to 4487 in 1994/95. These figures exclude grain milling units (approximately 5000) and the establishments employing less than 10 persons. The income generated by these 4487 units in 1994/95 was estimated to be Rs.230,360 and the value added was Rs. 20,585 million (CBS, 1996). Nearly 95 percent of the industrial units fall under the Cottage and Small Industry (CSI) sector and they account for nearly 82 percent of the employment and 58 percent of the value added (CBS, 1994). The manufacturing activities are concentrated mainly in the light industries, these include carpet weaving, ready made garments, food processing, textile spinning and weaving, wood working, construction materials, handicrafts, sugar, paper, distillery and breweries, etc. Large scale cement, sugar, textile, jute, pharmaceutical, dairy industries operate in the public sector. These are gradually being privatized. The overall contribution of manufacturing sector to GDP is nearly 10 percent and the annual growth rate of overall industrial production in 1995/96 is estimated at 4.9 percent (Economic Survey, 1995/96).

IV. Provisions for Technology Transfer in Industrial Sector

Promulgation of Foreign Investment and Technology Transfer Act (FITTA) in 1981 paved the road for transfer of foreign technology in the country. Prior to this, the importation of plant and machinery was the main source for technology transfer. Machinery imports were followed by on the job training by foreign supervisors or training for some key personnel in machinery supplier's country. The Act specified the following considerations by the Industrial Promotion Board before the approval of foreign investment or technology transfer:

- appropriateness of the industry for the country;
- whether it is import substituting or export promoting;
- whether it provides employment, training to Nepalese or involve Nepalese in management;
- whether it uses local raw material or not; and
- whether the terms and conditions of the investment, loan or technology transfer are sound or not.

Foreign investment and technology transfer was possible only in medium and large scale industries and the act had empowered the Government to give directions on the following aspects:

- quality, price and distribution of the product;
- management of the Industry;
- relation between the labor and management;
- environmental pollution; and
- protection of the rights of the general public.

FITA, 1992 has opened the technology transfer for any scale of industry and foreign investment in any industry with fixed capital investment exceeding Rs. 20 Million. Agreements may be entered for the use of any technological rights, specialization, formula, process, patent or technical know-how of foreign origin, use of any trademark of foreign ownership and acquiring of any foreign technical constancy, management and marketing services. However, these need to be approved by the Department of Industry (DOI) and repatriation of royalties, technical assistance fees and salaries of the experts are ensured as per the agreement (FITA, 1992).

The Act waved the criteria for the approval as specified by the previous Act. There are also provisions of business, non-tourist and residential visa for persons involved in foreign investment and transfer of technology. Income tax on royalties and technical assistance fees have been specified at 15 percent only. In 1994, with an amendment in FITA, the minimum investment requirement in fixed assets for foreign investment has also been waved. However, a small negative list exists.

Industrial Policy, 1992 also emphasizes the need for the transfer of advanced technology and efficient management. Industrial Enterprises Act, 1992 has made the following provisions with regard to promotion of technology:

- facility to capitalize skill development expenditure before operation;
- deduction of expenditures on technology development, product development and efficiency improvement from taxable income up to 10 percent of Gross Profit;
- employment of foreign expert for up to 10 years; and
- repatriation of up to 75 percent of the remuneration of the foreign personnel.

V. Status of Foreign Investment and Technology Transfer

The number of industries approved for foreign investment and technology transfer reached 342 by the end of February 1997. Out of these, 290 are under financial participation and 90 of them were for technical assistance, trademark licensing, management services or marketing services. Out of the 342 units, 154 are now operational and 40 of them are under construction. The majority of these industries fall under manufacturing, followed by tourism, service, agriculture and then energy sectors. India accounts for the highest number of units in terms of collaborating country - both for financial as well as technical collaborations. In the case of financial collaboration, India is followed by Japan, USA, China, Republic of Korea and Germany, whereas, for technical collaboration, it is followed by Republic of Korea, China and Japan (Source: DOI). Analysis of Chitrakar has shown that these industries under financial and technical collaboration have good prospects financially as well as economically (Chitrakar, 1994 pp. 156 and 185).

VI. Institutional Arrangements

History of development of science and technology in the country shows the establishment of Institute of Applied Science and Technology in 1973, which became Research Center for Applied Science and Technology (RECAST) in 1977. The objective of RECAST include among others i) development and adoption of appropriate technology; ii) improvement of traditional technology; and iii) provision of consultancy services to the

industrial sector for identification and adoption of technology needed (RECAST, 1996). RECAST is also designated as the National Technological Information Gatekeeper (NTIG) for Mechanism of Exchange of Technology Information (METI) with Asia and Pacific Center for Transfer of Technology (APCTT), an agency under ESCAP. Annual Report for 1993/94 and 1994/95 shows that it is carrying research works mainly on medicinal plant, solar energy, construction materials, food and bio-technology. Research work on development of electrical drier for hand made paper and exploitation of natural dyes for woolen yarn dyeing are seen to be directly related to industrial application. RECAST has been designated as the secretariat for National Council for Science and Technology (NCST), which was founded in 1976.

Royal Nepal Academy of Science and Technology (RONAST) was founded in 1982 with the objectives of

- advancement of science and technology for all-round development of the nation;
- improvement and promotion of indigenous technologies;
- promotion of research in science and technology; and
- identification and facilitation of appropriate technology transfer.

RONAST acts as the focal point of many regional and international organizations including APCTT and Information Network on New and Renewable Energy Resources and Technology for Asia and Pacific (INNERTAP).

Ministry of Industry (MOI) and the Departments under it namely the Department of Industries (DOI), Department of Cottage and Small Industries (DCSI) and Cottage and Small Industries Development Board (CSIDB) are involved in transfer of technology. MOI has a database package "EUROPEX" to assist industrialists to get information on companies from Europe. DOI is responsible for providing the permission for foreign investment and technology transfer as per FITA. The process of approval has been simplified to great extent after 1992. Elaborate screening of the technology transfer agreements by a technical committee practiced earlier has been abolished. Recently, Industrial Promotion Board has delegated the authority to DOI to approve technology transfer in projects having up to fixed capital investment of Rs. 500 Million. DOI is also responsible for the administration of industrial property as per the Patent, Design and Trademarks Act. DCSI and CSIDB are involved in promotion and extension service for cottage and small industries. With offices in all 75 districts in the country, they provide skill development training including attachment to industries or other training centers as apprentice, scheme preparation service and technical assistance service. DCSI and CSIDB also organize industrial fairs and exhibitions. Handicraft Promotion Section of DCSI develops and distributes new designs and carries out modification of equipment used for the production of handicrafts. Development of Pedal Loom by this section is noteworthy (Thapa et al, 1981).

Technology Transfer and Development Project (TTDP) has been undertaken by Industrial Enterprises Development Institute (IEDI) under MOI with the following objectives:

- provide technological information;
- organize training and seminars for the development of human resource involved in production;
- promote timely and appropriate technology; and

- provide services for identification and development of technology, development of design of new products, and record keeping of industrial property.

National Productivity and Economic Development Center (NPEDC) formerly known as Economic Services Center (ESEC) has been involved in promotion of technology through the preparation of industrial project reports and feasibility studies. Nepal Industrial Development Corporation (NIDC) also has a strong background for industrial project appraisal including appraisal of technology.

Realizing the vital role of Science and Technology, Ministry of Science and Technology (MOST) has been established in 1996 with the following objectives (source: MOST):

- to formulate and execute policies, plans and programs in Science and Technology;
- to develop and promote programs on Science and Technology;
- to organize research works and to analyze on scientific and technological development;
- to produce, supply and manage scientific and technological resources;
- to collect data and to carry out survey on ultra-modern technologies;
- to organize national, regional and international conventions, seminars and workshops on Science and Technology;
- to enter into bi-lateral and multi-lateral agreements and conventions;
- to develop contact and to coordinate with international organizations relating to Science and Technology.

RONAST, National Computer Center (NCC), NCST, Department of Hydrology and Meteorology (DOHM) and Alternate Energy Promotion Center (AEPC) are now brought under MOST.

VII. Problems and Constraints

A survey carried out by UNCTC consultants in 1988 (UNCTC, 1988) has drawn the following conclusion as major causes for the difficulties in the transfer of technology in the industrial sector:

- **Lack of industrial skills** - the technical manpower is not adequately trained. In most cases high skill jobs are done by engineers and technical persons from India. Education and training opportunities are inadequate.
- **Lack of Infrastructure** - Lack of good roads hamper the procurement of raw materials and spare parts resulting in under-utilized capacity.
- **Lack of Consistent Government Policy** - Machinery building industries are having negative protection due to low duty on their import while the raw materials for these are levied at higher rate. Similarly, government procurement is biased towards overseas source due to tied aids.
- **Lack of Information Network** - This is a serious constraint in the identification and selection of technology.

Similarly, a seminar on "Identification of Technology Need" organized by TTDP has come up with the following main constraints for the development of various sectors of industries in the country (TTDP, 2053):

- lack of adequate skill and skill development opportunities;
- lack of improvement and modification of equipment;
- lack of spare parts in time;
- lack of information on technology;
- lack of quality raw material; and
- absence of standardization and validation.

Some other constraints are:

- inadequate financial resources for the organizations for S & T development - The allocation of budget is either inadequate or absent for most of the objectives stated;
- more than one organization have the same objectives and this seems to have created confusion on the responsibility;
- apprehension of labor displacement by new technology- e.g. automatic looms in textile and machine wool carding were not permitted for sometime , mechanical spinning of wool is still controlled by license;
- ineffective industrial property laws - The Patent, Design and Trademarks Act do not have provision for compensation to the owner of patent and the amount of penalty for infringement is minimal; and
- lack of training in technology acquisition and management aspects.

VIII. Some Recommendations

Environment for new technology demand has been created now due to adoption of open and liberal market oriented economic policy, which built up domestic as well as international competition. Resource constraints pose a great deal of problems in carrying out research and development activities in true sense for the development of new technology. But there still are ample opportunities for transfer of suitable technology developed elsewhere. There is also good prospect for transfer of technology within the country. Some suggestions for effective transfer of industrial technology have been presented below:

Information Service

- strengthening of technology information service - It can be started with collection of handbooks, directories, information bulletin and CD ROMs;
- establishing a patent document library as it is a good source of technological information;
- promoting information technology

Training

- organizing refresher training for trainers, and science and mathematics teachers in schools;
- organizing training in technology management, technology licensing negotiation;
- promoting apprentice training;

Problem oriented research and improvement activities

- encouraging industry associations for undertaking and sponsoring research works relating to the problems they are facing;
- disseminating the advantages of group activities in the organizations such as QC circles, Kaizen, suggestion schemes etc. and assisting industries to undertake these activities;

Involve private sector and academic institutions

- involving private organizations such as FNCCI in determining important sectors for which the technological information must be compiled;
- developing an effective linkage between academic institutions like Institute of Engineering and industry associations such that the technical students get real life industrial problems for their project works and the industries get the services of the qualified persons;

Financing

- promoting financing for modernization of technology;

Support policy, legal framework and budget

- removing negative protection to machinery building industries;
- encouraging training by providing tax benefits;
- improving effectiveness of industrial property system; and
- providing adequate budget for programs necessary to achieve objectives.

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Transfer of Advanced Technologies to Developing Countries

Dr Mozammel Huq
University of Strathclyde

In an age which is witnessing a technology revolution in industrialised countries, following the successful introduction of new technologies - e.g., microelectronics, genetic engineering and biotechnology - the developing countries perhaps cannot be blamed if they want to import advanced technologies. The successful transformation of Japan and its rapid use of advanced technologies, thus enabling the country to remain an industry leader, can be excited as an example.

I. Importance of Advanced Technologies

Recent developments in electronics and information processing, biotechnology, new materials, remote sensing, photonics and superconductivity represent new and evolving stages in technological development, which are multi-dimensional in character and extend over a wide range of economic activities. The wide impact being brought out, e.g., by the electronics revolution is now widely felt, arising "with respect to the greater efficiency, precision and capability of new technological and production processes based on CAD/CAM, FMS and robotics, on the one hand, and to the development potential for telematics and information processing on the other." (UNCTC, p.52)

Advanced technologies carry with them the promise of technology leap-frogging which can enable a developing country to jump some steps in the process of obtaining industrial transformation, i.e. avoid having to go through all the stages in development experienced by the present industrialised countries.

It is possible to give three interpretations to the concept of leap- frogging (Bhalla 1996, p.43):

1. It implies the **narrowing of gaps** between countries at different stages of development.
2. Related to the above, it would involve **the adoption of advanced technology in the leap-frogging countries ahead of the more industrialised countries**. For example, Bessant and Cole (1985) define leap- frogging as the use of 'advanced generations of It-based capital goods ahead of developed country competitors which may still be tied to existing generations of investment'.
3. Leap- frogging may mean, as already noted above, that **developing countries can jump some steps** and avoid having to go through stages experienced by the present industrialised countries.

From the experience of rapid economic growth of some industrialised countries such as Japan (whose economy was in complete ruin after the second world war) one can suggest that technological progress can act as a powerful engine of growth. The role played by high technology in Japanese economic growth also becomes apparent from the rapid growth of the Japanese electronics industry and the growing importance of information-intensive products and services. (Bhalla, 1996)

The availability of the advanced technologies thus provide the new comers with a major advantage over the established industrialised countries which are 'locked in' with old technologies which are in some way inferior. But the latter group of countries cannot quickly abandon the old technologies as any replacement will mean a major restructuring and heavy costs. For the new comers, the new technology, e.g. mobile telephone is expected to provide better quality service at cheaper cost.

While the promise of a success looks wonderful the price of failure can equally be devastating. The fact that new technologies can replace the traditional use of raw materials is known to us. For example, Bangladesh as a major exporter of jute has for long been facing tough competition with the synthetic substitutes which, in many areas, are considered better substitutes. The competition is picking up in other areas as well, e.g. in the use of copper cable which is now being replaced by optical fibres. However, the danger which is now being strongly feared is that the advanced technologies are able to strongly challenge the comparative advantage the developing countries have in cheap labour.

II. Some Necessary Pre-Conditions for the Transfer of Advanced Technologies

While new technologies bring enormous promises, a number of pre-conditions need to be satisfied for the transfer of these technologies to take place. Besides meeting the conventional condition, in the form of current level of domestic technological capability in general, the transfer of new technologies presupposes.

1. An organisational capacity for manufacturing new products using new technologies;
2. Indigenous capability in production, design and engineering at a stage at which new technology can be produced/assimilated and efficiently utilised.

An analysis of the above basic conditions will reveal that for the transfer of new technologies, the developing countries not only need to be producing capital goods but also there must exist a high level of R&D activity side by side involving S&T institutions. As observed by Bhalla (1996,p.48): "The diffusion of new technologies is likely to be very limited in the least-developed countries, in which the requisite skills and a physical and research structure are quite scarce." He has argued further that for the development and diffusion of new technology

an interface is required between mechanical and chemical skills on the one hand and electrical skills on the other.

The labour force also need to be well trained so that they do not have difficulty in using advanced technologies. Beyond the high level organisational capacity for producing goods with advanced technologies (and this applies particularly to manufacturing), there is also a need for marketing capability involving both domestic and international marketing.

There may even be the need for satisfying other conditions. Bhalla (1996), e.g., believes that leap-frogging or 'catching-up' by the developing countries is also dependent on

opportunities of collaboration with industrialised countries and the speed and extent of technology diffusion.

It is expected that such opportunities will increase with the increasing globalisation of 'strategic alliances' between the leading multinational firms. Although such alliances may promote efficiency through greater information diffusion (see Mody, 1990, for this argument) there is a danger that the collusive behaviour can lead to inefficiencies.

III. The Prospect of Transfer?

From the above, it is apparent that while advanced technologies bring many promises their transfer is not going to be easy to developing countries. One should, however, add that developing countries vary enormously and a generalisation is not very safe. On the one hand we have countries such as South Korea and Taiwan which are successfully exporting many industrial goods by using advanced technologies and, on the other, there are countries - many of them in Sub-Saharan Africa which are struggling hard to use even the conventional technologies. Any classification of developing countries on the basis income per capita can, however, create a problem in the countries like China and India, was although suffering from low per capita income, have built a strong S&T infrastructure and using successfully in some areas advanced technologies.

While recognising the wide variation among developing countries, it can be safely concluded that the prospect of the transfer of advanced technologies is very bleak in countries which are finding it difficult to achieve technological capability in the conventional fields. Thus, a vast number of developing countries are automatically excluded. A closer analysis will also reveal that a high income per capita, say in a country such as Saudi Arabia, Singapore and Hong Kong, is no guarantee of an ease of transfer of advanced technologies because of the condition that there must exist R&D activity involving the S&T infrastructure. That such is the case emerges from an in-depth study conducted by Hobday on the electronics industry of Singapore (1994). He finds that the development of the electronics industry in Singapore has been a gradual process of learning (in pre-electronic areas such as mechanical, electro-mechanical and precision engineering). Unfortunately, there are not many studies which can enable us to see the level of transfer of advanced technologies to developing countries. One study which can perhaps be mentioned here is that by Watanabe (1993). He finds that "so far only the Republic of Korea and Taiwan (China) appear to have been exploiting the new technology for the purpose of 'catching up'". Not surprisingly, there is a broad consensus that "leap-frogging is likely to be more feasible and prevalent among countries of the North than among countries of the South. This is to be expected since the economic and industrial infrastructures of countries within the North are very similar, and preconditions -skills,

infrastructure and indigenous technological capability - exist although the degree to which they do may vary from country to country." (Bhalla, 1996,p.46).

In the case of Japan, the country's massive R&D effort is considered to be the main explanation for its success of moving from the category of technology borrower to that of a leader. For example, Japan's R&D expenditures rose from US\$ 129 million in 1953 to US\$ 1,060 million in 1964 and US\$ 14,200 million in 1977-78. (Bhalla, 1996, p.46). As observed by Soete: "it is the gradual shift of its endogenous technological effort from an auxiliary role to the import of technology, to autonomous technological development, which seems to be the crucial characteristic of Japan's emergence as a technological leader." The Japanese companies are now dominating in the production of one-megabyte dynamic random access memory semiconductors (DRAMs), estimated as high as 88% of the market share, as may be seen from Table 1.

Table 1
The World's Biggest Chipmakers, 1987 (Mil. US\$)

Company	Country	Semiconductor Sales	Total Sales
1. NEC	Japan	3,240	19,665
2. IBM	USA	3,100	54,217
3. Toshiba	Japan	2,980	26,027
4. Hitachi	Japan	2,560	34,919
5. Motorola	USA	2,380	6,707
6. Texas Instruments	USA	2,150	5,595
7. National Semiconductors	USA	1,725	1,868
8. Philips	Netherlands	1,550	26,021
9. Fujitsu	Japan	1,450	14,965
10. Matsushita	Japan	1,435	34,051
11. Intel	USA	1,350	1,907
12. Mitsubishi	Japan	1,185	15,543
13. Sharp	Japan	1,065	8,314
14. AT&T	USA	1,000	33,598
15. AMD	USA	997	997

Source: *Fortune* (20 June 1988) as quoted in UNCTC, p.33

IV. Concluding Remarks

For the low-income developing countries suffering from an acute shortage of S&T capability, the prospect of technology leap-frogging is rather bleak.

As observed by Bhalla (1996,p.48): "The diffusion of new technologies is likely to be very limited in the least-developed countries, in which the requisite skills and a physical and research structure are quite scarce."

In developing countries, most small producers are yet to be familiar with the potentials of new technologies like microprocessors, biotechnology and genetic engineering."

Moreover, **"the policy makers in developing countries are either totally ignorant about the scope for integrating new technologies with traditional production systems or are fully enamoured of these latest developments and their use without understanding the cost or the infrastructure requirements involved.** One way of orienting the policy makers towards the new technology culture is to organise new technology clubs, not only for factory workers but also for senior policy makers. These clubs could use specially designed kits and home computers for general training and sensitisation." (Bhalla 1996, p.64)

If we accept the proposition that all over the world "the major engine of growth has been advancing knowledge and technical progress, which needs to be embodied in human and physical capital to have an impact" (Maddison 1994, p.56) and further that there are serious market failures which do not allow us to depend on the market mechanism for technology development (see section ii), a developing country like Bangladesh is left with no option but to go for an explicit technology policy. Once the contribution of technology to economic growth is accepted, policy makers must stop treating it as a 'black box'. In other words, there need to be an **explicit technology policy** insisting on explicit technology evaluation referring to all the various components: designing capability; local manufacturing capability; assembling, installation and maintenance capability; production capability; investment capability; innovation capability; and linkages capability.

The implications are obvious. Given the externalities involved, strategic state support will be necessary for R&D (in both public and private sectors) involving the S&T institutions and the production units. The success of such a programme will, obviously, need a minimum level of capital goods manufacturing, and also the supply of scientific and technical manpower to assimilate technological development. It also goes without saying that at the industry and the firm level requisite capabilities need to be developed, e.g. production, maintenance, assembling, absorption and diffusion. Lall further adds that **"specific policies have to be implemented** on the extent of protection, domestic competition, imports of technology, in-house R&D, the nature and amount of foreign investment, the S&T infrastructure, and all other things that influence learning and production efficiency." **The learning process in technology acquisition perhaps needs to be emphasised.** Even if government intervention succeeds, through subsidies, etc., In making manufacturing activity profitable, there is **no guarantee that the capitalists will, or can, invest in manufacturing.** A number of other conditions including the availability of technical personnel need to be satisfied. (Amsden, 1989)

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Potentials and Problems of Biotechnology in Nepal

Kayo Devi Yami, Ph D
RONAST

I. Introduction

Biotechnology comprises any technique that uses living organisms, or parts of organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific uses. It is a way of controlling and adapting living organisms to the needs of human beings. In the past, biotechnology chiefly manipulated micro-organisms or plant food, through selective breeding for desired traits. The new biotechnology involve taking the parts of cells for manipulation and thus enhancing the capabilities of those cells to produce what we desire. New processes and products that seemed inconceivable before can now be developed by recombinant DNA technology and genetic engineering.

The basic development goals of most Third World Countries include increasing food production, improving public health, and increasing amount of energy for domestic and industrial purposes. Compared with many traditional development programmes, the anticipated results from biotechnology appears to be cost effective, fast and within the manpower requirement of most developing countries.

There has been considerable interest in biotechnology because of reported breakthroughs of great significance to life on earth. Some examples of these are: the development of nitrogen fixing plants; single cell edible proteins; new crops resistant to pests; bacteria for use in waste recycling and pollution control; petrochemical substitutes; the use of gene therapy to correct diseases like sickle cell anemia; the use of genetic screening for the isolation of genes responsible for birth defects; the microbial production of human insulin; the production of interferon and growth hormones (Swaminathan, 1984).

II. Status of Biotechnology in Nepal

Nepal has an area of 147,181 sq. km. with a population of about 20 million with a growth rate of 2.0 percent annually. Almost 94 percent of the total population is engaged in agriculture, which accounts for 60 percent of GDP and 75 percent of total exports. Only 20 percent of its total land can be used for cultivation of crops. Unfortunately, the growth in agricultural production has lagged behind the population growth for the last decade and Nepal experiences acute food grain shortages, particularly in hilly regions.

In order to feed its growing population and meet basic needs of its people, it is realized that science and technology should be applied in productive sectors of its economy. Biotechnology offers an opportunity to overcome agriculture and energy problem of Nepal. Some biotechnological programmes have already been implemented in various fields by different institutions.

A. Traditional Biotechnology:

Nepal has a wealth of traditional technologies. The old traditional biotechnology are mingled with the local culture, art and ethnicity. Some of the significant ancient biotechnology still surviving but confined to cottage scale or individual family consumption are as follows (Gajurel, 1984) :

- fermentation and distillation of characteristic alcohol drinks from rye (Kodo), rice, brown sugar (Sakhar) by using indigenous yeast. The process of making yeast is still a closely guarded secret.
- fermentation of leafy vegetables into the favorite food items of the rural Nepalese. For example, some of the specialties are Gundruk from the leaves of mustard plant, radish, or cauliflower; Sinki, from radishes cut into pieces, and Sinamani from the whole radish without leaves.
- browning of rice into Hakuwa (literally meaning black rice) by an indigenous technique of fermentation.
- pickling of fruits by fermentation.
- production of jute or Nalu from the bark of the hemp through the process of biological decortication.
- dungs used as fertilizers or manures and dungcakes for special fuel for cooking.
- preparation of Yogurt and hard cheese (Churpi).

Many plant materials like Timur (Xanthophyllum indicum) powder, Bojo (Acorus calamus), Titepati (Artemisia vulgaris) etc. have been commonly used as insect repellents in grain storage in the hills. It is interesting to note that the traditional biotechnology is being conserved predominantly by womenfolk.

B. New Biotechnology

Among the new biotechnology where most research have been carried out the more important are as follows :

Tissue Culture Techniques

Many Government, non-government organizations and private laboratories are using tissue culture techniques for micropropagating various plant species. Department of Plant Resources, Godawari has been engaged in this program since early seventies. 80 different plants including 38 wild Nepalese Orchids, Pyrithrum, Atropa, Berginia legulata, ginger, bamboo and other fodder trees have been successfully cultured by this Department. At RONAST shoot tip grafting technique has been successfully used to eliminate greening Citrus tristeza virus of sweet orange (Junar). The manpower development for this technology has been carried out by the Department of Botany, Tribhuvan University, Kirtipur.

A modern plant tissue culture laboratory has been established at the Potato Development Division, Nepal Agricultural Research Council (NARC), in Khumaltar with the assistance of Swiss Development Cooperation. At this division detection and identification of potato viruses are carried out by DAS - ELISA technique. These virus diseases are eliminated by thermotherapy and meristem culture. Rapid propagation of potato plants is done by single node cutting. This laboratory has been successfully producing and distributing virus tested, disease free minitubers prebasic seeds of Kufrijyoti, Sarkari Seto, Desire, Kufri Sindhuri and Achirana Inta to Government farms and seed growers of the country (Ranjit, 1993). Compared with using traditional seed tubers, the new biotechnology is highly cost effective and opens new possibilities for self reliance of high quality potato seeds. Scientists at the Godawary laboratory of the Department of Plant Resources can now produce 8000 to 10,000 potato plantlets per day through the application of micropropagation techniques which can then be easily rooted in sand beds by semiskilled workers (Rajbhandari, 1988). Annex 1. shows private tissue culture laboratories and techniques applied by them in Nepal.

Biodiversity and Biotechnology

Nepal is rich in biodiversity mainly due to its wide range of bioclimatic zones from tropical to nival. As such, it has 75 vegetation types, 35 forest types, over 5000 flowering plants of which 246 are endemic, and a wealth of wild relatives of cultivated plants. Traditional knowledge of plants and their use is depleting even faster than the plants themselves (Shrestha, 1995).

Medicinal and herbal plants are conserved in situ and ex situ by the Department of Plant Resources. The collected germplasms are currently maintained either in the field for evaluation and utilization or preserved at controlled temperature. This department has developed protocols for micropropagation of about 80 different plant species including medicinal and endangered plants.

Natural Product Development Division (NPDD) under the Department of Plant Resources is the pioneer Division in the country to harness the rich treasure of herbs and aromas for processing and producing medicinal extracts and essential oils for drugs. There is a growing evidence that many Taxus wallichiana trees have been removed and taken away to neighboring countries. RONAST and NPDD are isolating Taxol from this tree which has been reported to be very useful for cancer treatment. Several private companies have come up for the production of natural products. Among them Herbs Production & Processing Co. Ltd, Kathmandu is capable of exporting indigenous products like Lichen Resinoid, Sugandha Kokila oil, Tagetes oil and Jatamansi oil as well as exotic varieties such as Palmarosa oil, Citronella oil, Lemongrass oil and some crude drugs to neighboring and third countries.

The displacement and loss of conventional varieties because of increasing acreage under high yielding ones has resulted in a rapid erosion of genetic diversity. This erosion threatens the availability of genetic resources for future breeding of crops (Sasson & Costanini, 1991). The wild relatives of cultivated varieties as well as their traditional counterparts are the raw materials for biotechnology, genetic engineering and genetic manipulation. For example, the formerly popular Tauli, Marsi, Thapachinia and other rice

varieties of Kathmandu valley are difficult to find in farmer's field at present. Wild species of rice such as Oryza nivara and O. rufipogon are on the verge of extinction from Kapilbastu. Chhomrong Dhan is one of the few cold tolerant varieties cultivated in western hills of Nepal upto 2200m altitude under both irrigated and upland rainfed conditions. It is resistant to blast (Pyricularia oryzae) and bacterial sheath rot (Pseudomonas fascovaginae) diseases (Sthapit et. al., 1994).

Seed repository of Plant Genetic Resources Section of NARC has a collection of seed germplasms of 5282 cereals, 3216 grain legumes, 469 oilseeds, 394 vegetables, 7 industrial crops and 23 spices maintained at a 20 m sq. seed house at 5 c with 45 % relative humidity. These germplasms are used by NARC for the improvement of cultivars simply by conventional methods of plant breeding and selection.

Microbial Technologies

Microbial technologies may be examined under the following subjects :

a) Biofertilizers

Introduction of high yielding varieties need increasing amount of fertilizers. High rates of fertilizer application have had unfavorable impact on soil fertility including soil structural deterioration and increase in soil acidity. The use of chemical fertilizers usually implies a lump sum dose of the three major nutrients : nitrogen, phosphorus and potassium. These fertilizers are costly and are imported. These minerals react with the soil leading to unbalanced nutrition, loss of soil structure and soil fertility. The ready supply of the nutrients reduces the naturally occurring bioprocesses of the in situ decomposition of organic residues into nutrients, and hence erodes the biodiversity of soil organisms. Therefore research on biofertilizers is being extensively carried out in a number of institutions in Nepal.

i) Biological Nitrogen fixation

Nitrogen is frequently a limiting nutrient in agricultural productivity. The ability to fix atmospheric nitrogen (78% in air) is restricted to certain bacteria like Rhizobium, Azotobacter, Azospirillum, Cyanobacteria that contain the enzyme, nitrogenase. Biologically fixed nitrogen offers the most promising alternative to inorganic fertilizers. The Division of Soil Science of NARC and RONAST have been engaged in the development of Microbial Inoculant Technology by using bacteria like Rhizobium and Azotobacter. At RONAST more than 80 Rhizobium isolates for various pulses have been screened for their nitrogen fixing ability and for their yield increase. This technology has been successfully applied for the production of inoculant packets for increasing productivity of major grain legumes, pasture legumes and leguminous trees. Study of genetic diversity of rhizobia in Nepal is recently being taken up by RONAST.

ii) **Mycorrhiza**

Phosphorus is one of the major plant nutrients found to be low in most Nepalese soils. It has been understood that Vesicular Arvesicular mycorrhiza can increase phosphorus uptake of plants. RONAST is carrying out survey, collection and maintenance of Ectomycorrhizal fungi from Chirpine forests for enhancing the productivity of degraded forest lands in Nepal.

iii) **Frankia**

Soil and glacier erosions are frequent problems in Nepal every year. Alder trees (Alnus nepalensis and A. nitida) could be widely planted to check these erosions because of their ability to fix atmospheric Nitrogen into the plant roots with the help of Nitrogen fixing bacteria called Frankia. An attempt has been made by RONAST to isolate and develop Frankia inoculum for using it to establish Alder plants in eroded steep mountains.

b) **National Organism Bank**

A national type culture collection facility was established in RONAST in 1985. About 300 isolates, mostly bacteria, fungi which are important for agriculture, forestry, food and health have been maintained at this bank. This bank acts as a depository to supply authentic microbial cultures for the use in various research activities of research institutions, universities and industries. This is the initiation to conserve and utilize microbial genetic resources of the country (Yami, 1995).

c) **Biological Control**

Introduction of high yielding varieties of agricultural crops need increasing amount of fertilizers and pesticides every year. Many agricultural crops are lost annually due to insect pests and diseases. Insecticides, pesticides and fungicides are generally used for the prevention of crop loss. These chemicals have to be imported and are very expensive. In order to prevent heavy loss of crops and vegetables, farmers often use excessive amounts of these toxic chemicals. It has been reported that 165 types of pesticides, fungicides and herbicides are used in this country. Over application of pesticides poses health risks to consumers due to high accumulation of pesticide residues in food. DDT residues have been detected in vegetables like egg plants, onions, carrots, sweet peas etc. High residues of parathion in tomatoes were also detected (Thapa et. al., 1995). Increased pesticide use has also given rise to problems of pest resistance. It was in this context that RONAST has initiated research work on biological control of insect pests. Several isolations of Bacillus thurengiensis (Bt) have been carried out from Nepalese soils for biological control of Lepidoptera caterpillar in crucifer vegetables.

The Entomology Division of NARC have reported the use of Bt, Nuclear Polyhedrosis Virus (NPV) and Neemacol for the control of rice borers at Chitawan district. Use of Bt at the rate of 2 ml / litre of water was found to be better. A screening of seven plant materials was done at this Division against storage insects taking maize weevil Sitophilus zeamais as test insect under lab condition. Among them Bojo root powder (Acorus calamis), Neem oil (Azadiractin 0.15%) and neem seed extract (Azadiracta monotelata) were found to be

more effective than Kutmiro (Listea monotetala), Ashuro (Adhatoda vasia), Pirejhar (Polygonum hydropeper) and Masala (Eucalyptus sp.). Research at the Lumle Agricultural Center, Pokhara on insect pest repellent plants revealed that Bojo applied at the rate of 20 g / kg seed was as effective as Malathion chemical pesticide applied at the rate of 2.5 g / kg seed to control weevil in wheat (Panthee, 1994).

d) Fermentation

Fermentation of cereals into alcoholic beverages is quite common throughout the country. Effort has been made to select useful yeast strains from different Marcha for improving and standardizing the quality of cider and other alcoholic beverages by the Central Food Research Laboratory.

e) Cheese making

Dairy Development Corporation makes buffalo and Yak cheese in Kathmandu and high altitude field locations. Yak cheese is more popular. The bacteria used for cheese making are Lactobacillus helveticus and Streptococcus thermophilus imported from Denmark. In Nepal cheese industry is not developed much because on the one hand many people are not yet aware of its nutrient value and on the other hand they are very expensive.

f) Biogas technology

The anaerobic decomposition of organic wastes evolves biogas which can be used for cooking and lightening. The recycling of the organic wastes leads to sludge residue that makes a good biofertilizer and thus controls environmental pollution. Nepal Biogas Pvt Company has been extending this technology in rural areas.

g) Mushroom cultivation

Natural History Museum, Kathmandu has recorded 102 species of edible and 25 species of non edible mushrooms (Bhandari, 1984). Nepalese living in rural areas often go for collecting wild edible mushrooms from forests. The biotechnological exploitation of fungi by converting agricultural wastes into nutritious edible mushroom has become a common practice nowadays in urban areas because of their low fat content and richness in proteins, vitamins and iron. Division of Plant Pathology, NARC has been producing spawn for edible mushrooms like Oyster mushroom (Plurotus sajor - caju), Button mushroom (Agaricus bisporus), Shitake mushroom (Lentinus edodes) and Volvariella volacea. Several private companies have been established for the commercialization of spawn. The cultivation of edible mushroom in commercial scale is carried out by Himalayan Mushroom Pvt. Ltd. at Narayangadh.

III. Health Improvement

Animal Health

Preparation and Testing of simple type of rabies vaccine (20 % and 5 %), and the pre- and post- exposure treatment of man and animals is being carried out by Rabies Control Program of Veterinary Division. The division also produces H. S. vaccine for Haemorrhagic Septicemia (Bhyagutai Rog) caused by Pasturella species, B.Q. vaccine for Black Quarter disease (Charcharai Rog) caused by Chlosteridium species, and Anthrax spore vaccine for Anthrax disease caused by Bacillus species. Similarly, F1 and M strain vaccine for Poultry Newcastle and Fowl pox poultry diseases is also produced in the Veterinary Division.

Human Health

Very little research work has been carried out in the health sector. Research Center for Applied Science and Technology (RECAST) has been undertaking research activities on anticarcinogenic chemopreventive compounds by isolating them from buffalo blood, edible vegetables and fruits for cancer treatment (Tuladhar, 1994). Vaccines required for various diseases of mankind are all imported in this country.

At the Teaching Hospital ELISA kits are widely used for diagnostic purposes of diseases like HIV, Hepatitis B and other viral diseases.

IV. Status of Human Resources on Biotechnology

Based on the available information at least 72 graduates are involved in Biotechnological activities in this country. 57 % are of the Master's level and 32 % are of PhD level. Most of them have specialized in Agriculture and Botany with only few in Biotechnology (Tuladhar, 1994).

V. Advance Biotechnology of the Advanced Countries

In developed countries the problems of diseases, pests and food production are tackled genetically rather than by other means. Some of the interesting biotechnological achievements in different sectors of these countries are as follows :

Agriculture sector

Research is being conducted to develop modified microorganisms that will inhibit frost formation on crops and hence would allow production of vegetables and fruits in temperate climates over longer periods of the years. For example : the International Potato Center's works in cold tolerance has led to the development of cold tolerant potato cultivars through the introduction of a antifreeze protein of a flounder (flat fish) which can survive temperatures of - 1.5 0 c. The transgenic potato clones have been tested in Bolivia in green house conditions and results indicated that the level of cold tolerance has been achieved (Jaffe & Rojas, 1994). An IRRI another cultured, cold tolerant rice variety is being field tested in Korea, and the technique has been exploited in China for producing new rice

and wheat varieties. Agricultural researchers have been attempting to form Nitrogen fixing root nodules on the root of wheat by making infection possible by Nitrogen fixing bacterium Azospirillum in order to produce high crop yields less dependent on chemical fertilizers. (Beardsley, 1991).

B. thuriensis (Bt) toxin genes have been genetically engineered into dozens of plant species. By expressing a Bt toxin within their tissues the plants protect themselves from some insect pests without farmers having to resort to pesticide sprays (Whalon & Norris, 1996).

Livestock improvement

Recombinant Bovine Somatotropin (rBST) is a growth hormone, produced by a bacteria, which when injected into cows enhances lactation. rBST has been used commercially in the USA to enhance milk productivity since 1994 (Bijman, 1996)

Health sector

Transgenic plants producing antigens against Cholera, Hepatitis B and Rabies have been developed in US laboratories, (Prakash, 1996). American researchers at Biosource Technologies and the Naval Medical Research Institute recently produced an experimental malaria vaccine by infecting tobacco plants with a genetically engineered strain of TM virus. The tobacco plants infected by such virus produced large quantities of the surface protein, which is extracted by simply grinding up the leaves. Vaccine thus produced are easier to store, and it might be even safer, since the TMV cannot infect human beings. Moreover, it is cheaper since one plant may be able to produce more than a 300 litre fermentor (Coghlan, 1995).

Food & Feed

Recombinant DNA technology is being employed to produce single cell proteins from natural gas, agricultural or human wastes more efficiently to compete with soybean as cattle feed.

Enzyme technology

Advance in enzyme technology make it possible to convert any starch into fructose. Enzyme technology has led to the development of high fructose corn syrup. Further technological development such as immobilization of enzymes and ability to produce 90% fructose syrup, not only reduce the production costs but also made the product well suited for the soft drink industry.

Metallurgy

Metals can be extracted from low grade ores with the help of bacteria. Bacteria can be made to accelerate production of chemical solutions that wash out normally insoluble mineral compounds containing copper, zinc, nickel, lead etc. Bacterial leaching can be used to extract remaining minerals from mining and metallurgical wastes.

VI. Implications of Modern Biotechnology

There is no doubt that modern biotechnology offer a wide array of techniques that are flexible and applicable in many areas but developing countries should think twice to pick and choose from the technology supermarkets of developed countries because of the following implications:

1. The socioeconomic implications by the modern technologies may lead to displacement of existing agricultural activities, with widespread social perturbances, especially among poor and handicapped farmers.
2. Change in the traditional free exchange of plant materials and information among researchers due to the rapid commercialization of the technology which is creating secrecy and restricts the free flow of knowledge.
3. There is also a marked tendency of privatizing and monopolizing by large multinational pharmaceutical, petrochemical and seed marketing corporations of the know-how and of the results of plant biotechnology applications so that access to the new varieties is becoming increasingly difficult for the developing countries.
4. Bulk of the biotechnology research is concentrated in the United States, Europe and Japan. Developing Countries have suffered loss of export markets because of technological development in the past. e.g. petroleum based substitute for jute, rubber, indigo etc. It is estimated that one third of all prescribed drugs on markets around the world are originally derived from plants although most are now the synthetic analogues of chemicals found in plants. A number of high value plant secondary metabolites, such as fragrances, flavors and drugs extracted from plants exported by developing countries are being synthesized & substituted by industries in Japan and America thus leading to loss of export earnings of those developing countries.
5. There is also the risk to limit, through the selection of new crop plants or varieties, the range of plant genetic resources and diversity on which food and fibre production already relies. Consequently, too little attention is paid to the conservation of the world's rapidly diminishing stock of natural genetic materials. Developing countries which cannot set up an adequate facility for the preservation of their genetic resources will be at risk to lose them, or to have to buy the needed genetic stock from the industrialized countries.
6. Possible release of environmentally harmful, genetically engineered organisms or transgenic plants in countries that are not prepared to get rid of adverse conditions created by them.

VII. Potentialities of Biotechnology in Nepal

Since agriculture is the mainstay of the Nepalese economy modern biotechnology should be geared towards increased food production. The growing population of this country is facing a problem of food shortage. Increasing agricultural production and productivity of major cereal and pulse crops assume great significance at present. Because of the limited

financial resources and limited number of trained manpower in this country advanced level of biotechnology like genetic engineering could be a high ambition. Hence potential biotechnology which could be achieved with the available manpower and infrastructure are described below :

Agriculture

Nepal does not manufacture chemical fertilizers because of lack of appropriate technology, demonstration of economic viability and investment capital. In spite of Governments effort in subsidizing the fertilizer cost by about 60 %, Nepalese farmers are unable to buy expensive fertilizers. Costs are specially high since transport of agricultural inputs is a problem. Therefore, fertilizer consumption is high only in a few accessible areas like Kathmandu. The excessive use of chemical fertilizers in these places have increased the soil acidity thus deteriorating the soil structure and soil fertility status. Increasing the fertility of soil and improving the availability of nutrients through the use of biofertilizers is the current concern of this country. Research on the use of beneficial microorganisms like nitrogen fixers, phosphate solubilizers and cellulose degrading organisms must be extensively carried out for increased agricultural production for different agroclimatic conditions.

Grain legumes are commonly used as Dal curry in daily Nepalese diet. However the cost of these items are shooting so high that most of the people cannot afford them. In order to increase yield of pulse crops efficient strains of rhizobia should be isolated , screened and developed for inoculant industry. There are production facilities of inoculant packets at RONAIST as well as at NARC. However the facilities are inadequate for the production of inoculants in commercial scale as per the demand. In addition, there is also a need of an institution to look after the quality control of such products.

Soybean contains 37 % protein, 20 % of fat and essential amino acids particularly lysine, leucine and isoleucine. Now a days soybean oil has been popular oil used for the cooking purpose. At present large quantities of soybean grain and soybean oil are imported from Singapore, Malaysia. If the yield of soybean could be increased by using *Rhizobium* inoculant (Yami, 1995) it will be of tremendous benefit to Nepal. Brazil did not produce soybean till 1972. But by 1982 soybean became a major source of foreign income (Lewis, 1982).

Rice is the staple food of Nepalese people. A very promising system for nitrogen fixation in connection with rice cultivation is blue green algae. The potential of *Azolla* as nitrogen fixing, green manure crop suitable to rice cultivation has been well recognized in China and Vietnam for centuries. *A. pinnata* can fix nitrogen at the maximum rate of about 3 kg/ha daily and *A. filiculoides* at the rate of 10 kg/ha daily (Swaminathan, 1982). The International Network for Soil Fertility and Fertilizer Evaluation for Rice has examined the effect of *Azolla* green manuring and confirmed that one crop of *Azolla* gave an increase in rice yield equivalent to that obtained by application of 30 kg N₂/ha of urea. Because of its high protein content, it is also a potential source of animal and fish nutrition and can be used as such by farmers with small land holdings.

Vermiculture, the rearing and utilization of earthworms, is increasingly applied in Asian countries including India to sustain soil fertility, to reclaim wasteland and to treat solid wastes and waste waters. As a natural bioreactor, the earthworm stimulates microbiological activity important to the degradation of organic residues into biofertilizer.

Biological control

For minimizing pre and post harvest damage caused by pests and pathogens research on traditionally used pest repellent plant materials should be geared towards the formulation of active compounds. Research on biopesticide and biofungicides could have good impact on elimination of major pests and diseases.

Development of stress tolerant crops

Rice occupies 1.45 million hectare of land producing 3.49 million metric tons per year. Chilling temperature is one of the major constraints to rice production in hilly areas like Jumla, Humla, Lumle, Pakhribas resulting delayed seedling growth, increased sterility and prolonged growth duration. Division of Agronomy has been making crosses for a range of traits to get new genetic variability. Since this is a conventional type of hybridization the Division should be strengthened to make genetically engineering possible for producing cold tolerant varieties.

Animal productivity

Embryo transfer

Embryo transfer is a sequence of steps that begins with the stimulation of multiple egg production at the time of ovulation. Artificial insemination is followed by embryo recovery, usually providing 10 - 15 embryos from a single cow, which are stored at laboratory conditions. The embryos are eventually transferred from the genetic mother to host or surrogate mothers. Now a genetically superior donor, through its recipient cows, can produce 50 - 60 superior calves in a single year.

Vaccines

Vaccines are the most effective and least expensive means of controlling infectious disease. Only three vaccines for bacterial and two vaccines for viral diseases are produced in Nepal. Many other vaccines are imported for other diseases of cattle and fowls. But these could be produced in the country itself with the facility available at the Veterinary Division.

Preservation of germplasms

Germplasms are required for genetic variability for variety development. Germplasms maintenance is an especially critical problem for vegetatively propagated species because of the labor and expense required in addition to exposure to climatic uncertainties, pests and identification errors. In Nepal crop germplasms are maintained in the form of seeds at 5 c which is quite unsafe. Tissue and cell cultures are generally used as the forms in which

germplasms are maintained. Storage of germplasm in the form of tissue cultures utilizing cryopreservation techniques at very low temperatures (-196°C range) offers a great promise for maintaining germplasm of crops.

2) Food and Feed Production

Nepal can achieve food production by

- selecting naturally occurring mutants among somatic cells - because one in every 10,000 to one million cells in the plant body is a naturally occurring mutant. Mutants can be selected for tolerance to disease, saline soils, drought, heat or cold.
- using anther cultures to produce new varieties of wheat, rice and other crops in about one third the time it takes to produce varieties by traditional methods (Lewis, 1982).
- using tissue culture techniques, one can remove the embryo relatively early and rear it in a test tube where it grows free of all stresses.
- protoplast fusion enables breeders to make wide crosses between genera. It has been used for fusion of a potato cell and a tomato cell, producing an exotic hybrid that is sterile.

Improving the quality and quantity of protein by the production of single cell protein can achieve food and feed production to some extent. The term single cell protein designates microbial protein produced by the mass culture of yeast or bacteria on hydrocarbons or other substrates, often waste by products with few alternative uses. The engineering of a microorganism's metabolic pathways makes it possible to convert efficiently low value feed stocks into higher value products such as amino acids, proteins etc.

Yeast cells are generally produced as a by product of brewing or grown in lactoserum, a by product of cheese making. They are generally used for human consumption in small quantities to supply proteins, vitamins and minerals. Microbial biomass of Saccaromyces cereviseae, Candida utilis and Torula utilis could be produced by growing them in sugarcane molasses, distillery wastes and paper mill effluents thereby decreasing the pollution of rivers. In Cuba, since 1965, ten plants have been producing approx. 100,000 tons of fodder yeasts per year by growing Candida utilis on molasses supplemented by the sugar industry. Several countries like Vietnam, Thailand, Mexico have exploited Spirulina, a cyanobacteria for use in animal feed and as a dietary supplement for human consumption. Clinical trials have revealed that this single cell protein powder has beneficial effects on liver disease, chronic pancreatitis, diabetes, gastric ulcers etc. (Sasson, 1988).

Fermentation

Nepal have been traditionally using fermentation processes in order to increase the nutritive value of agricultural products or / and to preserve them. Biotechnology can improve and extend the established processes more efficient in addition to creating new products. For example, research work carried by ORSTOM in France showed that Aspergillus niger a fungus strain grown on cassava flour for 24 - 30 hours, increased the

protein level from 2-3% to 18-20% and it is used as an acceptable and enriched animal feed. Similar techniques of protein enrichments have been developed for other starch and tubers by using a variety of fungi. Furthermore, the enzymes synthesized during the growth of fungi could be isolated and used in various processes of food and chemical industries.

Forestry

Mass multiplication of elites, high yielding types and generations of more variations could be achieved through tissue cultures. Tissue culture produces genetic duplicates of superior plants, by fastest method of cloning, up to a million times faster than traditional methods. And scientists have perfected test tube environments for hundred of plants, ranging from carrots and tomatoes to fir trees and giant sequoias. The duplicates produced are of uniformly high quality, free of disease, and more vigorous than plants grown from seeds.

Industry

Many higher plants possess active compounds which could be exploited for the production of secondary natural products and pharmaceuticals. The most prescribed products of plant origin for various purposes like contraceptive, analgesic, antimalaria etc. are as follows (Fowler, 1984b):

Steroids derived from Dioscorea deltoidea

Codeine	"	"	<u>Papaver somniferum</u>
Atropine	"	"	<u>Atropa belladonna</u>
Reserpine	"	"	<u>Rawolfia serpentina</u>
Digoxine	"	"	<u>Digitalis lantana</u>
Scopolamine	"	"	<u>Datura stramonium</u>
Digitoxine	"	"	<u>Digitalis purpurea</u>
Quinidine	"	"	<u>Cinchona ledgeriana</u>

It is estimated that the world market of plant medicinal raw materials amount to over \$ 1 billion/year. China, Egypt, India, Mexico and Sudan are the main exporters, whilst, in the early 1980s, member countries of EEC imported medicinal plants worth \$ 180 million and the USA \$ 78 million (Sasson, 1988).

Out of 7000 vascular plant species in Nepal at least 700 species have been identified as traditional medicinal plants which are extensively used by the rural population (80%). Due to the lack of favorable national strategy, at least 14 species of such medicinal and aromatic plants have been identified as endangered species (Shrestha, 1995). Processing the medicinal plants in exportable form together with the commercial cultivation of the same should be encouraged. Starting from naturally occurring compounds with a view to isolating them or producing novel pharmaceuticals is an attractive proposition for Nepal whose pharmacopoeia is very rich in raw substances. Such research programmes may give rise to fruitful cooperation between Nepal and industrialized countries where pharmaceutical companies need continued supply of raw materials.

Through the application of biotechnology, aromatic plants which possess medicinal properties as well, may turn out to be good source of highly priced materials for the manufacture of fragrances, cosmetics, flavors and food additives. Advance in tissue culture techniques enables industrial production of a number of high value plant secondary metabolites such as Vanillin, Jasmine, Vincristine, Reserpine, Shikonin, Pyrethrin and Quinine.

Controlled biosynthesis using medicinal plant cell cultures would have several advantages:

- desired compounds could be produced under controlled conditions independent of climatic or agronomic conditions and at potentially reduced cost
- products from plants of tropical, temperate, or mountainous regions could be produced at one location and
- products from rare and endangered species could be made available.

Energy Production

Biomass in the form of firewood, agricultural residues and animal dungs is the principal source of energy. Installation of biogas is becoming quite popular in rural areas. However the production of biogas faces problem when we go to higher hills because of the difficulty in decomposing crop residues due to cold climate. In such cases addition of microbial inoculants containing Methanococcus, Methanosarcina, Methanobacillus and Clostridium together with the designing of digesters for better fermentation processes could increase the biogas production. Such biogas program can be aimed not only at improving the production of energy for domestic purposes, but at integrating with food production, the recycling of agricultural residues, and with pollution control.

Health Improvement

Antibodies, protein molecules produced by certain cells in the body, are basic constituents of human and animal diseases fighting immune systems. Monoclonal antibodies contribute to a better knowledge of the epidemiology of human, animal and plant diseases. The technique of creating pure, and uniform antibodies against a specific target is relatively simple and straight forward to use and can be readily developed and made available for use in Nepal.

Although poverty, chronic malnutrition, illiteracy, lack of medical care and contaminated water and food all contribute to the spread of infectious organisms, immunization remains one of the most economical means of preventing specific diseases. Every year this country spends millions of foreign currencies in importing various vaccines. It is high time Nepal thought of producing its own cheaper and safer vaccines for most prevalent diseases like Hepatitis, Tuberculosis, Polio, Meningitis etc.

VIII. Problems of Biotechnological Developments in Nepal

1. There is no specific policies to set priorities for biotechnological research in the framework of national needs. R & D institutions are often free to adopt and apply biotechnology within their own framework of on going research and development. Priorities for applications of biotechnology must be demand-driven and user oriented.

Decision makers should create a policy environment which allows biotechnology to thrive in national R & D institution, or in commercial and industrial systems.

2. There is an increasing evidence of growing interest and piracy of genetic resources by international biotechnology industries of Europe, America and Japan. However there is no effective policy and legislation to protect Nepal's sovereign right to its genetic resources, and to ensure any flow back of benefits to the Nepalese people.
3. There is no Biotechnology Department as such in this country. Biotechnological research activities are taken up in bits and pieces by various research institutions but the research results are generally confined to laboratories only because of their limited mandates. Thus little attention is paid to technology diffusion or marketing mechanisms or to the demand aspects of biotechnology.
4. Without the incentive of a strong market potential private firms are unwilling to take the risk of production and marketing.
5. Research institutions are not technically equipped in addition to their lack of financial resources to move from small to large scale testing or to move to pilot plant or large scale commercial production. In some institutions such as Veterinary Department at Tripureshwor, Horticulture Development Division at Kirtipur and the Janakpur Livestock Development Unit adequate laboratory facilities were created with the installment of equipment worth crores of Rupees by various projects of The World Bank, FAO, JICA. However these facilities are under utilized because of inadequate operational budget, lack of trained manpower, lack of incentives to skilled persons, inadequate maintenance of laboratories, and unreliable power supplies.
6. Since there is no Government policy and strong legislation towards biotechnological research works there is growing number of foreign companies hiring local NGOs to study the effect of foreign microorganisms in the name of EM for speeding up composting and for removing bad odor of chicken and pigs in Nepalese soil.

IX. Conclusions

The development of biotechnology should proceed with caution and critical thinking to ensure that the results are indeed responsive to end users, ecologically sound and beneficial to our society. What is appropriate in the industrialized countries may not be so for Nepal. Science should not be viewed as a source of power and wealth but as a service to the poor and the underprivileged.

Already, some research works are being taken by different institutions on biofertilizers, biological control of pests, conservation of endangered plants through tissue culture and preservation of germplasms of Nepalese crops. Modern technical backups should be provided to these institutions both in terms of modern infrastructure development and trained manpower. We must remember that unless we have strong capabilities we cannot even adapt new improved technologies to local conditions.

In order to reap benefits of modern biotechnology there should be a pooling of resources on a regional basis to establish laboratories that can solve regional problems. One such possibility of getting cooperation is from MOU between RONAST and Council of Scientific and Industrial Research (CSIR) and Indian Council Agricultural Research (ICAR). Besides, there are International Centers of Genetic Engineering and Bio - technology (ICGEB) Laboratories in New Delhi, India and in Trieste, Italy. If Nepal could be a member of this center Nepalese scientists would be able to carry out advance research activities there and transfer appropriate technologies into Nepal.

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ANNEX 1

Private Organizations

Research Laboratory for Agriculture Biotechnology and Biochemistry (RLABB)	i. Colonal propagation of pine trees by tissue culture	Develop inverted embryo technique
	ii. Anther culture of rice for improved efficiency in conventional breeding and application of RELP	To raise anther derived cold tolerant cultivars and improve them for better survival and yeild when grown at higher altitude and develop RFLP
	iii. Sex determination of Lapsi (Choreospondias axillaries)	Early sex determination of Lapsi at seedling stage
	iv. Development of low erucic and low glucosinolate <u>Brassica Campestris</u> var. <u>toria</u> and <u>B. Juncea</u> for cultivation in Nepal using anther culture	Create homozygous, screen seeds for low euricic and glucosinolate level, filed performance of anther derived seeds and integration of anther derived lives
Tissue Culture Factory, Godavari	i. Shoot tip culture of potato	
	ii. Shoot tip culture of ornamentals	
Nepal Biotech Nursery	i. Shoot tip culture of banana	Use of shoot tip culture for production
	ii. Shoot tip culture of fodder crops	
	iii. Shoot tip culture of ornamentals	
Himalayan Flora Tech	i. Tissue culture of oak	Use of tissue culture for production
	ii. Tissue culture propagation of orchids and other ornamentals	

Technology Transfer to Nepal

Dilli R Joshi and Junelee Pradhan

Science and Technology Policy Research Unit, RONAST

I. Introduction

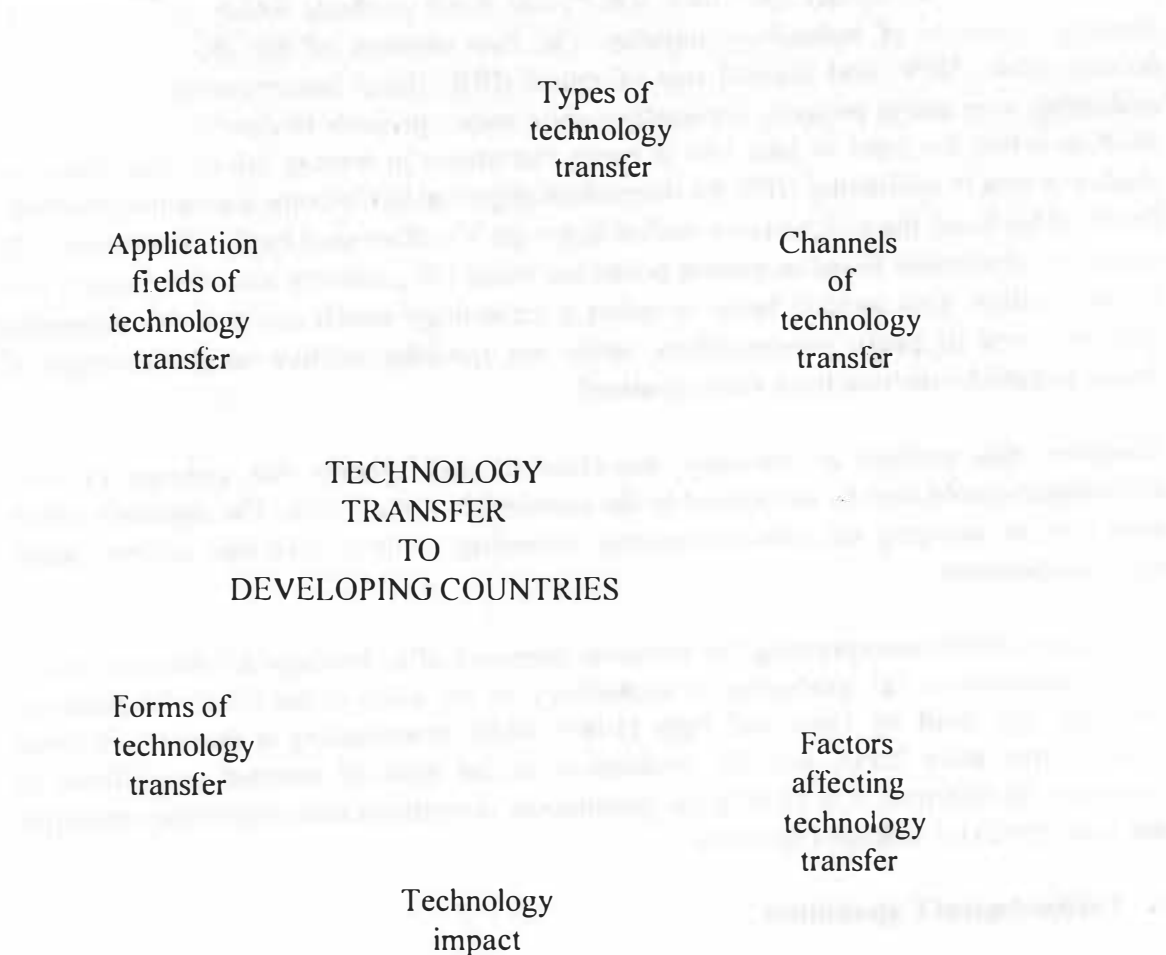
Transfer of technology plays a key role in the economic development of the least developed countries (LDCs); as Teece (1977, p70) stated, "the economic growth of every nation is inextricably linked to the successful international transfer of technology". Technology transfer provides a range of benefits to a country. E.g. (a) technology transfer permits the use of material means such as capital goods and machinery, necessary for economic development, and that (b) technological progress, resulting from successful technology transfer, fosters healthy competition and puts pressure on inefficient industries. In practice, however, LDCs have, because of some inherent constraints, not always achieved these benefits; Nepal is not an exception to the general rule of limited achievement.

The term 'technology transfer' itself is a multivalued term and can be understood in various ways depending upon which aspect it is emphasized, and there appears to be no universally accepted definition. For some, it takes place whenever technical knowledge, a technique or a device which emerges from, or is developed by one group is taken up and used or applied by another. This definition covers both hard technology (material devices and designs of such devices) and soft technology (ideas and the know-how needed for implementation of such ideas). And for some others it is a progressive and continuous effort to move technical devices, material, methods and/or information from the point of discovery or development to the users (Miedzinski, 1977).

Basically, two groups are involved in the transfer process. The first group can be referred to as the *technology source*, the second as the *technology receiver*. Impediments to technology transfer can be divided into categories depending upon whether they arise mainly at the source, with the receiver or in the interactive process linking source and receiver. It is easy to identify conditions in the source and those in the receiver which will favor successful technology transfer. The basic requirement is that the source possess technical knowledge and/or a capability which could be useful to the receiver. In addition, the source must understand the need and limitations of the receiver.

The conditions that should apply at the receiving end are essentially complementary to those at the source. Thus, the receiver should have complementary knowledge and capability, should understand the circumstances and potential contributions of the source, should demonstrate interest, and be able to support this with its own incentives (Al-Ghailani and Moor 1995). If these conditions are met, and if there is mutual confidence between the source and the receiver, eliminating conflicts and misunderstandings between both the parties, then the way for successful technology transfer will be open. Both parties should thus understand their responsibilities and obligations towards the other.

Technology Transfer to Developing Countries - A General Model



Source: Al-Ghailani and Moor (1994)

II. Why is technology transferred?

There are, in essence, two reasons for the transfer of technology:

- a) The inventor or possessor of technology wishes to recover the cost of his creative work and to make a profit by reaching a broader market, and
- b) Governments recognize that new and improved technology can bring improved or less costly goods and services to the marketplace, and thus benefit the general public.

III. Evaluation of Transferred Technology

What is the cost of technology transfer? It is observed that although there are a large number of factors which determine the total cost of transferring technology the most important considerations are: equipment, pre-engineering technology, engineering technology, research and development, pre-start-up training and royalty (Sarfaraz and Emamizadeh, 1993). Applying the factor method on these components can yield a reasonable estimate of the total technology transfer cost.

Huq (1994) has reviewed various evaluation criteria of technology transfer to developing countries using discounted cash flow (DCF) and other methods which incorporate the dynamic elements of technology transfer. The two versions of the DCF method, net present value (NPV) and internal rate of return (IRR), have been extensively used for evaluating investment projects, especially public sector projects in developing countries. Shadow prices are used to take into account distortions in market prices. Incorporating shadow prices in estimating NPV for investment appraisal has become a common practice. On the other hand, the standard conversion factor (SCF), often used by the World Bank for correcting distortions found in market prices has made life relatively easy for planners and project analyst. This method helps to select a technology which can pass the economic efficiency test of profit maximization, while not ignoring relative surplus/shortage of inputs as input costs have been shadow-priced.

However, this method is basically neo-classical and ignores the concept of how technologies could best be introduced to the economies of the LDCs. The approach which aims only at selecting the cost minimizing technology fails to take into account many dynamic elements.

Evaluation criteria incorporating the dynamic elements of technology are basically based on two approaches: (a) evaluation of technology on the basis of the level of technology adoption, e.g. used by Enos and Park (1987) while investigating a number of South Korean large scale firms, and (b) evaluation on the basis of selected capabilities, as suggested by Dahlman et al (1987), i.e. production, investment and innovation capability, and Lall (1992) i.e. linkage capability.

IV. Technological Capabilities

The success of any technological change is contingent upon the ability to adapt the mode of action to the necessities of innovation. From the wheel to the computer, success has been dependent upon creating a process that demanded a new system of production. Domestic technology generation does not necessarily imply developing a new technology, but achieving effective adaptation and improvement of imported technology for domestic application. Lall (1987) observes that such knowledge and skills can only be acquired through a long process of learning. This process can be extremely complex and varied, depending upon the industry, its competitive environment, developments in its input and output markets, their accumulated base of technological knowledge and experience, direct investment in the creation of new knowledge and skills, and availability of imported technology from abroad.

However, the process of learning is very demanding and slow. "Acquiring this experience is not automatic. Nor is it rapid and effortless. It takes conscious effort over a long period of time" (Dahlman et al, 1987, p 764). Thus, it can be inferred that the development of technological capabilities goes through a sequential process (Dahlman et al, 1987 and Lall, 1992). This, however, is contrary to the 'neo-classical' viewpoint as it states that "technology is freely available to all countries, and within countries, to all firms and there is no problem in assimilating the transferred technology in the developing country; and there are no adaptations required, since alternatives are available" (Lall, 1992, p 165).

In many cases developing countries may have to increase their imports of technology in order to develop their own technological capability i.e. their ability to generate new technologies. This has been true in most of the Newly Industrializing Countries (NICs) in South Asia which are fast becoming innovators. Countries like South Korea and Taiwan spend as much on R&D as a proportion of their GDP as many European economies and their spending has grown more rapidly in recent years than that of any rich economy. The result are apparent from the fact that Taiwan now registers more patents in America each year (per head of its population) than does Britain (*The Economist*, May 18-24, 1996).

V. Acquiring Technology

Foreign technology is acquired through different types of transactions. There are fundamentally three main channels through which technology may be transferred: a) the importation of capital goods, b) direct foreign investment, and c) licensing agreements. The strategy of acquiring foreign technology may differ from country to country or from one firm to another firm. Other types of arrangements for technology transfer are: literature, information and example of technical personnel, management contracts, consultations, design and supervision contracts, and installation and construction agreements (UN, 1972).

Technology is readily absorbed by the importing country, modified to suit local conditions and even developed by future generations provided that the recipient has a strong and well balanced technical infrastructure. In most developing countries the capacity to absorb and to adapt a new technology is much lower and technological dependence will tend to increase regardless of the form in which the technology is received. In the long run the problem is solved only, if the less industrialized countries are capable of developing their own technological capacity which will exert a positive influence on the imported technology (Ramanathan, 1994).

VI. Managing Imported Technology

It is very important to note that technology consists not only of manufacturing processes or know-how, but also of the management capabilities which make it possible to operate the imported technology. Such capabilities cannot be imported by buying a technology, they have to be developed by domestic efforts.

Technology transfer to developing countries is conceptualized as a learning process. Success is seen as the acquired ability of the technology receiver to reproduce, modify and innovate the transferred technology (Kumar, 1995). International technology transfer to the developing countries takes place within international alliances and co-operative arrangements between enterprises located in these countries and companies from the industrialized nations.

Looking at the phenomenon of technology transfer theoretically and practically one realizes that it really means conveying or acquiring know-how within a co-operative venture. The idea of 'conveying' or 'acquiring' in depth suggests learning, and the success of technology would then imply a 'learning process' (Bell, 1984). Learning (success) can be understood as a process of acquiring knowledge, skills and attitudes in terms of

enhancing the cognitive, practical and mental ability needed to perform a specific job. The job specification in connection with technology transfer to developing countries is invariably related to industrial activity, specifically industrial manufacturing. Due to the complexity of manufacturing processes, however, it is assumed that the technology receiver's ultimate manufacturing ability develops in stages which depict incremental learning. These stages of 'manufacturing learning' are (Westphal, 1985; Austin, 1990):

- a) Reproduction
- b) Adoption/modification, and
- c) Innovation

The reproduction stage is relatively the easiest and fastest to achieve. On the basis of imparted knowledge and skills the technology receiver can quickly be put in a position of simple imitation of the manufacturing process. In the developing countries the attainment of reproductive manufacturing ability is in itself considered a successful step in progress towards import substitution and self-sufficiency (Kumar, 1995). In the Adoption stage technology receivers are in a position to modify imported knowledge and skills as appropriate. This achievement also complies with development goals because it helps not only in substituting for imports but also in developing appropriate indigenous technology (Ito, 1986). Finally, in the Innovation stage, technology receivers acquire manufacturing ability that enables them to develop new products and processes on their own. Desai (1984) considers this as the ultimate goal of technology transfer which developing nations aspire to achieve on their way to industrialization.

VI. SUGAR MANUFACTURING - A CASE STUDY

We will now examine the nature of technology transfer to sugar manufacturing in Nepal. The production of white sugar in Nepal started in 1948 with the establishment of Morang Sugar Mills, a private enterprise, with a capacity of 250 tonnes crushed per day (TCD). There are only 6 modern sugar factories, at present, producing white sugar in the southern part of Nepal (table 1) with an other 6 under construction.

Table 1

Location, Employment, Milling and Production Capacity of the Existing Sugar Mills

Manufacturers	Location	Estd	Employment	Owner-ship	Milling Per day (TCD)	Sugar Production Capacity (T/Year)	Production in 1992/93 (Ton)
Morang Sugar Mills	Biratnagar	1948	480	Private	210 (1000)	2,800	2,700
Mahendra Sugar Industry	Bhairahawa	1963	800	Private	650	8,700	6,300
Birgunj Sugar Mills	Birgunj	1964	1480	Public	1500 (1,800)	20,400	20,000
Indu Shankhar Sugar Mills	Sarlahi	1985	623	Private	800	10,800	9,000
Lumbini Sugar Mills	Sunwal	1985	1000	Public	1,000 (1,800)	13,500	14,000
Shri Ram Sugar Mills	Garuda	1994	NA	Private	1250 (2,500)	NA	5,578

Source: Economic Survey 1994/1995, (MOI, 1995)

Note : The figures in the bracket are the expansion plans of the factories.

Though in aggregate, the production of sugar has roughly doubled compared to 10 years ago; however, it still falls short of meeting the growing national annual consumption demand and in turn, Nepal has to import sugar from India and other countries (table 2).

Table 2

Production, Imports and Consumption of Sugar in Nepal

Fiscal Year	Production (Ton)	Sugar Production (MT)	Sugar Import (MT)	Net Sugar Availability (MT)	Production as % of Availability	Imports as % of Availability
1986/87	616,580	24,565	27,953	52,518	47	53
1987/88	814,400	30,040 (22.29)		30,040	100	
1988/89	903,010	24,197 (-19.45)	26,494	50,691	48	52
1989/90	988,300	31,927 (31.95)	20,735 (-21.73)	52,662	61	39
1990/91	1,105,640	44,548 (39.53)	22,037 (6.27)	62,436	71	29
1991/92	1,291,340	52,748 (18.40)	21,763 (-1.24)	74,511	71	29
1992/93	1,365,879	34,502 (-34.60)	37,023 (70.12)	71,525	48	52
1993/94	1,293,092	22,215 (-35.61)	48,214 (30.22)	70,429	32	68
1994/95	NA	40,000 (84.05)	20,000 (-58.51)	60,000	67	33
1995/96	NA	46,422 (16.05)	20,000	66,422	70	30

Source : Economic Survey 1995/1996 (MOI, 1996)

Note : Figures in bracket represent annual growth rate.

Production Technology

The machinery and equipment used in the sugar factories is imported from abroad. Some of the manufacturers bought second-hand machinery from India, which, however, had not been manufactured in India, but procured earlier from abroad. Some machinery and equipment used in these factories is obsolete, thus making the replacement of spare parts very difficult. In such cases the only solution is to replace the broken parts with Indian parts. In table 3, the sources of technology and mode of transfer in some of the enterprises are presented.

Table 3**Sugar Manufacturing: Sources of Technology and Mode of Transfer**

Manufacturers	Country Origin of Technology in use	Supplier of Technology	Mode of Transfer of Technology	Remarks
MSM	Germany, India	Buckau of Germany	Bought	Second-hand machinery from India
MSI	UK, India	Standard Mirreles Watson, Scotland	Bought	"
BSM	Czechoslovakia, India, China	Czechoslovakia	Technical Collaboration (Soviet Aid Package)	"
ISSM	India, Germany	BMA of Germany	Bought	Second-hand machinery from India
LSM	China	China National Complete Plant Export Corporation	Technical Collaboration	250 Chinese Technicians involved in establishment

Source: Personnel communication

Human Resources

Technical manpower is considered as the backbone for any industry. A higher percentage of technical manpower is understood to contribute to production capabilities. Sugar factories are operated round the clock on a shift basis in Nepal with the objective of achieving economies of scale. The number of employees (table 1) indicates that the principle of saving labor by scale is hardly realized. In particular, both of the public enterprises, Birgunj Sugar Mills (BSM) and Lumbini Sugar Mills (LSM), are found to have a considerably greater number of personnel for a factory of capacity 2,000 TCD compared to the numbers employed by other factories. These two publicly owned factories are said to have about 720 and 300 employees respectively in excess of estimated requirements (UNDP, 1992).

Repair and Maintenance

Maintenance has long been considered as a negligible function in most of the developing countries. It however comes to the forefront when machines and equipment break down and the production process is hampered. Tandjaoui (1996) observed that, it can be taken as the important basis of technological mastery and technology transfer.

For repair and maintenance and spare parts sugar manufacturing is heavily dependent on foreign personnel and products. Except for some minor parts, spare parts are procured from the country of origin of machinery and equipment, or from India, depending on availability. All the sugar factories have their own workshops within their premises, but are capable of repairing only minor breakdowns in the production process. For major breakdowns there is no alternative other than hiring experts from foreign countries.

R & D Facilities

The National Sugar Development Program (NSDP) was initiated in 1971 with a view to helping the sugar manufacturers and to provide improved technologies to sugar cane growers. NSDP has conducted a number of research activities which include variety trials, inter-cropping, micro-nutrient, adoptive trials, etc. and has been successful in making major recommendations on promising seed varieties. However, it is reported that there is very little effect of NSDP research activities on production as most farmers get seeds from India or produce them locally. On the other hand, no research is carried out at the factory level. Little or no efforts are made to adapt and absorb the transferred technology in the local conditions. It would not be an exaggeration to say that the plants are operated on an *ad hoc* basis.

Linkages

It is observed that there is very little linkage with collaborating agencies, institutions, and other industries. Whatever linkage is established is primarily on a personal basis. Sugar factories mainly have interaction among themselves for fixing the market price. Similarly, Government contribution, besides providing loan and other general facilities, is negligible in relation to the private sector factories. All the sugar factories are working individually on their own for improvement, and the approach varies from one another. There is a great awareness of the need of a proper process of technology selection and assessment. However, due to various limitations, that does not occur in either private or public sector factories. Private factories go for cheap technology whereas public factories are aid dictated, having no say in selection or assessment of the technology.

Though sugar production is generally increasing, the demand is not fully met through local production, and Nepal has to import sugar from overseas. Capacity utilization in sugar manufacturing has also been low mainly because of the uncertain supply of sugar cane. A further reason for low productivity is the nature of the technology employed. Some machinery and equipment used in this manufacturing are obsolete, which makes the replacement of broken parts very difficult; by contrast, some plants have the latest technology which again causes operational problem because of lack of adequate trained personnel.

Imported technology in this manufacturing sector has not been absorbed in the country. There is a great reliance on foreign parties for any major repair and maintenance, and for spare parts. It is found that the transfer of technology, which has taken place has been mainly confined to production and local maintenance. So far as other capabilities, such as the manufacture of machinery and equipment, innovation, and linkages are concerned, the achievement is nil or negligible.

VII. Conclusion

It can be inferred that it is often the case that the existing technology transfer process often fails to engender the various desired technological capabilities in LDC's. In fact, many observers believe that it actually hinders the achievement of these goals because inadequate and inappropriate technology is transferred, accompanied by too many restrictions and controls over its use by the recipient. The transferred technology can also be termed as inappropriate on account, in many instances, of its requiring the use of relatively scarce factors of production and neglect of abundant resources

Another criticism frequently encountered is that the transferred technology makes the recipient country technologically dependent. Firms in developing countries often obtain from abroad all or most of the technology required, and thereby make little use of technology and skills locally available. Furthermore, many transactions take place under very imperfect market conditions in which the bargaining advantage is held by the technology selling institutions which makes the whole process very expensive for the buying institutions, and at times result in over-payment of scarce foreign exchange.

To overcome these problems, it is a matter of crucial importance that the recipients properly appraise technology being considered for transfer, keeping in view the objective of promoting the several desired capabilities and consequences, viz. production, innovation, investment, and linkages.

The process of importation of technology in Nepal has been going on largely without any planning and virtually without any reference to the conditions and needs of the country. There is no specific institution with the role of collecting relevant information on advanced technologies, monitoring the transferred technology, and advising the public and private sectors in the transfer of technology. Furthermore, Science and Technology Policy is yet to be incorporated in the technology transfer network.

In general, the choice of manufacturing technology in Nepal is usually determined by taking the cost of capital into consideration as well as the availability of spare parts and the ease with which repair and maintenance work can be done. Automatic processes are frequently at a disadvantage owing to the irregularity of supply of electricity; however, automatic or semi-automatic processes are not uncommon.

A major way forward for promoting technological development in Nepal would be to create a network of links between universities or research centers and industry. In particular, the coalition between the Science and Technology Academy and industry is very weak. A framework for promoting University-Academy-Industry dialogue should be established, so that the desired synergy in molding of University graduates and the development of an indigenously strong, stable, and dynamic industry may be facilitated (Yaker, 1996). It will greatly help if research carried out at the academy sought to show how science and technology-based development should be promoted for the benefit of rapid socio-economic development in Nepal.

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Use of Internet in Nepal: Present and Future

Mr. S. Rajbhandari
Mercantile

I will give a brief history, on the use of internet technology and the availability of internet access in Nepal. It is been very difficult road with pot holes. We have made a lot of progress but it has not been with out its fair share of difficulties. Then I will give you a run down of the interesting applications, not just the e-mail and browsing but the innovative applications of internet today. I will also try and cover the applications that various organizations in Nepal are planning in the near future. I am not talking about the past six months. The story of internet is not complete without the start off with RONAST.

In 1994 RONAST started e-mail service as an experiment from upstream provider from New Delhi and my company also started a few months later. This was a very difficult phase. Communication to India was not very good. Ultimately RONAST slowly wound down the services. The providers went to other upstream providers in India, Australia and Singapore. At that time a second higher speed Internet service provider also came into the picture providing e-mail home services via a dialback system from US. At about the same time healthnet which is a project of satellite started providing email services to health institutions in Nepal. The second half of 1995 saw upgrading of lease circuit to Singapore and also dramatic reduction in prices of email services. It was only last year full internet access was available and the application on cover mainly dealt in the development that have taken place in the last one year.

A third provider for computer land communication systems provide e-mail services only via a X.25 circuit. It was only towards the beginning of 1996 that a 64KB Digital service was obtained to Singapore. 64KB lease circuit is by most international standards extremely very small. It is all we have to work with.

This year about 2 weeks ago another company secured or acquired a lease circuit to Bombay via VSNL which is equivalent to NTC in India. A full POP (pro-quested presence) was established in Pokhara which means anybody in Pokhara can get access to all the services of internet. A second lease line was also acquired by my company. Both were expanded. There is one more company testing a link to upstream provider in Canada. The Ministry for Information and Communication has announced ISP regulations -highlighting licence fees, quality service and control of undesirable content. So how many people have access to the internet? Very few. There are less than one hundred people with access to basic e-mail and less than 600 people access to internet service. What are the reasons for this slow growth. First and foremost as it is the cost. International lease circuit cost us about anywhere between 20 to 50 times more than one and half megabyte circuit in the cells. So we pay as much as 400 to 500 at least more than ISP in America.

Till 1997 early this year there were no proper guidelines from the MOIC. Let me explain this, the telecommunication act of Nepal 1972 basically outline the basic services that NTC could provide. However, that act was totally silent on value added services. Let me give you an example. The fact that the hotels have been giving value added services, provide services in your room and charge for it. One did not know whether it was illegal or not because the act was silent. So staying with the internet services it is a value addition on basic services provided by telecom. But the act was silent. Therefore there was a certain amount of hesitation from the business community to actually provide these services because when you have a situation when things are unclear it does not provide a lot of confident investors and also poor tele communication structure. If you want a 100 or 200 phone lines in any place you have to wait a few years. What is the future of internet services access in Nepal? It is fairly bright for the time being. We can expect internet services in at least 7 or 8 cities in Nepal. And my company is planning to put 4 to 5 within this year in various parts of Nepal which means that you can have access to this services from most of the cities in Nepal. There will be more internet service providers, there will be more bandwidth available, it will cost more but it will be available. The number of users are expected to more than double every year and hence costs are expected to reduce. So what are the applications? The basic application of course are email, internet browsing, File Transfer (FTP) file transfer and internet presence. Because we can take it for granted that email are used by many people and they are gaining not only in terms of time but also in terms of cost. So I will not cover that. This is a list I made last night and I have taken out 10 applications which were interesting. I will cover each one very briefly; the garment industries, hospitals and clinics, publications, software development companies, carpet industries, courier companies computer hardware vendors, travel industries and time permitting I will also try and cover what additional new applications are being planned such as internet shopping, tele-medicine, intranet, library network, internet banking and so on.

Garment Companies: The way the garment companies worked here was like : a design would be sent by courier or it would be faxed to Nepal. Fabric would come from India. They would go by a design that was communicated by fax or telephone then they would make the garment and sell it and hoped it would not be rejected. With the introduction of graphics on email and the internet what the companies have now been doing is, they have been sending design of both fabric and garments over the internet from USA to here. A design is made, it is then sent to the states. The buyer approves it saying that yes you have understood me, a sample of fabric is scanned and sent back. He approves the colour of the fabric and the design. Only then the production is started. Hence there is cost saving, tremendous sales in time, less problems of rejection of consignment by customers. This is what is most important. There are many garment industries that have flopped here in Nepal because consignments have been rejected. Why? because pockets are sewed this way, the buttons are missing. That is virtually eliminated. The technology used has been a simple multimedia computer and a graphic scanner thus coupled with internet provides a very powerful tool in the garment industry.

Hospital and Clinics Telemedicine: There are two projects here in Nepal which ties the hospital and clinic here of Nepal to institutions in America like the medical electronic link dogma. They have connected six hospitals; Teaching Hospital, Kanti Hospital, Bir Hospital, Sher Memorial of Patan, CIVIC and Nepal International Clinic. When the doctors come across difficult cases, they will log on computers in dogma via internet. They will post the

difficult cases and that center is manned 24 hours a day. When they sent the cases abroad they also scan X-rays, they take digital photographs of the patient and send it across the world in a matter of seconds. The cases is viewed by the experts and a recommendation is made within half an hour. The doctors in a small clinic like Nepal International Clinic have access to the world's best brains. They also have access to large data base libraries and so forth. The technology they have used again is a multimedia computer, graphic scanner and a digital camera. In the case of Garmouth University they have also given special soft ware. Till last year even Bir Hospital was doing this. A doctor by the name of Mike Frank was here. He was a surgeon. He has actually been posting cases to Tokyo and he has been getting responses from Tokyo.

Publications: There are quite a few Nepalese publications on the internet but the benefits are little hazy. None of the publications here are charging in providing information on the internet. Whereas the readers who are abroad get instant access to both Nepalese news and as well as Nepalese respective to international news. Examples of this is our The Kathmandu Post, Independent, Himal, you can also hear Radio Nepal. Voice and real audio, we started about two months ago together with and other publications. The software companies have been taking part in software developmental forums. They have access to software developmental forums, libraries, experts and they also can vie for new business. Example of this is three companies are doing it at this moment and have direct communications with these four companies. The carpet industry had a problem like the garment industry; everything was done on what they thought was good understanding. Typically out here an artist drew a design and put it in a frame out there and made the knots. When they send it they hoped that the buyer in Germany liked it. Now using the internet they can solve the problem very much like the garment industries. They can send the designs back, get approved and start manufacturing. And of course with the use of Email they can keep each other informed about the production schedules. The courier service companies could keep track of the courier parcels instantaneously. If you have a consignment number, DHL, UPL you can track parcels down anywhere in the world.

The Computer Hardware Vendors: The hardware vendors are also using this they have got access to expert advice. They also, as most of us, do all the tracking on the internet. We no longer have to wait for their respond. We have access to the data bases and we track our orders via the internet. The travel industries our essentially advertising in the internet. There is very little here but there is great scope here. The newer applications are internet shopping. Benefit of this is the customers are given 24 hours service, there is home delivery and parking so travelling is unnecessary. The super market can maintain zero inventory because they can go to the supplier pick it up and deliver. The technology that are being used are relation data based management system accessed by the internet with secured transactions. The Blue Bird Department Store is going to implement this in a couple of months time. If you look at Bluebird Department Store they have a number of problems. Parking problems: the problem perceived to be expensive and if they have all the prices on the internet that perception can be wiped out immediately. The customers do not have to come there but the goods will be delivered to you, they do not have to necessarily stock everything, they can pick it up from a fresh house and deliver it.

Telemedicine: Right now the telecommunication project is such that it is time the people in Kathmandu utilise it properly. Would not it be infinitely more useful if we could tie hundreds of hospitals in Nepal using various spots around the country to experts in Kathmandu, as the experts in Kathmandu will know the situation in Jhapa. A personal doctor would not certainly know. He probably would say call an ambulance. So if you could make a network in Nepal which in turn is tied to the network abroad it makes it infinitely more powerful.

Virtual Private Network: I will not cover this because it is primarily required by large companies and large government offices. I will just tell you very briefly how it works. This is the internet that has connection to Pokhara, Bharatpur and so forth. If the election commission wants to hook-up their computer from Kathmandu to Jhapa or Duhabi near Bharatpur they would not set up their own network. They would go via the internet work using cheap access. Using a technology known as virtual Private Network that gives them secure network. This network would know only this one and vice-versa. Nobody else from the industry can come into this network. So using the backbone infrastructure of the internet service providers services you can make nation wide or world wide networks. This would probably be the most powerful application of the internet here in Nepal.

There is a project to hook up libraries. I am not very familiar with all the issues here. I do know that an experiment is going to take place to tie up 4 or 5 libraries here in Nepal. There is a bank whom we are working with and are developing software for. We will provide internet banking with the benefits of 24 hour banking, low investment and very expensive customer support areas like a lobby and also you can tap into international markets and that is very strong point if Nepal wants to position itself as a optional banking or financial centre this technology can be used because you need not develop networks outside your home, only need to connect to an existing network. Again you are using a technology known as SET (secured enabled transactions)

I will stop there and take questions.

Promotion of Electronic Load Controllers for Micro-hydro Installation in Nepal

Indira Shakya, RONAST and Surendra Mathema, NMHDA

I. Background

With the advent of new technologies like micro-electronics, biotechnology and new materials, the technology debate regarding the developing countries assumes new dimensions. Developing countries cannot afford to remain indifferent to new technological developments taking place in the industrialized countries. According to Freeman (1989), economic growth depends heavily on the introduction and efficient diffusion of new and improved processes and products in the economic system. As late-comers developing countries may enjoy the advantages in utilizing the new technologies to leap-frog and achieve international competitiveness in terms of price and quality. However, mere reproduction or use of borrowed technology is unlikely to strengthen the technological capabilities essential for becoming competitive (Bhalla, A. S. 1995). In a study of the software industries Watanabe (1989) affirms that without local technological capability the developing countries are likely to find it difficult to unpackage technology to develop the technology locally.

Developing countries are characterized by dependence on other countries for technology, lack of finance, low investment and inconsistent government policy. However, it is imperative that these countries face the technical challenges to uplift their present status. A major step in this direction is the integration of new technologies; improvement of low-productivity economic activities through the use of high technology and technology blending,² a concept introduced by A. S. Bhalla (1995).

This paper attempts to analyze factors influencing the integration of an electronics based product, the Electronic Load Controller, in the micro-hydro plants used for electrification in the remote areas of the country.

Micro-hydro schemes generally located in the mountainous regions are not simply scaled down versions of large hydro projects. They require new design approaches to ensure that they are easy to maintain as well as cost effective. Typical micro-hydro schemes are rarely designed with water storage reservoirs. A portion of the river flow is simply diverted along an irrigation-type channel, down a pressure pipe and after passing through the turbine re-enters the river. This reduces the cost as well as environmental problems associated with dams (N. Smith and A Harvey, 1994).

² The concept of technology blending is distinguished from that of appropriate technology of the seventies and eighties.

Most of the micro-hydro schemes provide direct power for requirements such as grain milling and rice hulling. In this case the speed of the turbine is not critical and manual control by varying the water flow is quite sufficient. Same is not true when used for electricity generation. Here greater control is generally required as the electrical equipment is designed to work within a specific voltage and frequency range.

II. Available Controller Technologies

Mechanical Governors

For several years mechanical governors have been widely used to adjust the turbine power at the desired speed to match the load imposed. Mechanical governors require regular maintenance and are expensive, with the cost rising even above the cost of the turbine and the generator (*Smith and Harvey, 1994*). Thus the use of mechanical governors for micro-hydro schemes in developing countries is highly discouraged. This has forced micro-hydro designers to look for alternatives.

Induction Generator Controller

Induction generators are widely available. They are very robust and can be as little as one-third of the cost of synchronous generators. But their use has been limited mainly due to the difficulty in voltage control.

An induction motor can be operated as a generator. The chief advantage of using induction machines is their wide availability, old ones can be refurbished to reduce the cost. Rewinding of induction machines is a common practice in developing countries. A 5 kW induction machine complete with excitation capacitors is approximately one-third of the price of a synchronous generator. This cost advantage decreases with increasing size until a break-even point is reached at a value between 30 kW to 50 kW. Being robust they can withstand significant over speeds and require no maintenance except for routine greasing of the bearings. Induction machines are not fitted with voltage regulators. Voltage regulators have been developed for induction generators. The basic task is to control the large reactive currents which makes them expensive. The additional cost of these voltage controllers along with their complexity far outweigh the advantages of using induction generators for variable load system.

The induction generator controller (IGC) developed at Nottingham Polytechnic dispenses with the need for a separate voltage control module by exploiting the intrinsic characteristics of the induction generator and water turbine. It is essentially a modified electronic load controller which controls both voltage and frequency to within acceptable limits (*Smith, 1988*).

The IGC senses voltage rather than the frequency, reducing the "ballast load" if the voltage falls. The operation principal is similar to that of the electronic load controller which will be described in later part of the paper in more detail.

Electronic Load Controller

In order to obtain constant voltage irrespective of the load, synchronous generators fitted with an automatic voltage regulator can be used. Frequency control is critical if motor loads such as refrigerators and irrigation pumps are used. These can be damaged if frequency is not carefully controlled. The frequency produced by a synchronous generator is proportional to the speed of the turbine and therefore, depends upon the power speed characteristics of the turbine and amount of load applied. If there is no load on the turbine, then the turbine will operate at its maximum speed. Added load such as electric generators for electricity supply, reduces the speed and hence the frequency drops so as to balance the power output from the turbine and the load imposed on the turbine.

In recent years advancement in electronics has permitted a new approach for speed control measures in micro-hydro schemes known as electronic load control (ELC).

III. Principal of Operation

To keep the speed of a water turbine driven generator constant, generated power and consumed power have to be matched. Turbine speed changes as electric appliances are switched ON and OFF. The same happens when the water flow entering the turbine varies. The Electronic Load Controller keeps generated frequency constant by diverting any excess power to a ballast load (ADB/N, ITDG/UK, 1989). (See Fig. 1)

Fig. 1 Schematic Operation Diagram of an Electronic Load Controller

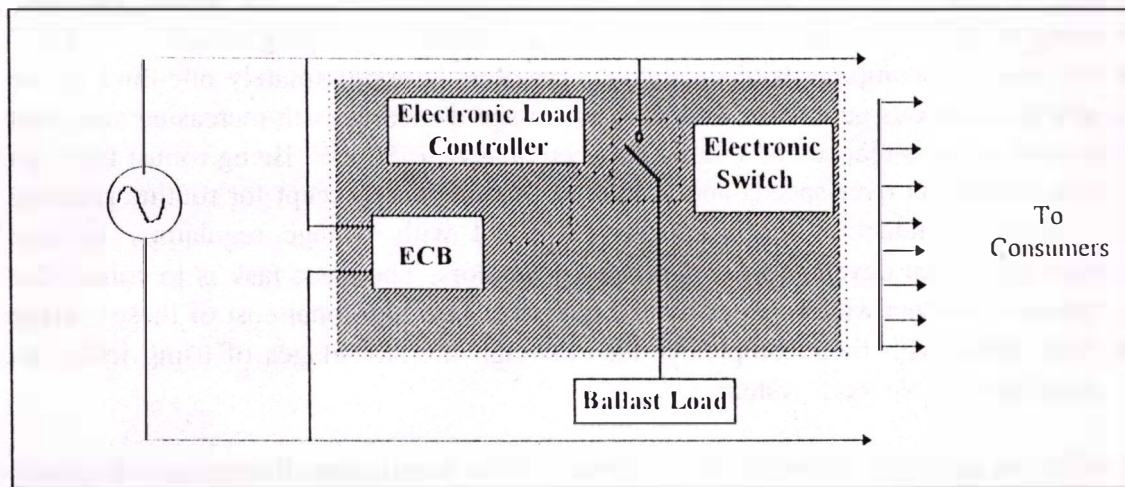
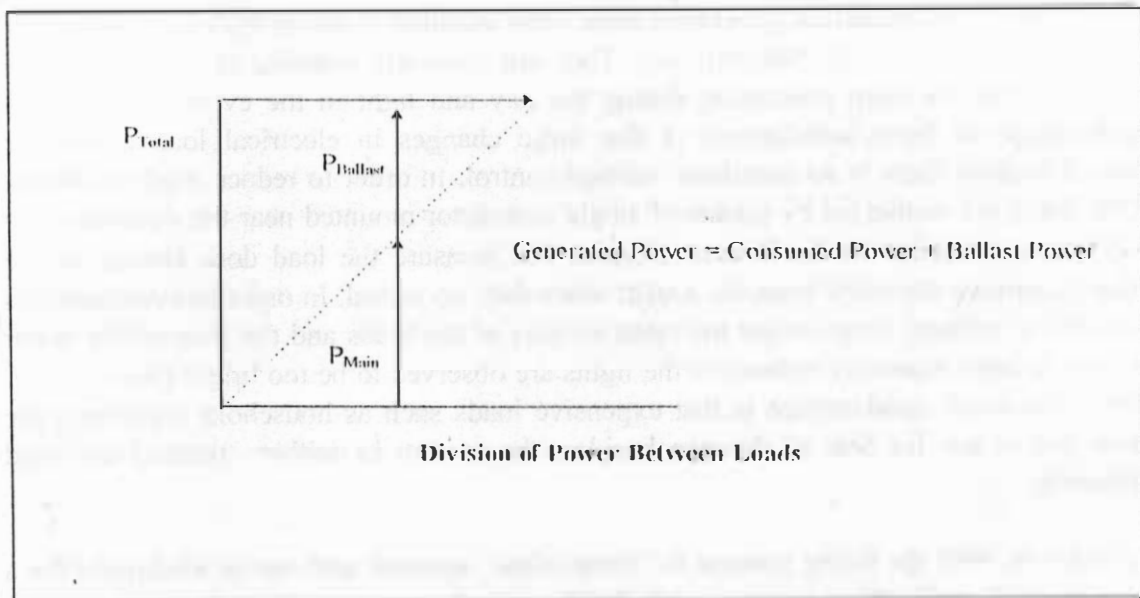


Fig. 2 Power Distribution in an Electronic Load Controller System



The Electronic Load Control Board senses the generated frequency. When the generated frequency falls below the set value of 50 Hz, the voltage falls and hence the controller will reduce the power dissipated in the ballast load. This reduction in resistive loading causes the turbine to speed up and thereby increases the generated frequency. On the other hand when the generated frequency rises above the rated value voltage rises, the system is connected to the additional load, the ballast load. This reduces the speed of the turbine and thereby the frequency. In both cases the purpose is to maintain consistency of the frequency generated by the turbine. (See Fig. 2.)

IV. Advantages of Electronic Load Controllers

With the addition of load controllers flow through the turbine is set at a constant level and all the water is used for power generation. The problem of water wastage is irrelevant in case of small hydro plants which have no water storage. But maximum use can be made of the energy generated in a load controller system as the “ballast load” can be used to heat water or for space heating. Eminent experts such as A. Smith³ and A. Harvey⁴ have strongly advocated the use of ELC for remote communities in the developing countries. Their experience shows that if properly designed and installed ELC is more reliable than mechanical governors and are considerably cheaper.

In Nepal electricity costs are significant, one comparison indicates that the capital cost of a 15 kW installation used for agro-processing and electricity generation is more than twice that of the same scheme used for agro-processing alone (Rijal, 1986). Thus the main aim in the use of any kind of technology specially in the remote areas of this country is to eliminate high cost.

³ Consultant for micro-hydro centre in the department of electrical engineering at the Nottingham Trent University

⁴ Micro-hydro Project Manager at ITDG/Rugby

V. Need for the Technology in Nepal

A large number of induction generators have been installed in micro hydro schemes over the last four years (A. M. Nakarmi, cc). They are generally installed in sites where the turbine is used for agro processing during the day and light in the evening. The main disadvantage of these installations is that large changes in electrical load cannot be allowed because there is no automatic voltage control. In order to reduce load variations, all the users are connected by means of single contractor mounted near the generator. No switches are installed in the houses. Despite this measure the load does change as the villagers remove the bulbs from the socket when they go to bed. In order to overcome this problem the voltage is set below the rated voltage of the loads and the flow of the water into the turbines manually reduced if the lights are observed to be too bright (*Smith et. Al, 1990*). The main disadvantage is that expensive loads such as household appliances are rarely put to use for fear of damage besides, the system is neither operated nor used efficiently.

Furthermore with the rising interest in 'stand-alone' systems and use of electricity for a large range of applications assurance of reliable control system is necessary. This problem to an extent can be solved with the use of automatic load control systems. Automatic control systems such as electronic system used in the synchronous generators, the generated frequency is controlled by maintaining a near constant load on the turbine, see fig. 1. The electronic load controller compensates for variations in the main load by varying the amount of power dissipated in the resistive ballast load (*Henderson and MacPherson, 1988; ADB/N and ITDG/UK, 1989*). The synchronous generators unlike the induction generators have an unbolt voltage regulator. With an increase in 'electricity only' schemes the use of ELC has increased. Attention has to be given to ease of use and reliability, since in remote villages, electrical knowledge is limited and the controllers are often used in quite arduous environments.

VI. Status of the Technology in Nepal

The transfer of ELC technology to Nepal follows three distinct stages

Introduction of the technology

Information regarding the electronics based load controller was initially brought before the micro-hydro turbine manufacturers in the country through ITDG. This technology was initially developed in UK by Gerry Pope. The manufacturers involved in ITDG rural - electrification projects were provided with an opportunity to see closely the technology in operation. Training courses were also conducted by ITDG/N in Nepal on demonstration, theory, operation, manufacture and installation of ELC⁵.

⁵ ELC - Electronic Load Controller was jointly invented by Gerry Pope of Electronics and Rupert Evans of Evans Engineering in United Kingdom. It has also been awarded the International Inventor's Award. It is also known as the GP-ELC

Know-how importation

Having generated an awareness of the technology ITDG organized several training programs to impart the knowledge regarding the use and installation of ELCs in micro hydro schemes. In 1990 a further step taken in this direction was the granting of permission to manufacture the ELCs in Nepal. However, at this stage only part of the ELC was made in the country and the main board (the black-box) had to be imported from UK. This helped in reducing the cost to a certain extent.

In-country production

In 1994 an agreement was signed between ITDG/N and Gerry. Under this agreement two of the manufacturers, Nepal Power Products (NPP) and Butwal Engineering Works (BEW), were granted permission to produce all the components of the ELC system. (See Table 1 for Details of the manufacturers).

Table 1

Name, Location and Size of Industry of Mini and Micro Hydro Turbine Manufacturers

<i>Name of Manufac- - turer</i>	<i>Year of Establish- - ment</i>	<i>Location</i>	<i>Authorized Capital in million NRs.</i>	<i>Type of Organ- - zation</i>	<i>Foreign Counter- - part</i>	<i>No. of Share- - holders</i>	<i>Employ- - ment</i>
1. BEW	1977	Butwal	3	Private Limited	UMN	3	192 (HS-25 S-25 SK-19 UN- 6 TECH - 28)
2. NPP*		Kathmandu	0.4	Private Limited		3	9

* These industries have been registered at the Department of Cottage and Village Industries (DCVI)

Source: Interview and Manufacturers' Brochure

BEW has been established through foreign collaboration, whereas, the NPP was initiated by private entrepreneurs.

VII. Salient Features of ELCs Produced in Nepal

Raw Materials

The ELC system comprises of the following units: thyrister (silicon controlled rectifier); ammeter; voltmeter; MCB/MCCB⁶ and over voltage trip board.

⁶ Miniature Circuit Breaker and Moulded Case Circuit Breaker

The product, ELC is mainly electronics based. Thus, almost all the elements that go into the making of the ELC have to be imported though they are mostly available in the local market. The elements are imported mainly from UK, Singapore and India. But the connecting items such as the wire and switches used are made in the country itself.

Comparison of the element that have to be imported with those that are locally available shows a 50/50 % integration.

Cost of Product

Table 2 gives a picture of the cost of a sample of ELCs produced in the country. Although the item produced locally its cost has not changed remarkably (cc. S. Mathema). The reason being as mentioned earlier the dependency upon import of most of the elements that go into making of the good.

Table 2

Cost of Electronic Load Controllers Made in Nepal

<i>Capacity /Phase</i>	<i>ELC Standard System Unit Price in '000 NRs.</i>	<i>Remark</i>
upto 4 kW/ 1 ph/ 220v	258	Metering consists of 1 line voltmeter, 1 Ballast voltmeter
4 kW - 8 kW/ 1 ph/ 220v	249	Metering consists of 1 line voltmeter, 1 Ballast voltmeter
upto 15 kW/ 3 ph/ 380v	852	Metering consists of 1 line voltmeter, 3 Ballast voltmeter
15 kW - 25 kW/ 3 ph/ 380v	949	Metering consists of 1 line voltmeter, 3 Ballast voltmeter
25 kW - 50 kW/ 3 ph/ 380v	115.1	Metering consists of 1 line voltmeter, 3 Ballast voltmeter
50 kW - 75 kW/ 3 ph/ 380v	134.6	Metering consists of 1 line voltmeter, 3 Ballast voltmeter
75 kW - 100 kW/ 3ph/ 380v	158.2	Metering consists of 1 line voltmeter, 3 Ballast voltmeter

Source: Field Survey

VIII. Factors Influencing the Promotion of ELC in Nepal

Skill Development

Use of local skills in the manufacture and installation of ELCs in Nepal has increased in recent years. As a result the cost has reduced dramatically in this area. The local manufacturers themselves have been well trained for this purpose. Although the equipment are of lower standard the down-time is invariably less due to the fact that local manufacture means local repair is also available (*Smith et al, 1990*).

Most of the training needs of BEW/ NHECO are met amicably through inputs from international experts (collaborating agents) who interact with these companies on a regular basis. A number of regional as well as National Training Programs have been organized by the International Organizations such as Intermediate Technology Development Group (ITDG/N).

Locally too, considerable measures have been taken by the Nepal Micro-hydro Development Association to train and thereby upgrade the staff. With periodic training incorporated within the factory mandate BEW has managed to deliver the required knowledge.

IX. Linkages

Linkages with the collaborating agencies

Linkages with the collaborating agencies is the main source for technological information as well as technical advice. It also provides an opportunity for upgrading of the technical staff. Working together with the foreign counterparts has helped gain experiences in design, development of manuals, identification of appropriate technology as well as product development suitable for the home market.

Linkages with Institutions

Development of manpower as well as their periodic training has been facilitated due to the strong linkage with the training centers like Mechanical Training Center (MTC) as well as Butwal Technical Institute (BTI). Both, the firms (NPP and BEW) as well as the training institutions (MTC and BTI) have benefited due to this linkage as the firms co-operate as a laboratory for the institution, while the centers provide the theoretical as well as vocational training.

Technical support has come chiefly from ITDG. This organization has also helped in the promotion, development and research besides providing financial support to this sector in the early stages.

Inter-industry Linkages

The use of Electric Load Controllers (ELC) into the system as a load control measure together with the production of peltric set⁷ has generated work for several ancillary industries like foundries and manufacturers of ELC. The creation of these industries means an increase in job opportunities as well as reduction in the cost of the electrification unit⁸.

⁷ Pelton turbines used for electrification purpose

⁸ When this study was carried out, the production of ELC had just been initiated therefore, the economics of this activity remains to be determined.

The introduction of ELCs opens challenges to end-use producers. Besides agro-equipment that operate on mechanical power from the micro-hydro turbines they have an opportunity of expanding their products to house-hold electric appliances as well. The fear of damage through inconsistent electricity supply is reduced.

Research and development

The manufacturers involve themselves in R&D activities in only a limited way and even then it interferes with the scope of expansion of production facilities. BEW and NPP have distinguished themselves by their innovative and development activities on different aspects of micro-hydro technology and its ancillary equipment. The contribution of formal research institutions have been negligible. R&D institutions have to be encouraged to do relevant research. Simultaneously there has to be an arrangement for smooth transfer of information from these institutes to the manufactures. This is an area which requires substantial strengthening in the country.

X. Role of Government

Acquiring technological capability is not an easy, automatic or costless process nor is it rapid. It takes conscious effort over a long time.⁹ Developed countries like Japan and the Republic of Korea have depicted this technological capability to be a national asset, the development of which commands a strong supportive role of the Government.

Although liberal economy is being campaigned as necessary for industrial development, in the case of developing countries, due to several embedded drawbacks such as market failures, in both product and factor markets (*Pack and Westphal, 1986*), intervention from the Government has been considered more important for the provision of an infrastructure conducive to the development of a country's technological capacity.¹⁰ Furthermore, according to Lall (1990), the national technological capability (NTC) depends upon the incentives provided to industry, the supply of skills available, the efforts undertaken to master, adapt and improve upon technologies and the institutions set up to support the functioning of markets. These are the areas where the government is called upon to play an actively supportive role.

Rural electrification schemes were introduced in 1981. However, a relatively rapid rate of implementation became apparent only in 1985/86 and is attributable to: a) the government announcement for provision of subsidy and b) the introduction of locally manufactured induction generators.

⁹ For details see Lall, 1991, p. 124 and Dahlman *et al* 1987, p. 764.

¹⁰ A comparative study carried out by Huq (undated) on technology promotion and state role for Bangladesh, India and Korea determines that due to the inability of the market forces to take into account the externalities which are involved in the absorption and diffusion processes, a supportive role of the Government is called upon for technology promotion in the developing countries.

The ADB/N has been the only agency which through its loan and subsidy program has taken a direct interest in the implementation of small units. In 1985 HMG for the first time announced a policy of subsidy on the cost of only electricity generation, transmission and distribution for private rural electrification projects. The amount of subsidy is differentiated with respect to the area concerned i.e. 75% in case of remote areas and 50% for remaining districts. The subsidy has been disbursed only since 1988/89.

The current rate of development and distribution of micro-hydro systems is largely the consequences of the active leadership and sustained promotions that were undertaken by the ADB/N from the mid-1970s onwards. Not only were loans and subsidies¹¹ made available by the bank, but also resource surveys, feasibility studies, promotion of manufacturers' involvement, technical backstopping and training were provided as required.

The ADB/N efforts were facilitated by two important policy decisions concerning rural electrification by the Government:

- * delicensing of all electricity installations below 100 kW (1984)
- * 50% subsidy (75% in case of remote areas) on electro-mechanical¹² costs, including generators (1985)

The Agricultural Development Bank has provided necessary credit assistance to the manufacturers and entrepreneurs for technological innovations.

However, the availability of the funds for this program was not consistent (*See Table 3.*). The funds were available for some years; while they were almost non-existent for others. Similarly, the interest rates have varied from 15% to 19% but recently reduced to 17.5%¹³. This inconsistency inevitably affected confidence of the recipients and also caused the large variation in the volume of business for the manufacturers, as well as forced them to switch over to do something else. This has a direct impact upon the production of ELCs as they are directly related with the installation of micro-hydro turbines in the country.

XI. Conclusion

ELC production was initiated in the private sector assisted by the International Agencies. These manufacturers are specialized in production, installation as well as repair and maintenance. From manufacture of equipment to its promotion the Nepalese organizations have absorbed and adapted the technology to a certain extent. It is difficult to say at this stage whether the transfer has been successful. Adaptation, promotion and training by international and Nepali technical, financial and development institutions have played the main role in the growth of this sector to what it is today.

¹¹ Prior to the new loan/subsidy policy of ADB/N, the local entrepreneur was getting an average loan of 50 to 60% of the total cost payable over 5 years and a subsidy of 30-35 % of the total cost. At this rate the entrepreneur had to be prepared to pay only 5-10 % of the total cost from his own pocket.

¹² Subsidy is not provided for the turbine, intake system etc. itself

¹³ Contacts with manufacturers as well as entrepreneurs

Training

These training programmes are however, limited to assembling of the equipment and its installation. It is believed that if right inputs and guidelines could be provided to the manufacturers in the country to improve quality and performance, not only the local requirements could be met amicably, considerable exports to the nearby countries in South/Southeast Asia and the Pacific may also come by. Costs of the equipment may go up due to these improvements, however, they would still be much lower than the products imported from developed countries (WECS, 1995).

Research and Development

Very little R&D and promotional efforts have been made. As technology needs improvement, that means research has to be a continuous process. But till now most of the research relating to ELC has been conducted by the individual companies themselves or the foreign counterparts involved in the transfer of technology, virtually no grant is available for the research activities.

Inter-institutional Linkages

At present linkages with the Academic institutions like Tribhuvan University, Institution of Engineering as well as Research Organizations¹⁴ are negligible. Support related with R&D which could have come from this area is non existent. Instead whatever R&D work has been carried out has evolved from the collaborative works with the foreign counterparts or on in-house facility only of testing of the equipment.

Role of Government and Funding Agents

So far the government has taken a positive attitude towards hydro-power development but the emphasis has been more on the larger scale power plants. This is clear from the lack of policies related directly with the development of this sector. The government policy of subsidy to electrification schemes, combined with the loans from ADB/N have encouraged the proliferation of several micro-hydro units in the country which directly affects the promotion of ELCs. This however requires careful analysis with particular focus on consistency and sustainability over a long time frame. It is important to note that a radical shift in the current practice could very well disrupt the progress that has been achieved so far.

XII. Some Measures for the Development of this Sector

- * It is important that the expansion of both the firms and their production capacity be expanded. For this the Government has to promote such a venture by providing necessary incentives for capital investment including import facilities as well as encourage the manufacturers to specialize in specific activities. The manufacturers

¹⁴ Royal Nepal Academy of Science and Technology (RONAST) and Research Centre for Applied Science and Technology (RECAST). Both have carried out works related with micro-hydro turbines but not at industry level.

need to expand their manpower to engage in activities such as R&D, site survey and feasibility studies, manufacturing, installation and training or else leave the responsibility to other agencies. This emphasizes the need for promotion of such activities and also for coordination in an effective manner.

XIII. Areas of Research that deserve attention are

- * Assessment of potentials for ELC development, and the design of a systematic plan to develop appropriate schemes of Micro-hydro plants through location specific feasibility studies
- * Establishment of quality control with particular focus on performance testing of controllers and standardization of equipment design

A realistic plan has to be formulated based on an all-round assessment of people's priorities, manufacturers' capability and research and development requirements. Government attention needs to be directed to the following issues:

- * the provision of necessary incentives to manufacturers, by providing import facilities to develop and produce more efficient units;
- * encourage research and development institutes to investigate into new technologies and more effective ways of implementation and provision of training ;
- * the mobilization of necessary funds and resources and the orientation of donors towards a broader outlook in micro-hydro development.

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Table 3

ADB/N Loan, Subsidy and Number of Turbines Installed By Different Purpose
(1981-1995)

<i>Year</i>	<i>No. of Units</i>	<i>Total Capacity kW</i>	<i>Total Loan (NRs. '000)</i>	<i>Total Subsidy (NRs. '000)</i>	<i>Electricity</i>	<i>Mechanical</i>	<i>Mechanical & Electrical</i>	<i>Total Electricity & Mechanical</i>
1981/82	1	3	18000	0		29	16	16
1982/83	2	13	624000	0		57	11	11
1983/84	3	14	88000	23000	1	68	16	17
1984/85	4	21	172000	88000		68	12	12
1985/86	11	72	400000	351000		86	16	16
1986/87	18	171	1142000	832000	4	69	15	19
1987/88	11	99	800000	659000	1	73	15	16
1988/89	9	79	1652000	865000	2	45	8	10
1989/90	11	149	973000	1355000	8	31	7	15
1990/91	4	105	8039000	954965	2	29	6	8
1991/92	3	47	986570	846969	4	43	3	7
1992/93	12	129	917001	2820429		22	5	5
1993/94	8	364	2726287	9098585	1	11	1	2
1994/95	7	172	8691089	4637980	1	18	3	4
1995/96	119	190	7134038	8028000	2	5	3	5

Electric Transport Technology for Public Transportation in Kathmandu: An Overview

G. B. Banjara

Small Business Promotion Project

I. Background

The problems of Kathmandu have been compounded with the rapidly growing population, lack of proper planning of infrastructure, insufficient housing, water supply, communication, transport and many more. Over the years there has been no significant improvement of the urban facilities but continued centralization of political, economical and commercial activities and the growing business opportunities have resulted into a virtual exodus of population from hill, Terai and from neighboring countries.

The transport sector in Nepal and especially in Kathmandu is witnessing a rapid growth in recent years.

Table 1

Number of registered vehicles in Kathmandu- a comparison

Types of vehicles	No. Vehicles March 1987	No. vehicles March 1995	No. of vehicles upto August 1996
Bus, Trucks and Minibus	4510	6588	7345
Car and Jeeps	13460	24248	27583
Motorcycles	6150	49299	59003
Tractors Power tillers	900	1670	1674
Autorickshaw, Tempos	620	3844	3862
UN/ CD cars/ jeeps	-	3012	3476
Total	25,640	88,681	1,02,943

Source: Bagmati Zonal Transport Management Office

Kathmandu accounts for almost 60 % of the total number of vehicles and 70 % total transport fuel consumption in Nepal. Thus majority of transport related problems are concentrated in Kathmandu valley.

Increasing air and noise pollution, poorly maintained narrow roads, growing congestion, increasing traffic related accidents, weaker enforcement of transport regulations, spurious spare parts, poor maintenance of vehicles, poor quality of fuel, poor urban transport management are some of the problems in the transport sector in Kathmandu.

The problems of public transport system are more acute in Kathmandu. Most of the public transport vehicles are very old and inefficient. Most of the buses operating in Kathmandu are brought here when they can no longer render services on the long route. Many buses and taxis in Kathmandu are operating for last 30 years. One of the backbone of public transport system of Kathmandu is 'route tempos' and 'meter-tempos' which have very inferior 2 stroke engines.

However the most serious of the problems in Kathmandu is growing air pollution mainly caused from emission of the gaseous pollutants from the vehicles.

As public transport vehicles travel more kilometers, carry more number of people each day and are subject to high negligence, their share of contribution in the emission of gaseous pollutants and other transport related problem are also very high.

Vehicle emission consists of harmful gases such as Carbon Mono Oxide, Nitrogen Oxides, Hydrocarbons, Oxides of Sulfur, Lead Oxide (from petrol engines), particulate matter and suspended solid particles. Research studies reveal that in many busy traffic intersections, most of these parameters already exceed the maximum permissible level set by World Health Organization (WHO). Exposure to these gaseous pollutants has led to serious adverse consequences to public health.

Kathmandu suffers from availability of limited options for public transport system. Unlike many other metropolis in India and elsewhere, a public transport system to carry very large number of people such as tram and train has not been explored and unlikely to come to Kathmandu in foreseeable future.

Thus Kathmandu's existing transport scenario, clearly speak of a requirement of an improved form of public transport system, which can fulfill the city's growing demand of mass transport requirements effectively and efficiently, at the same time also help to redress the current problems to a significant level.

Among many alternative technologies, one frequently being argued is the 'Electric Transport Technology' or the electric vehicles.

II. Status of Electric Vehicle Technology

Global Status

History of electric vehicles goes back to the last century. Electric vehicles were in use in the USA and Europe even before the advent of internal combustion engines. Till 1900, electric vehicles were the most popular form of vehicles. They were regarded as the fastest and most comfortable as compared to the steam powered and fuel oil powered vehicles. However earlier in this century, Henry Fords fuel oil driven mass scale car manufacturing

technology and the explorations of huge oil fields in the USA gave the internal combustion engine (ICE) vehicles a clear lead over the other two rivals.

It is argued by the electric vehicle industry lobby that despite of the high potentialities, electric transport technology could not succeed in past because of the negative role of the large car manufacturing companies, relatively cheaper international fuel oil prices, resource hungry wasteful materialistic lifestyle of people of the developed nations and limitations of speed, charging and operation range made electric vehicles less popular means of transport in the developed nations. Nevertheless they are already in use in wider range of activities such as in hospitals, airports and industrial in-house transportation applications.

Increasingly stringent emission standard for fuel oil driven vehicles in the developed nations, the need to slowly switch over to alternative energy sources in view of the worlds fast depleting petrochemical resources (which according to experts will last up to for next 40 years), recent improvement in the field of electric vehicle technology such as improved performance range, speed and designs have heralded back the electric vehicles technology into a promising future transport system across the world.

In this respect it is worthwhile to mention the recent announcement of various international car companies to launch a mass scale electric vehicle models in the USA and Europe. Already the U.S. government has passed a so called "EV mandate" (law) stating that by 1998, 2 % of all the new cars manufactured in the State of California (major car manufacturing state in USA) must be 'Zero Emission Vehicles (ZEVs) such as 'battery operated cars', 'flywheel cars' or 'hydrogen cars'.

National Status

As it may sound, electric vehicles are not a new phenomena in Nepal. The "trolley bus" operating from Tripureswor, Kathmandu to Suryavinayak, Bhaktapur (16 KM) was the first electric transport system in Nepal. Since its establishment in 1978, these buses are silently carrying a whole generation of the people of these twin cities.

The recent focus in the electric transport technology in Nepal however is in the Lead Acid Battery operated vehicles. In Nepal battery EVs were introduced in 1993, on experimental basis by Global Resources Institute (GRI), an American NGO, with the grant assistance of USAID . As part of its program GRI assembled seven proto-type electric vehicles namely SAFA TEMPO (meaning clean vehicles) on the chassis of Vikram tempos and locally made body.

After a 6 month long trial operation of these tempos on the local roads as public transport, these tempos were considered successful for commercial operation and subsequently handed over to the private sector operators in February 1996. The clean looking, non emitting, less noisy and relatively more comfortable safa tempos since then have attracted the attention of many people. At present two companies are working with the objective of promoting, assembling and operating the electric vehicles in Kathmandu. One of the company has developed its own model of 7 more tempos and operating along with the

SAFA tempos (built by GRI), another company is preparing its first fleet of 15 vehicles to bring on the road soon.

Electric vehicle have got apparently high priority from the Government and donors alike. Government has already given a custom benefit by levying minimum of 1% import tax on the components of the electric vehicles technology. Recently Danish Development Co-operation (DANIDA) has announced a revolving loan fund of up to Rs. 300 Million Rupees mainly to facilitate the conversion of the existing diesel/petrol tempos into electric ones.

III. Prospects and Limitations of Electric transport Technology in Kathmandu.

Prospects

Following arguments have been illustrated to justify the potentials of electric vehicles as public transport system in Kathmandu.

Topography

The bowl like shape of Kathmandu leads to high retention of the pollutants generated here, because of low dispersion factor. Electric vehicles generate almost no pollutants while in operation.

Mobility requirements

Kathmandu being a densely populated city with concentric shape the requirement of shorter distances and low speed (also due to bad road conditions) are easily met by electric vehicles with simple technology.

Reduction of atmospheric pollution

Substitution and conversion of internal combustion vehicles into electric vehicles can reduce the already worsening atmospheric pollution in Kathmandu.

Electricity potentiality

Electric vehicles offer high opportunity of utilizing the nonpolluting hydroelectric power resource, which is available in abundance in Nepal.

Economy

Promotion of electric vehicle production will stimulate the weak economy of Nepal. It could be a potential area where multinational joint venture companies can come in future with a view to operate in the regional international market. It will help create more employment to the people.

Sustainable vehicle technology for the future market

The persistently increasing motorization in Kathmandu and Nepal can be encountered by increased use of locally assembled and manufactured electric vehicles.

Offshoot international dependency

Substitution of diesel and petrol vehicles with electric vehicles would enable to reduce Nepal's total international dependency on imported fuel oil.

High acceptance of electric vehicles

In the context of currently prevailing old uncomfortable vehicles electric vehicles have received a high acceptance from both the public and the government.

Limitations/ Challenges

Technological limitations

Number and weight of batteries, operation and maintenance of vehicles, frequency of battery exchange, maintenance, care of batteries, limitation of speed and distance travelled per charge cycle, availability of skilled technical manpower, and skilled drivers are some of the technological challenges to be met for the successful electric transport system.

Talking of conversion, it is technically as well as commercially viable to convert the route tempos (Vikrams), but same cannot be said for the meter Bajaj tempos with the currently available technical know-how, which are in far greater number (2900) as compared to the former (about 1000) in Kathmandu.

Commercial

The current experience tells that the initial investment on the electric vehicle (tempos) is higher by 40% than the current market price of diesel (vikram) tempos. (cost of new diesel Vikram tempos is not available as the government has banned their import to Kathmandu 5 years ago). Further more it is seen that operating EV is about 1.5 times more expensive than operating a petrol vikram tempo and up to 3.5 times more expensive than a diesel vikram tempo (including the amortization cost of the battery).

Infrastructure

Battery infrastructure plays a key role in the success of electric transport system which calls for a huge initial investment and careful planning.

Ecological

Though electric vehicles are called ZEVs (zero emission vehicles) but truly speaking it is not so. If not handled with care and managed properly, the used batteries from the electric vehicles pollute as badly. The acid electrolyte and lead from batteries is very harmful to

soil and water upon their disposal without necessary treatment. Recycling of the used batteries is possible but there has to be a minimum critical mass/ volume of waste batteries to make recycling in Nepal economically viable.

Economical

Even if we attain some independence from the import of fuel oil, we can not stop the foreign currency going out of the country. Electric transport components and spare parts are highly sophisticated and have to be imported from developed nations (USA, UK, Germany etc.), instead of petrol we will be importing the batteries which bear sizable cost ($2/3^{\text{rd}}$ of the total cost of operation).

Management and Administrative

Unless a well knit network of battery exchange system is developed, operation of electric vehicle is possible only for mass scale operation. i.e. a fleet of over 5 or more number of vehicles. Operating electric transport fleet also requires a considerable management and administrative knowledge. This does not favor our conventional individual transport ownership practices.

Psychological and social

Electric public transport system being a new technology to Nepal and possibly in the whole world (electric tempos), the risks are high. Private operators are dissuaded from running EV fleet because of this reason.

A technology cannot be regarded generally as good or bad in itself, but its introduction, implementation, adaptation and assimilation with respect to the specific needs and conditions of that society. It is very much possible to make electric transport technology successful in the Nepalese context.

IV. Considerations for promotion of Electric Transport Technology in Kathmandu- a case based suggestions for conversion of diesel, petrol Tempos.

It makes no sense to add a new fleet of new electric vehicles in Kathmandu's already congested roads. The focus should be given in the conversion and replacement of already existing old 3-wheeler and 4-wheeler vehicles (as long as possible) with electric vehicles. This process can initially start from the 'route tempos'. But it requires to have a clear objective and strategy keeping in view of all the factors influencing the process. The policy and punishment can not bring the smooth transition. The interest of all the players should be considered while bringing the policy and its implementation.

To illustrate this let us see some of the mini and micro economic indicators in the route tempo sub sector with respect to the conversion in to electric tempos.

- * There are approximately 1000 registered route tempos in the Kathmandu valley which on an average carry about 1,50,000 people each day. The new system must contribute to the equivalent number of commuters if not more.

- * The cumulative investment in the route tempos at the rate of current market price is approximately Nrs.180 million. The converted product must justify and compensate at least 75% of this investment in addition to the cost of conversion.
- * The existing trend of tempo ownership is mostly limited to one to two numbers, (most of them are the owner cum drivers), it is providing direct employment to 1000 people and a good earning support to 1500 to 2000 families directly. Indirect employment could go to another thousand. During formulating the conversion modality, one must consider these micro-level indicators and should adjust to the existing trend as far as possible.
- * Currently existing low entry and low exit barrier in tempo ownership practice, has helped in creation and development of entrepreneurship in the small and medium scale industries which has helped the nation to great extent. (assumption: once an entrepreneur always an entrepreneur) The new system of electric transport should attempt to maintain this practice.
- * The earning from the converted tempos must not be less than the current earning from the diesel and petrol tempos. At the same time the public should not be pushed too hard. (The government can provide some subsidy to maintain this, when the government is subsidizing to diesel why can't it do so to the electric transport?)
- * The current operation system of route tempos is more systematic than the other forms of transport, the new system must maintain this unless until substantial improvement can be realized with the revised system.
- * Electrification of existing tempos is not the overall solution to the current problems of transport sector, it is only one of many, thus the conversion policy should be made in a way which contributes to building a trouble free integrated transport system in the Kathmandu valley. This can be brought only by synergy of various transport systems, not by conflict among them .

These are some of the illustrations which are far from being complete. But the point is not this. The main point being, we should consider all possible factors which have the present and the future consequences while implementing the conversion process.

V. Strategies for Promotion of Electric Transport Technology in Nepal

The author suggests following points to implement while expanding the electric transport system in Kathmandu.

- **Form a co-ordination central working body involving representatives from all concerned sectors with the widest possible overview to formulate policy, co-ordinate and monitor the implementation of the electric transport system.**
- **Establish a research and a development center along with a training center to constantly improve the electric transport technology and to produce necessary skilled manpower in the sector.**

- **Establish a net work of battery exchange facility in different parts of the city. The management of running these stations can be given either to the smaller 'transport operating associations' or the private sector. The co-operation and involvement of the local investors, donors and the foreign investors is highly sough after.**
- **Make stage wise action plan to tackle problems of pollution from used batteries. This may involve, initially a safe treatment and disposal, secondly establishment of a battery recycling plant and finally battery production facility locally.**

VI. Conclusion

By mere transferring the economic opportunities from one section of society to another section in the name of promoting a new technology will not bring desired changes in the transport sector. There should be a rational justification of employing new technology whose success can be achieved only when we aim to bring about a win-win situation to all concerned players (transport people, government, public). This is not an easy task to accomplish, this can be brought only through a sheer commitment to change for better future and the compliance to the set policies / guidelines at all levels

New Technologies in Telecom Sector: An Overview

Mr. Sugad R. Kansakar
Nepal Telecommunication Corporation

I. Emerging Trends

Telecommunications is one of the fastest growing sector in the world. This fast paced development of telecommunication technology is not only going to change life style in developed countries, but also going to help in the economic upliftment of vast majority of the population in undeveloped countries like Nepal.

Before analyzing the impact of new technologies in telecommunication scenario of Nepal, it will be worthwhile to explore recent world wide trends in the emerging new technologies. The world of telecommunications is becoming more and more sophisticated and diversified. New terminology, new concepts and new ideas are giving conflicting signals to planners and policy makers of third world countries like Nepal. Multi-media, global information society, global information infrastructure (GII), information highway etc. are few buzzwords increasingly used in the present day telecommunication world. In fact the present Vice-president of USA Mr. Albert Gore first coined the phrase "Global Information Infrastructure" (GII) to conceptualize a future seamless multimedia system offering a wide range of services around the world encompassing entertainment, education & business which includes video-phones, video-conference, data communication, interactive personalized television etc. This technological convergence (i.e. Combination of Voice, Video and Data) may ultimately result in virtually elimination business travel, as face-to face interactions or meetings could be created or re-created in a digital space. In other words, the system will make it, possible to see, listen and talk with any other person at any time and any place around the world. Experts opine that due to fast-paced progress in new technologies, this scenario of multi-media along with global information highway may be a reality in a couple of years time.

Followings are some of the presently available and emerging new technologies and concepts:

- Fibre Optics
- Cellular Mobile (GSM/CDMA etc.)
- FPLMTS (Future Public Land Mobile Telephone System)
- Internet
- VAST (Very Small Aperture Terminal)
- SDH (Synchronous Digital Hierarchy)
- WLL (Wireless Local Loop)
- Broadband ISDN
- SONET
- ATM
- PCS (Personal Communication Services)
- GMPCS (Global Mobile Personal Communications by Satellite)
- Information Highway

- Interactive Television
- Global Information Infrastructure (GII)
- Intelligent Networks (IN)
- Advanced Intelligent Networks (AIN)

II. Third World Perspective

Against this background of highly optimistic future scenario in new technologies, it will be worthwhile to analyze the situation from third worlds perspective. In spite of this continued new technological innovations, there are more than two billion people of the world mostly in rural areas where the telephone density is close to zero. Likewise, although the cellular mobile phone has become almost indispensable for vast majority of the population in developed countries, the same is being used by only one percent of the world population. But then it will be a futile exercise to blame the technology or lack of technology for this sorry state of affairs in the third world countries. However the choice of appropriate technology may, to certain extent, ease and expedite deployment of telecommunication services in countries like Nepal with difficult terrain, specially in remote rural areas.

Now let us examine the possible influence of new technologies on telecommunication services in countries like Nepal. This can be analyzed from two perspectives - positive and negative.

Positive Aspects

The urban population and associated development activities, commerce and industry need reliable telecommunication services. The new technologies will result in better and reliable services and also bring new advanced services like cellular mobile, data transmission, video-phones etc. Which will definitely be an impetus to overall economic upliftment of the country, especially in the new liberalized environment. Presently NTC (Nepal Telecommunications Corporation) is facing a lot of criticism for not yet introducing new modern services like cellular mobile, E-mail, paging etc. Apart from this, the new technologies may help in bringing telecommunication services to remote areas where there are no reliable telephone services available at present. For instance, a satellite based new concept of Global Mobile Personal Communications by Satellite (GMPCS) system will help to quickly expand rural telecommunication services to the entire region including the most inaccessible parts of the country without installing cumbersome and time consuming radio base stations and repeater stations of the conventional system. Few of the GMPCS systems shall be in operation sometime by the year 1999-2000

Leap-frogging into the more reliable and modern technological solutions by-passing conventional technologies is another distinct advantage of new technologies for undeveloped countries. Nepal, for example, is presently having almost hundred percent of telephone exchanges and transmission links already digitized, which is not achieved yet by even some of the developed countries of the world. This became possible due to the fact that way back in 1984 itself NTC took a bold step to go for the then latest technology by jumping into the digital exchanges, where as in those days very few third world countries were having digital exchanges. Similarly, while introducing cellular mobile systems,

Nepal now have an option of going directly to GSM or CDMA technologies without entering the analogue environment. It is being speculated that CDMA is likely to dominate the world market of cellular mobile system in future, whereas the CDMA system is in operation in very few countries of the world. The advent of new technologies should therefore be looked upon as a positive phenomenon and a necessity, but one should make sure that it should be taken with a pinch of salt-end product which must be the right service of right quality and right price. Promotion of new technologies is definitely a source of economic development, better quality of life and improved public service.

Negative Aspects

Now, let us view the introduction of new technologies in telecommunication sector from a slightly negative perspective. First it could be argued that undue haste and indiscriminate use of new technologies may require huge capital expenditure. In fact most of the telecommunication operating companies of the world are often accused of being notoriously slow changing technology and the main reason is the cost involved to change to newer technology.

The suppliers of new technologies with their excellent sales talks may sometime convince the planners and policy makers that a particular system is the best available at the lowest cost, where as it may not be the case. And due to the very nature of new technologies, the planners and engineers in the absence of latest knowledge, may not be able to analyze pros and cons of introducing a new technology.

Secondly, the present day research and development in the field of telecommunication is very much focused in the consumer-oriented, ultra-modern society. Obviously, the main driving force for moving towards new technologies is the demand for advanced services in entertainment, business and education. This will create further barrier along the line of social classes, dividing between rich and poor societies. For instance, interactive TV broadcasting is going to be a reality in near future, whereas on the other hand vast majority of people in the third world countries cannot afford to or do not need even basic telephone line.

Thirdly, many social scientists are opining that indiscriminate use of new services in the name of new technologies may result in diminishing social responsibilities and distorting cultural and moral fabric of the society. The negative effect of numerous TV channels like STAR TV, MTV and Zee TV on young generation is already a matter of heated debate among intellectuals in almost all countries in South Asia and ASEAN region. In this context, one can imagine the estimation, when interactive TV broadcast in the name of pioneering new technology, shall be a reality in near future. This problem of cross cultural influence is not confined to third-world countries. A case in point is the concern voiced by an European Commissioner and former Prime Minister of France Mr. Edit Cressen regarding American influence from cyberspace, which, according to him, is not only "a question of protecting the broadcasting of films in television, but above all of ensuring that there is a minimum of European content on CD-ROMS and other data base."

III. National Scenario

To come back to the present scenario of telecommunications sector in Nepal, it will be no exaggeration to state that NTC is not so much lagging behind in introducing new technologies in telecommunication services. As stated earlier, almost cent percent of telephone exchanges and transmission links are already digitized with all exchanges within, Kathmandu Valley Linked by use of optical fibres. Latest technologies like MARTS (Multi access radio transmission system) and VAST are already in operation to serve rural areas. The average annual growth in telephone lines is almost 20% between 1991 and 1997 where as the world average is around 10% only.

NTC is in the process of preparing an ambitious five year plan to coincide with the coming ninth national plan. The plan shall include among others doubling of existing telephone line capacity, introduction of new services like cellular mobile, Internet, paging, Wireless Local Loop etc., extension of optical fibre network, establishment of second earth stations & massive expansion of telephone services in rural areas. It must be emphasized here that all above expansion programmes require right choice of available new technologies. The choice of technology is influenced by following factors:

- Cost
- Interaction with donor countries, if any
- Degree of liberalization and competition
- Compatibility with existing systems
- Adaptability with future global telecom scenario
- Market forces specially "desire" and "wants" of business and industrial communities.
- Availability of bandwidth or efficiency in the use of radio frequencies.
- Degree of obsolescence of the technologies.
- Degree of quality and reliability of the services to be offered.

IV. Conclusion

Finally, regarding the promotion of new technologies in telecom sector in a poor country like Nepal, question may arise as to the logic of introducing latest new technologies in a society where more than 80% of the population are poor and live in an agriculture based economy. Not-with-standing this agricultural based poor economy, one cannot ignore the urban population and associated development activities, industry and commerce, which cannot grow in the absence of adequate infrastructure like telecommunication. More over, the challenging task of providing telecommunication service to vast rural areas in the most remote part of the country does need new technologies specially so due to difficult mountain terrains. It is true that new technology, in itself cannot be the ultimate satisfaction for the mankind, but it is definitely a catalyst for improved living standard and happier life style.

Promotion of Selected Alternate Energy Technologies in Nepal

Gyani R. Shakya
RONAST

I. Introduction

Nepal, a landlocked country, spans over an area of 147,181 sq. km. It has an undulating width of 193 km (North to South) and length (East to West) of 885 km. Geographically it lies sandwiched between the two giant countries, India and China, at 26° 22' N to 36° 27' N latitude and 80° 4' to 88° 12' longitude. Ecologically the country is divided into three distinct regions, running north to south. They are the mountains, hills and the tarai (plains). The distribution of the 18.6 million population (*Census 1991*) over these regions is 7.3 % in the mountains; 46 % in the hills and 46.7 % in the tarai whereas the distribution in the rural and urban areas is 91 % and 9 % respectively.

The Nepalese economy is broadly characterized by a subsistence oriented agricultural sector and a nascent industries highly dominated by agro-based enterprise. The contribution of the agricultural sector to the gross domestic product production (GDP) is about 58 % and it provides a source of livelihood to about 90 % of the population. The manufacturing sector contributes less than 10 % share to the total GDP and generates employment opportunities for less than 25 % of the labour force.

The varied geographical features and the ruralised distribution of its population pose unique challenges to the energy planning as well as other development projects for the country.

II. Overall Energy Situation

Being agrarian, it is not surprising that the country is highly dependent upon the forest and farm as its main source of energy. Historical trend of the energy use show that the traditional types of fuel have over last 10 years provided more than 90 % of the energy whereas commercial forms of energy make up for the remaining 10 %. Analysis of the energy consumption pattern for the year 1994/95 show traditional forms of energy to be 92 % (fuel-wood - 69 %; agro-waste - 15 %; animal waste - 8 %); share of commercial forms of energy is 8 % (coal - 1 %; petroleum - 6 %; electricity - 1 %).

Although consumption of all fuel types assumes continuous growth the individual growth rates have been different. Commercial energy consumption has grown more rapidly as compared to non-commercial traditional fuels.

The largest energy consuming sector is the domestic sector. A typical domestic energy consumption pattern indicates the following pattern:

Energy Consumption in the Domestic Sector, 1994/95

Fuel Type	Units	Urban Area	Rural Areas
Fuel-wood	' 000 kg	1066662	10248149
Agro-waste	' 000 kg	47242	3281729
Animal waste	' 000 kg	114897	2047670
Kerosene	KL	26666	125614
LPG	' 000 kg	5762	0
Electricity	MWh	185065	115305
Coal	' 000	762	0
Total	' 000 GJ	21598	239788

Source: WECS, Energy Synopsis Report, 1994/95

III. Applications of Renewable Sources of Energy

For most of the rural areas alternate/renewable sources of energy appears to be the answer to their energy problem which is enhanced by the fast depleting forests on one hand and the absence of grid-connection on the other. With this in mind several programs and projects have been encouraged in Nepal for the promotion and development of alternate/renewable sources of energy.

Solar Photovoltaics

Solar Photovoltaics are used mainly in the rural areas for remote communications, water pumping for irrigation and drinking as well as electrification purposes. The total installed PV system is about 354 kW. The Nepal Electricity Authority (NEA) has installed three large systems, of 50 kW, 50 kW and 30 kW capacity each, for rural electrification at three different locations. Nepal Telecommunication Corporation has installed highest capacity of 162 kW for rural telecommunication. About 43 airports in the kingdom use solar PV energy for civil aviation purpose. The Royal Nepal Academy of Science and Technology has installed three PV water pumping projects of 1.4 kW, 4.2 kW and 40 kW capacity each for field experimentation and demonstration purpose. Few installations for water pumping and electrification have been made by Center for Renewable Energy, Agricultural Development Bank and private parties. The total installed PV capacity in different sectors are:

Number of Photovoltaics Units Installed

End Use	Number	Percentage
Residential	132 kW	37 %
Drinking Water	51 kW	14 %
Civil Aviation	9 kW	3 %
Telecommunication	162 kW	46 %
Total	354 kW	

Source: WECS, Energy Synopsis Report, 1994/95

Besides the photovoltaic systems solar energy is also extensively used for solar water heating and to some extent for drying and cooking purpose.

IV. Government Incentives

In recent years several measures have been undertaken by the Government for the promotion of this sector. The rural electrification policies of 1981 and subsidy measures introduced in 1985/86 have played a pivotal role in the development of alternate energy schemes in Nepal. The newly established Alternate Energy Promotion Center does emphasize the strong commitment of the Government towards this sector. Although minuscule the Government has laid aside certain budget for this sector.

Percentage of Budget Allocation by Government in Various Power Sector
(1982/83-1993/94)

Fiscal Year	Micro Hydro	Small Hydro	Bio-gas	Solar Power	Wind Power	Alternate Energy	Large Hydro
1982/83		5.46				0.11	95.32
1983/84		7.93				1.11	91.89
1984/85		7.62				0.18	93.11
1985/86	0.15	8.76			0.01	0.5	91.35
1986/87	0.14	5.07		1.75	0.12		92.92
1987/88	0.15	7.00		0.94	0.11		91.80
1988/89	0.22	6.69		0.65	0.01		92.37
1989/90	1.53	38.46		1.6	0.01		823.49
1990/91	0.15	3.02			0.09		96.74
1991/92	0.42	2.83					134.14
1992/93	0.37	3.72	1.33				106.89
1993/94	0.48	0.41	1.94				

Source: WECS, 1995

Budget Layout for Alternate Energy Development in the Eighth Five Year Plan
(1990-95)

Development Programs	Targets	Investment in '00, 000		
		Govt.	Pvt.	Total
Micro-hydro Electricity	5000 kW	500	2,500	3,000
Bio-gas Plant Installation	30,000 nos.	2,500	8,000	10,500
Solar Energy		100	1,900	2,000
Solar Water Heater	5,000 nos.			
Solar Cooker	5,000 nos.			
Solar Dryer	2,500 nos.			
Wind Energy	Preliminary Studies and Master Plan	50	250	300
Bio-mass Energy	Improved Cook-stoves Distribution	200	500	700
Total		3,350	13,150	165,500

Source: Eighth Five Year Plan

Solar Systems

There is no direct government subsidy on the installation of all kinds of solar energy system. However, PV systems have been granted certain subsidy at the rate of 75 % of total system cost if used for irrigation and 50% for electrification. Besides, industries manufacturing solar PV systems are entitled to seven years of tax-holiday period, including two additional years for energy-related manufacturing. The Government also provides concessionary duties and tax on the import of raw materials and equipment to solar power manufacturing sector.

V. Other Renewable Energy Technologies

Wind Energy

Besides the annual budget laid aside for this sector there are no definite strategies charted out so far for the development of wind power in the country. The manufacturers too have not received noticeable motivation either in the public or private sector. However, the Government has reportedly resorted to technical and financial support from donor agencies such as UNDP and DANIDA.

Micro-Hydro

In 1985 HMG for the first time announced a policy of subsidy on the cost of units used only for electricity generation, transmission and distribution for private rural electrification projects. The amount of subsidy is differentiated with respect to the area concerned i.e. 75% in case of remote areas and 50% for remaining districts. The subsidy has been disbursed only since 1988/89. The ADB/N efforts were facilitated by two important policy decisions concerning rural electrification by the Government:

- * delicensing of all electricity installations below 1000 kW (1984)
- * 50% subsidy (75% in case of remote areas) on electro-mechanical¹⁵ costs, including generators (1985)
- * No registration required for units below 100 kW

A scenario of the relation between distribution of micro-hydro systems and subsidies made available by ADB/N is apparent from the table below:

However, the availability of the funds for this program was not consistent. The funds were available for some years; while they were almost non-existent for others. Similarly, the interest rates have varied from 15% to 19% but recently reduced to 17.5%¹⁶. This inconsistency inevitably affected confidence of the recipients and also caused the large variation in the volume of business for the manufacturers, as well as forced them to switch over to do something else.

¹⁵Subsidy is not provided for the turbine, intake system etc.

¹⁶Contacts with manufacturers as well as entrepreneurs

Number of Turbines Manufactured and Subsidy Provided Over the Years

<i>Year</i>	<i>TOTAL</i>	<i>Subsidy '000 NRs.</i>	<i>ADB/N Loan '000 NRs.</i>	<i>Average Loan</i>
1977/78	4		200	50
1977/79	18		1,431	80
1979/80	18		1,357	75
1980/81	12		1,672	139
1981/82	47		3,013	64
1982/83	48		3,664	76
1983/84	81	23	4,976	79
1984/85	78	88	8,686	107
1985/86	89	351	8,875	115
1986/87	101	832	10,252	153
1987/88	97	659	10,131	1511
1988/89	69	865	8,618	216
1989/90	58	1355	8,105	270
1990/91	41	1460		
1991/92	32	600		
1992/93	31	3000		
1993/94	16	15000		

Note: Subsidy was not provided for all the plants.

Source: Energy Sector Synopsis. 1992/93, WECS, ADB/N records

The Agricultural Development Bank has provided necessary credit assistance to the manufacturers and entrepreneurs for technological innovations.

VI. Institutional Framework

In the field of Solar PV System, there is only one manufacturer. There are few private Agencies providing services such as supply and installation of the system. Royal Nepal Academy of Science and Technology is involved with research activities related with the use of solar PV for pumping water, lighting and battery charging. Nepal Electricity Authority on the other hand is involved with use of Solar PV for electrification. Nepal Telecommunication Corporation and Department of Civil Aviation are utilizing PV for rural tele-communication and civil aviation. Subsidy is provided by the government through Agricultural Development of Nepal.

Except for few experimental attempts not much has been done in the case of wind energy. Wind energy measurement/ assessment is being carried out by EN, Department of Hydrology & Meteorology and ROANST.

There are a good number of mini/micro hydro manufacturers. They do perform all related works needed for site survey, manufacture and install the total system. The current rate of development and distribution of micro-hydra is largely the consequences of the active leadership and sustained promotions that were undertaken by the ADB/N from the mid-1970s onwards. Not only were loans and subsidies¹⁷ made available by the bank, but also resource surveys, feasibility studies, promotion of manufacturers' involvement, technical backstopping and training were provided as needed. Other organizations involved with research and development and promotion of this sector are the Small Hydropower Development Board, the Royal Nepal Academy of Science and Technology, Research Center for Applied Science and Technology as well as Center for Rural Technology. Working closely with the national organizations are some foreign agencies like the Intermediate Technology Group of UK, United Mission to Nepal, United Nations Development Program, DANDER as well as the German Technical Co-operation.

VII. Recommendations

The utilization of renewable energy resources can contribute significantly for overall national development. The use of this form of energy not only protects the environment and reduce the burden on valuable traditional forms of energy but also saves a lot of foreign currency which is used for the purchase of petroleum products. Renewable sources of energy is the only form of energy which is available at the location of its need and can be utilized in almost all the locations of rural areas.

¹⁷ Prior to the new loan/subsidy policy of ADB/N, the local entrepreneur was getting an average loan of 50 to 60% of the total cost payable over 5 years and a subsidy of 30-35 % of the total cost. At this rate the entrepreneur had to be prepared to pay only 5-10 % of the total cost from his own pocket.

**National Workshop
on
Promotion of New Technologies in Nepal
March 24-25, 1997**

Closing Ceremony

Date	:	25 March, 1997 (Chaitra 12, 2053)
Place	:	RONAST Meeting Hall
Time	:	5:00 P. M.
Remark	:	Participants
Remark	:	Dr. M. M. Huq, Associate Director, DCRU, UK
Address	:	Mr. Hugh Moffatt, Assistant Director, The British Council
Certificate Distribution and Address	:	Prof. Dhruba Man Singh Amatya, VC, RONAST
Closing Remarks	:	Mr. Chandra B. Khadka, Secretary, RONAST

Participant Remarks

Suman Basnet, REDP

I. Definition

Technology is the "bridge" or the "medium" which links or matches the available resources of a nation with its subsistence and developmental needs. It is the tool for development which is acceptable, affordable and thus sustainable.

"New" technology can be of two kinds. One is emerging technology or state-of-the-art technology which has just left the research tangle and entered the commercial arena. Such technology is essential for Nepal if it wants to find a niche in the global market. The other is "improved" technology which enables cost effectiveness, efficient increment, environmental friendliness etc. Such technology is a must for improving the quality of life of the citizens of Nepal.

II. Impacts of New Technology

The most visible impact is in the socio-economic front. On the one hand, with increase in life expectancy, increased comfort, increase in productivity, there will be a substantial enhancement in the living standard of the people of Nepal. On the other, Nepal will boldly enter global competition and be a respected member of the world community.

Hand in hand with the positive impacts, new technology can bring negative results too. There may be danger of cultural invasion, loss of employment and high stress living. High risks associated with introduction of new technology may push back whatever development has already been attained. Finally, there is the grave danger that the wide gap between the rich and the poor will further increase.

III. Necessary Infrastructure

For the effective promotion and transfer of technology, a number of infrastructures are necessary. Firstly, visionary and committed leadership from the policy and decision makers is the need of the hour. Secondly, consciousness among the citizen is also very important. Thirdly, trained manpower or a labour force which is receptive to skill upgrading must also be available. Fourthly, a congenial R&D culture must be the capacity to mobilize resources, be they human resources, financial resources or natural resources. Finally, there must exist a pressure group of academicians and professionals which will give direction to the government and legislature. To sum up, what is needed is a visionary, supportive and non-interfering government, a committed and socially responsible private sector and S&T institutions that serve as think tanks to the government and which have close links with the industrial sector.

Participant Remarks

Mohan Karki

Ministry of Science and Technology

Good afternoon Ladies and Gentlemen.

I am not telling much about workshop as such, I will just give you a brief role about the Ministry of Science and Technology.

As you know, it is very recently formed ministry and it is still getting established. However, by now by its establishment, we have an organization, a platform to discuss on S&T related matters and take further action on it; Though it still is at its infant stage, it has now with it an able institute like RONAST. So I hope we can force further by taking care of all the problems with the feeling of togetherness. Among policy level roles, decision making roles, facilitating roles, coordinating roles, monitoring roles are the key roles of the ministry. However, the academicians have to perform as an eye opener to the ministry and as a constant chaser. I am sure we will positively succeed in our efforts.

Thank You.

Participant Remarks

Surendra Man Shrestha
National Planning Commission

Good afternoon Ladies and Gentlemen

I will speak about the role of RONAST in promotion of technologies. What sorts of role could RONAST play to promote these new technologies in Nepal ?

There exist many institutions and government bodies in the field of S&T, for e.g. RONAST, RECAST, MOST, NCST, NPC and other units also which may be found in various ministries like Agriculture, Industry etc. So problems lie in mainly some areas, like, lack of coordination, job duplication and even ego clash among the organizations which are existing at present. It has been more than fifteen years back that RONAST was established. It is of course a big organization having high status. This organization is headed by the Prime Minister. It has been mandated overall objectives which aims to advocate for advancement of S&T for all around development of the Nation. So its objective is very broad.

We have pointed the alternative way out to strengthen its depended roles to promote new technologies in Nepal for e.g., firstly like ministries and other non governmental organizations which are engaged in S&T field, they should be left free to carry out their research and developmental works and developing new technologies. RONAST should keep itself, in some areas which are economically feasible and which has bright future for the country for e.g. it maybe in water resource sector, bio-fertilizer and high altitude research etc. RONAST should focus on these areas and it can come out as a bold and effective organization to lead.

Another point is that RONAST, though has been mandated to serve as an advisory body, it should confine itself to the implementation aspect rather than advisory. RONAST can also play its role by making concerned agencies, ministries and other non governmental bodies aware of its existence. Many times RONAST has been undermined in its research and development programs and even organizing meetings. So RONAST should be given due importance. Representatives from RONAST should be invited.

Another point is there should be a pool of experts who looks after, as mentioned previously. That pool should be supported by fund which must be sufficient of course. Close interaction between NPC, MOST & RONAST is also advocated. If possible RONAST should establish and initiate an evaluation system of what ministries and other concerned organization do in the field of developing technologies. It will definitely enhance its role. RONAST should insist on ministries to establish research and development units within them apart from the effort to strengthen the R&D within RONAST at present. Finally, RONAST should do everything possible to give incentives to those scientists and enable people to come out with concrete proposal, with strong commitment to output. Because if we could give such incentives then the development of new technologies maybe enhanced.

Before all these, RONAST itself must be determined and able to solve its internal problem which is there at present. Without this, it is not possible to enhance the work outside RONAST.

Address

Dr. M. M. Huq
Associate Director, DCRU
University of Strathclyde, UK

Honourable Vice Chancellor Professor Amatya, Mr Chandra Bahadur Khadka, Fellow Participants, Ladies and Gentlemen.

It gives me great pleasure to make some closing remarks.

I have been asked if I could also give my impression about the workshop. In fact, the words used were different: Could I also evaluate the Workshop. But how can I evaluate my own thing? In Bengali, there is a saying that to a father even a blind son is a lotus, the queen of flowers. The morale of the saying is obvious. Any evaluation I make, even if impartial, will be viewed as biased.

I am, therefore, refraining myself from making any evaluation. The best I can perhaps do is to give you some hints of my impression of the workshop. As I mentioned yesterday, when I got involved with the project at RONAST I could not dream that there was going to be a day when we would have an opportunity to take the discussion, can I say, to something like the frontier of knowledge in the field. Any remarks I am making should, therefore, be viewed in the context of my low expectation. Don't take it that it is something to do with Nepal only. I have such low expectation for developing countries in general and particularly those low-income countries which are burdened with various inherent problems.

In the context of the above introduction, let me now make some remarks.

- (a) CONTENTS OF THE WORKSHOP. Keeping with the overall theme of the workshop, the papers were obviously selected in such a way that some idea could be given about the transfer of new and emerging technologies to Nepal. One or two papers (e.g. the case study on sugar manufacturing) obviously didn't fall into the category, although it helped us to know about the problems and prospects of promoting technological capability in Nepal by viewing one important industry. However, the papers in general did enable us to know a lot about the transfer of new technologies to Nepal. Some of the papers were undoubtedly highly appropriate, e.g. the lecture by Mr Sanjiv Rajbhandari on the "Use of Internet in Nepal: Present and Future" and the paper by Mr Sugat R Kansakar on the "Promotion of Telecommunication Technologies in Nepal."
- (b) DISCUSSIONS. I have also been impressed with the discussions that followed after each presentation. It is true that one or two of us had more than our fair share of time. However, from the level of the interaction I could easily get an impression of the interest the participants have maintained from the beginning to the end. It was, of course, natural as all the paper presenters, except one, were participating in

the workshop, which itself also speaks about the high level the workshop has been able to achieve.

- (c) FIELD VISIT. Let me also say a few words on the field visit which took the participants to a solar-powered water pump. The project itself is an example of a technology which will perhaps be a common feature in the future. But that is not all. It is a project about which RONAST can be rightly proud of. It showed me how appropriate institution building can help a country not only to receive new technologies from outside (in this case, from Japan), but also learn from its implementation and use.

I must check my temptation to go into further details, as I fear that some of you are perhaps already accusing me, that I have again started beating my own drum.

It has indeed been a great privilege for me to be in the company of friends for whom I have always maintained high regards. I can see that the curve representing the level of participation is always upward rising. I must, therefore, congratulate RONAST for their remarkable achievement. All my praise go to Indira, Junelee, Dilli, Luna and all others who have worked hard to bring the project to the present level of participation and deliberation.

I must also thank the British Council and, in particular, Mr Hugh Moffatt for inspiring the staff members of STEPRUN.

On behalf of Strathclyde University and, on my own behalf, please allow me to express my gratitude for all your kindness and hospitality. I am very proud that you think that I am one of you. I don't think I should expect anything more!

Thanking you, ladies and gentlemen, for your patient hearing.

Address

Mr. Hugh Moffatt
Assistant Director, The British Council

Prof. Amatya, Dr. Huq, Ladies and Gentlemen, Participants

I think again my education continues with the summary provided by Mr. Basnet and Mr. Shrestha. You presented it extremely well and gave me a clear picture of the situation and the problems that you face. One of which I can emphasize and sympathise with, is the definition of RONAST's role in Nepal.

From a Council prospective, the Council has been changing over ten years. The ten years I worked in the Council, one of the hardest thing to say is what does the Council do, what will the Council do ? I think the issue that you face is something that I feel very familiar with and that is the issue of vision where you will be in the future. Who you will be serving, what sort of research you and organizations like RECAST will be doing. You have number of organizations all doing something similar, but it is that definition I think that is all important. It is heartening to have the creation of the Ministry of S&T which hopefully will ensure that, that definition be given which allows RECAST to do their things, RONAST to do their thing and I think that is important.

Mr. Karki mentioned that the support and definition can come from you, the academicians, the people of RONAST. They have the experience, the knowledge probably more so than the people within the ministries and that definition therefore can come from you. Mr. Shrestha particularly highlighted on the need of defining who does what, in terms of the vision, looking beyond this year next year and going beyond that, is very important. And when the things are changing so fast as they are in Nepal, you can wait for the right environment and you can wait for things to happen. But it is you who can do it now. Its you who can think where you will be in four years time. The issues you have highlighted made me realize that you are in that position, that you are going to say RONAST is the institution for research or it will have a specific role in the society in Nepal. And with the commitment you've shown I am sure that will continue for many years and that definition would become more and more refined as the years go by.

This very much is a layman's view, so I am not going to say more than this. You only know where you can be or where you could be or where you want to be. I must say the presentation you have given, the information you have given, show, you know very clearly what the problems are what the issues are. The next stage is then to address those issues. Thank you all for your views and for again enlightening me as I continue with my education of what's happening in Nepal. And thank you to those of you from outside of RONAST for contributing so much and we hope the dialogue continues to their additional forums. It can happen here, you can do it. Once again ladies and gentlemen, thank you very much. I feel privileged to be here and I very much enjoyed being here. People in RONAST particularly Indira, Junelee, Dilli and Luna. It has certainly been an experience for me. And I would say if you need, come to the council to talk to me about any thing. Please come along. Thank You.

Vote of Thanks

Shekhar Shah, RONAST

First of all, I would like to discuss the evaluation of the workshop which you have done. I would like to assure you that we will definitely consider these suggestions for our future workshops. Starting with the duration of the lecture period it was found short and the time allotted for discussion was even shorter. It was suggested that the paper presenters should present the main points and give more emphasis on the discussion.

Comments :

Most of the participants mentioned the workshop to be fruitful, interesting and relevant however, there were few comments on it such as :

1. Some papers were not relevant to the theme.
2. Time allocated should be more after each presentation.
3. Presentation from private association was missing.
4. Discussion paper should be circulated few days in advance

Suggestions :

1. Workshop should include practical aspect also.
2. There should be more papers discussing on policy matters related to Science and Technology.
3. Should also include papers useful to rural communities
4. RONAST should frequently organize similar workshops in different sectors and in different districts.
5. Participants from outside the valley should be included.
6. Set up technological assessment team to assess parliamentarian and concerned government bodies such as ministries, departments, laboratories.
7. Promote and arrange discussion at policy level and to take the appropriate decision.

These are the findings from the evaluation of the National Workshop on "Promotion of New Technologies in Nepal".

Having said these please allow me to say a few words as closing remarks. I would like to extend my sincere thanks to our Vice-Chancellor Prof. Dhruba Man Singh Amatya and our Secretary Chandra Bahadur Khadka, Academicians of RONAST and all the organizations who have deputed you all to participate in this workshop and also to the participants who have actively participated in this workshop. We would like to assure you that we will definitely incorporate your suggestions while organizing a workshop in future. It would not be fair if I do not say anything about our unit Science and Technology Policy Research Unit (STEPRUN). Please allow me to take their names again which Dr. Huq has mentioned: Indira Shakya, Junelee Pradhan, Luna Vajra, Prabina Rana, Tara Upadhya, Nirmal Sigdel, Pradeep Dhodhari who have worked around the clock to make this workshop a success. Similarly, I would like to thank RONAST management for its supports and cooperation to make this a success. I must not forget the University of Strathclyde with which we have a link and which we seek to strengthen still more in future. I must thank Mr. Moffatt also for his participation both in inauguration and closing session inspite of his busy schedule. As I said earlier we would whole heartily accept the comments suggestion whatever you all have made in the future. I would also like to mention that the report of this two days workshop will definitely circulate among you. I also hope you all will be participating again in this kind of workshops which we will conduct again in future with the help of Strathclyde University and the British Council, saying this I would like to adjourn this workshop.

ANNEX

1. List of Participants
2. List of Paper Presenters
3. List of Chairmen
4. Organising Committee

List of Participants at the National Workshop on Promotion of New Technologies in Nepal

1. Mr. Mohan Bahadur Karki
Ministry of Science & Technology, Singhadurbar
2. Mr. Suman Basnet
Rural Energy Development Program, Pulchowk
3. Mr. Ramesh Man Singh Maskey
National Productivity & Economic Development Center Ltd., Balaju
4. Mr. Sanjeev Rajbhandari
Mercantile Communication Pvt. Ltd., Durbar Marg
5. Mr. Surendra Man Shrestha
National Planning Commission Secretariat, Singhadurbar
6. Mr. Madhusudan Bhattarai
Nepal Industrial Development Corporation (NIDC), Durbar Marg
7. Mr. Pushkar Shrestha
National Council for Science and Technology (NCST), Kirtipur
8. Mr. Chandika Prasad Bhatta
Department of Industry (DOI), Tripureswor
9. Mr. Gopal Tiwari
The Kathmandu Post, Baneshwor
10. Mr. Pravakar Khadka
Ministry of Industry, Singhadurbar
11. Mr. Surendra Singh Karki
Industrial Enterprise Development Center (IEDC), Tripureswor
12. Mr. Bishwa Nath Ghimire
Industrial Enterprise Development Center (IEDC), Tripureswor
13. Mr. Lalit Kumar Baidya
Department of Standards and Metrology, (DMS), Balaju
14. Mr. Sanjaya Pandey
Youth Journalist

- 15 Mr. Amar Bahadur Manandhar
Ministry of Industry (MOI), Singhadurbar
- 16 Ms. Minova Yonjon
Herbs Production and Processing Co. Ltd. (HPPC), Koteswor
- 17 Mr. G. B. Banjara
Small Enterprises Promotion Project (SIPP), Sanepa
- 18 Dr. M M Huq
University of Strathclyde
- 19 Dr. Kayo Devi Yami
Royal Nepal Academy of Science and Technology (RONAST)
- 20 Mr. Gyani Ratna Shakya
Royal Nepal Academy of Science and Technology (RONAST)
- 21 Mr. Lalit C. Shrestha
Royal Nepal Academy of Science and Technology (RONAST)
- 22 Mrs. Indira Shakya
Royal Nepal Academy of Science and Technology (RONAST)
- 23 Mrs. Junelee Pradhan
Royal Nepal Academy of Science and Technology (RONAST)
- 24 Mr. Dilli Raj Joshi
Royal Nepal Academy of Science and Technology (RONAST)
- 25 Ms. Luna Vajra
Royal Nepal Academy of Science and Technology (RONAST)
- 26 Mr. Nirmal Sigdel
Royal Nepal Academy of Science and Technology (RONAST)
- 27 Mr. Nar Raj Giri
Royal Nepal Academy of Science and Technology (RONAST)
- 28 Dr. Ramesh Man Singh
Royal Nepal Academy of Science and Technology (RONAST)
- 29 Mr. Sugad R. Kansakar
Nepal Telecommunication, Singhadurbar

List of Paper Presenters at the National Workshop on "Promotion of New Technologies in Nepal"

- 1 Mr. Sanjeev Rajbhandari
Mercantile Communication Pvt. Ltd., Durbar Marg
- 2 Mr. Amar Bahadur Manandhar
Ministry of Industry (MOI),Singhadurbar
- 3 Dr. M M Huq
University of Strathclyde, UK
- 4 Dr. Kayo Devi Yami
Royal Nepal Academy of Science and Technology (RONAST)
- 5 Mr. Gyani Ratna Shakya
Royal Nepal Academy of Science and Technology (RONAST)
- 6 Mrs. Indira Shakya
Royal Nepal Academy of Science and Technology (RONAST)
- 7 Mr. Dilli Raj Joshi
Royal Nepal Academy of Science and Technology (RONAST)
- 8 Mr. Sugad R. Kangsakar
Nepal Telecommunication (NTC), Chauni
- 9 Mr. G. B. Banjara
Small Interprises Promotion Project (SIPP), Sanepa

List of Chairman

Technical Session

- | | | |
|----|---|----------------|
| 1. | Dr. Ramesh Man Singh
Chief, Promotion & Publication Division
RONAST | First Session |
| 2. | Dr. M. M. Huq
Associate Director, DCRU
Economic Department
University of Strathclyde
UK | Second Session |
| 3. | Mr. Shekhar Shah
Chief, Planning & Evaluation Division
RONAST | Second Session |
| 4. | Mr. Amar Manandhar
Under Secretary
Ministry of Industry | Third Session |
| 5. | Mrs. Indira Shakya
Incharge
Science & Technology Policy Research Unit
RONAST | Third Session |

Organising Committee

1. Mrs. Indira Shakya
2. Mrs. Junelee Pradhan
3. Mr. Dilli Raj Joshi
4. Ms. Luna Vajra
5. Mr. Nirmal Sigdel
6. Mrs. TaraUpadhaya
7. Mr. Pradeep Dhodari
8. Ms. Prabina Rana