**Environmental Expert Panel Report**

**Technology Foresight Exercise**

**Pakistan Council for Science and Technology**

**Ministry of Science and Technology**

**Government of Pakistan**

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Acronyms

CAMB Center for Applied & Molecular Biology

CWHR Council for Work and Housing Research

HEC Higher Education Commission

MoST Ministry of Science and Technology

NIO National Institute of Oceanography

NUST National University of Science and Technology

PCRET Pakistan Council for Renewable Energy Technologies

PCRWR Pakistan Council of Research in Water Resources

PCSIR Pakistan Council of Scientific and Industrial Research

PCST Pakistan Council of Science and Technology

PCST Pakistan Council for Science and Technology

PSF Pakistan Science Foundation

PSQCA Pakistan Standards and Quality Control Authority

R&D Research and Development

STEEPV Social, Technological, Economic, Environmental, Political and Values

TF Technology Foresight

UNIDO United Nations Industrial Development Organization

**Preamble**

The report of the Technology Foresight Study on Environment, has been developed by the Task Group constituted by the Pakistan Council of Science and Technology (PCST) under the Ministry of Science and Technology, Pakistan. The report develops a roadmap for scientific and technology interventions for creating different environment related scenarios and suggest action for improvement over the next decade or two.

Pakistan is the 25th country which has undertaken Technology Foresight program. The methodologies used and exercises conducted were framed by six fundamental pillars of future studies – mapping, anticipating, timing, deepening, creating (alternatives) and transforming the future.

Pakistan is a land of diverse landscapes, climatic regimes and equally varied environmental issues. With a growing population, likely to rise to over 200 million within the next few years, more and more of which is migrating to urban centers, the country is faced with a myriad of environmental problems.

Water pollution due to untreated sewage and industrial effluents, lack of access to proper sanitation, inadequate means of solid waste disposal including hazardous waste, deforestation, land degradation and air and noise pollution in the cities, are the major issues that are estimated to cost 6% loss in GDP to the national exchequer which needs the attention of the decision makers, the technical experts and the people who are bearing the burden of these problems.

**Executive Summary**

The Task Group on Environment carried out Technology Foresight Exercise and developed a road map that emerging science and technology can address key environmental challenges to reduce the huge cost of environmental degradation.

Steep V exercise was carried out for identification of issues, drivers and scenario development. For identification of issues and drivers social, technological, environmental, economic, political and cultural aspects were taken into consideration.

The Panel came out with ten most important issues/drivers, viz; Environmental awareness, Political sensitization, Population, Local Technology Solutions, Water Conservation, Urbanization, Bio-diversity, Commercialization of Research, Plastic Bags and Integrated Water Management that can shape up the development of the environment sector on the horizon in the next 10-15 years.

For scenario building the local technology solutions and environmental awareness were considered as the most two important issues/drivers.

The Panel concluded that the Pakistan Council of Science and Technology (PCST) is in an ideal position to play a pivotal role in achieving these objectives; as Policy making institution it can influence the decision makers, and, through the scientific organizations in the country, in general, and through its sister organizations, within the Ministry of Science and Technology can facilitate in the development of indigenous technological solutions to many of the current, or emerging, environmental problems.

**TECHNOLOGY FORESIGHT**

**What is Technology Foresight?**

Technology Foresight (TF) can be described as a systematic approach in which various methodologies and techniques are combined in order to create a better preparedness for the future.

Technology Foresight is neither about delivering probabilistic predictions of the future technologies (Technology Forecasting) nor is about anticipating the impacts of future technologies in today’s society (Forecasting Assessment), rather Technology Foresight is a Systematic Process to visualize Science, Technology, Industry, Economy and society in the long run, with the purpose of identifying technologies that can generate economic and social benefits. Pakistan is the 25th country which has undertaken Technology Foresight program.

The methodologies used and exercises conducted were framed by six fundamental pillars of future studies – mapping, anticipating, timing, deepening, creating (alternatives) and transforming the future.

Foresight is by nature multi-disciplinary, requiring the expertise of disparate groups in order to combine scientific and technological expertise with an understanding of society, economy and environment. It is usually intended to have a major impact, and often includes controversial issues where there are lots of vested interests. This is especially true of priority setting for the allocation of resources, which is a common application of foresight.

**Foresight’s role is**

* **to help government think systematically about the future.**
* **to give ownership of decisions to all stakeholders for adoption of policies and their implementation.**
* **to promote culture of future oriented thinking.**
* **to promote networks between ministries, departments, institutions and companies.**

**Project Objectives**

Based on a decision taken by the Pakistan Council for Science and Technology, a sectoral and nationwide Technology Foresight exercise was proposed. This approach aims at enabling the Government’s intention of uplifting key sectors through improved operation of limited national resources. It results in selecting public policies needed to align scare resources for supporting assimilation of technology by the industry. Additionally, Technology Foresight fosters increased rate of national innovation. This is achieved through the rigorous application of those Technology Foresight strategies, techniques, and methodologies that have proven successful in other countries, and are also conducive to our country’s milieu.

**Specific Objectives**

According to the United Nations Industrial Development Organization (UNIDO), Technology Foresight is the *systematic process of visualizing science, technology, society, and economy in the long-term, with the purpose of building consensus to identify technologies, which will cause the greatest social and economic benefits*.

Technology Foresight in Pakistan has been implemented to provide valuable inputs to strategy and policy planning as well as to mobilize collective strategic actions. It aims at doing so by:

1. identifying potential opportunities for the economy or society from new science and technologies, and
2. considering how future science and technologies could address key future challenges for the Pakistani society.

Pakistan’s Foresight program involves constructively bringing awareness of long-term challenges and opportunities into more immediate decision-making. It looks beyond normal planning timescales to identify potential opportunities from new science and technologies. It, then take actions to help realize these opportunities. It brings together scientists, technologists, businesses and consumers, with those who can help deliver benefits. This leads to a systematic process for discussions on the future.

The consultations facilitate identification of policies and projects. The starting point for a policy or a project recommendation is a key issue where science holds the promise of solutions (e.g. information and communication technologies, in which Pakistan has already invested considerably). In addition, it may be an area of cutting edge science where the potential applications and technologies have yet to be considered and/or articulated more broadly (e.g. biotechnology, nano-technology). Foresight policies and projects will:

* Encourage the creation of new networks between science, business and society
* Have the support of at least one of the interested communities (Government, research funders, business, etc)
* Add value to existing activities and initiatives – with the scope to deliver outputs that would not otherwise be achieved.

**Methodology Adopted**

Technology Foresight experts all over the world use different methods and tools to conduct this activity. These methods and tools are adopted according to the availability of resources. Since this project at PCST was launched at a time when severe economic crunch was being faced by the government, therefore budget and manpower was not provided according to the envisaged plan as per PC-I.

Keeping in view the limited resources at hand, expert panel method was used by the project team. However in order to find out the priority areas on which the foresight study needed, a mini Delphi Survey was carried out. As a result of this nationwide survey, ten sectors were identified, namely, ---- Energy, Agriculture, Industry, Education, Environment, ICT, Health, Materials, Transportation and Management.

Expert panels were formed on each of the above sectors, comprising of all the stakeholders. These panels held their meetings in which brainstorming sessions using STEEPV and Scenario Planning methods were invariably used. During panel meetings presentations by other experts were also arranged. Subgroups to handle specific tasks were also formed.

As a result of the meetings, recommendations pertaining to policy, projects, along with roadmaps were produced.

**TERMS OF REFERENCE**

The Terms of Reference of the Expert Committee were:

1. The panel will work as a Think Tank, in a particular field, for the Government of Pakistan using Technology Foresight process.
2. The panel shall review the issues related to development in the respective fields, suggest short, medium and long term strategies, to be undertaken by the government of Pakistan, for strengthening S&T activities required towards industrial and economic progress in Pakistan.
3. The panel shall identify and prioritize R&D projects of high national importance by considering short, medium and long term development that need to be supported by the Government of Pakistan.
4. The panel will work for duration of six months, at the end of which a comprehensive report, indicating the current status vis-à-vis strengths, weaknesses, opportunities, and threats of the sector under study.
5. Recommendation of implementable policies and projects will be the final tangible outcome of the exercise, in addition to more desired intangible outcome i.e. process benefits.

**Identification of Issues and Drivers**

**3.1Social Aspects**

It is a common observation that concerning the environmental issues, a sense of apathy prevails in the people. This is partly due to their socio-economic conditions and partly due to the uncertainty about the future. Because of the lack of awareness people do not give much importance to the environmental issues; the situation can, however, be improved through both active and passive measures. It is envisaged that this would definitely happen in the decade to follow.

Change in attitudes can occur through awareness and through formal and informal education. For the latter, PCST, through MoST, may approach the Text Book Boards, Ministries of Education and HEC etc., for introduction of textual content, about environmental issues, in the curricula at the primary, secondary and tertiary level. This would go some way in addressing this issue.

Resource conservation, waste recycling and other programmes have a greater chance of success if the stakeholders and beneficiaries are involved right at the planning phase of the project. To set an example for others to follow, development of guidelines by PCST for other R&D organizations of MoST would go a long way in environmental improvement.

Inputs from the panel were received on the following points:

1. Behavioural change
2. Project ownership
3. Awareness
4. Education
5. Population
6. Professionalism
7. Enabling Condition
8. Membrane Filtration Technology
9. Solar Thermal Technology

**3.2 Technological Aspects**

While tackling “local problems through indigenous solutions” may be the guiding principle for the researchers and academics, developing a local technology for everything, may be not a wise as well as a practical approach to follow. Rather, indigenization of a proven technology, after suitable improvements and modifications, keeping in view the local socio-economic parameters, would be required.

Pakistan is already a water-stressed country and water conservation is critically important. One of the best approaches, in this context is recycling of the used water, a good example of which is the treatment of domestic sewage wastewater to a level where it could be used for such non-potable applications as watering the plants, or recharging the ground water for raising the underground water-table.

Technologies like membrane filtration, for such treatments, do exist and are cost effective now. Similarly, storm water collection and rain water harvesting, at the municipal and the domestic levels, respectively, are very attractive propositions. It is envisaged that in the coming years, all over the world, a combination of such water conservation would gain popularity. Through our R&D organizations and academic institutions such technologies need to be investigated for domestic applications.

The panel members gave specific inputs on the points given below:

* 1. Sustainable Production and Consumption
  2. Scientific Testing of Products
  3. Continuity & Patronization
  4. Technology Assessment
  5. Indigenous Technology Development
  6. Product Design
  7. Biodegradable Bags
  8. Hybrid Cars
  9. Monopoly of Technology by Developed Nations
  10. Marriage of Imported Technology to Indigenous Needs
  11. Green Technology
  12. Irrigation Technology
  13. Reverse Forest Management
  14. Herbal Plant Directory

**3.3 Environmental Aspects**

One of the highest nuisances in the urban environment (although it is now penetrating the rural areas, as well) is the plastic shopping bags. In the absence of a viable alternate, banning these bags is certainly not a solution. University departments and researchers may intensify their efforts in developing photo-degradable material for such bags in the coming years.

While biodiversity is an important issue with all conservationists, it is also important that in the next decade or so, seed-banks for all indigenous herbs may be established. PCST may be instrumental to launch such a project through MoST.

Innovative approaches in other conservation areas such as ‘reverse forestation’ is to be popularized to ‘indigenize’ our forests now lost to ‘imported’ implantations.

Integrated Water Management may be adopted during this decade for the benefit of the country. Here again PCST may suggest guidelines for the appropriate sister organizations in MoST to take a lead.

The specific topics discussed were:

1. Sector Specific Technology
2. Academia Industry Linkage
3. Extended Life Furniture
4. Grey Water Reuse
5. Restoration of Medicinal Plants
6. Water Recycling
7. Storm Water Storage
8. Integrated Water Resource Management
9. Environmental Awareness for Politicians

**3.4Economical Aspects**

Economics is the driving engine for every thing. Whereas it is the duty of the state to provide the basic needs, including safe water and sanitation to its citizens, at affordable prices, it may also be realized that nothing comes for free. Moreover, if a utility like water is accessible, free of charge, there is no incentive for economizing on its use. In the coming years, through the marriage of technologies, dependable, robust, and easily monitored water meters are to be developed. Through comprehensive exercise water meters may then be installed for the domestic consumers.

Similar steps for the industrial consumers would motivate them to recycle their wastewater and thus ultimately contribute to water conservation efforts.

Compilation of the recycling technologies, developed within the country, and appropriately popularized, could help the individuals and the industrial units to help them save on their expenses.

It is hoped, that in the coming years, with the improvement of economy, more chemicals used as a raw material in industries, would be made reducing the foreign exchange expenditure.

Under this heading, the issues highlighted were:

* 1. Resource Utilization
  2. Access & Affordability
  3. Entrepreneurship
  4. Organic Waste Utilization
  5. Refuse Derived Fuels
  6. Air Pollution Remedial Measures
  7. Water Metering
  8. **Political Aspects**

In a democratic society, it is ultimately the “political will’ that gets things done. No matter how elaborate the plans are, for improving the environment, within the country, unless the decision makers, in general, and the political players, in particular, are taken on board, such plans would have little chance of being effectively implemented. A number of steps need to be taken to make this possible, some of which are indicated below:

* + - * Through Ministry of Science and Technology ALL major political parties may be approached to form a ‘Think Tank’ on environment within the party. This, hopefully lead to the inclusion of environmental concerns in the manifesto of these parties which would certainly be the first step in the right direction.
      * Both upper and lower house of the national legislature be requested to activate their respective ‘standing committees’ on environment.

Here the panel stressed the following points:

1. Management
2. Implementation
3. Involvement of Politicians
4. Scientific Policy
5. Standardization
6. R&D Funding Mechanism
7. Economic Value of Environment.
8. Environmental Think Tanks for Political Parties

**3.6 Cultural Aspects**

Due to our religious obligations, a considerable amount of water is used during ablution, five (5) times a day, in the mosques all over the country. Collecting such water that is only slightly polluted, and purifying it, would not be very difficult. Development of suitable technologies in this context is, therefore, envisaged to contribute to water conservation efforts to a great extent.

In our academic institutions, most of the research carried out by our faculty and students, in general, and in Environmental Science and Engineering, in particular, does not address the problems on ground. Even if some work which could be applicable to solve an environmental problem is documented, the academician is generally shy of converting it to a viable product. With the establishment of Innovation and Commercialization cells in the universities, across the country, the faculty and postgraduate research students would be motivated, to focus on solving the existing environmental problems in the country and to implement such solutions in the field.

The researchers in the country also have the problem that they are more interested in publishing their research work because it affects their career growth directly. The scientific journals generally accept papers, with in-depth scientific treatment; on the other hand, simple applied research is generally very difficult to publish. It is, here, that PCST could take a lead by revamping its journal “*Science Technology and Development*” and accepting, predominantly, result oriented research, after raising the journal stature through the standard refereeing process. This would help in bridging the gap from the laboratories to the market, in all fields of science technology including environment technology.

The specific issues considered here were:

1. Product use
2. Simple Life
3. Quality Products
4. Environmental Conservation vs Rehabilitation
5. Foreign vs Local Products

**Scenario Development**

This exercise involved the prioritization of the issues and the development of scenarios for the future. The prioritization of issues and drivers was done, first on the basis of importance followed by uncertainty; scenarios were then constructed around two most critical drivers so identified. Lastly, actions were identified that could lead to the creation of the ideal scenario conditions in the country by 2020-2025.

**4.1 Brainstorming Session for Prioritization of Issues & Drivers**

Following the review of the major issues discussed during the first part of the exercise focus was shifted to the prioritizing these issues and drivers.

Here, the importance of indigenization of technologies was highlighted underscoring the fact that a particular technology may be adopted after suitable improvements and modifications, keeping in view the local socio-economic parameters. It was believed that it is the technology which drives the economy, but now the fact of the matter is that the economy drives the technology.

The importance of making laws to conserve our environment was discussed and it was emphasized that strict standards and quality control, including the adoption of environmental standards during production of edible items should be assured.

Lack of awareness, at all levels, was identified to be the major cause hampering efforts for improving the situation regarding environmental degradation in the country. Increasing population of Pakistan and urbanization were also considered to be the major contributing factor towards some of the critical environmental problems, as this leads to uncontrolled expansion of the mega cities. The need to effectively address these issues through introduction of the subject of environment in the curricula, at a very early stage of our educational programs, was stressed.

**4.2 STEEPV Voting on the basis of Importance of Issues/Drivers**

After a detailed session the panel came out with the 10 most important issues/drivers which can shape up the development of the environment sector on the horizon in the next 10-15 years. The panel then arranged these issues in a descending order of priority with ‘1’ being the highest priority. Results of this exercise are summarized in the table below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| |  |  |  | | --- | --- | --- | | **Sr. No.** | **Issues / Drivers** | **Priority based on Importance** | | 01. | Environmental Awareness | 41 | | 02. | Political Sensitization | 46 | | 03. | Population | 47 | | 04. | Local Technology Solutions | 54 | | 05. | Water Conservation | 57 | | 06. | Urbanization | 62 | | 07. | Bio-diversity | 71 | | 08. | Commercialization of Research | 72 | | 09. | Plastic Bags | 79 | | 10. | Integrated Water Management | 85 | |  |  |  |  |  |  |  |  |  |  |  | 41 |

**4.3 STEEPV Voting on the basis of Uncertainty Associated with the Issues/Drivers**

Following this, the panel looked at how uncertain one is about the development of each driver and its impact on the topic under consideration. Starting with the most uncertain issue first, based on the input from the panel members, the issues were arranged as follows:

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Issues / Drivers** | **Priority based on Uncertainty** |
| 01. | Population | 19 |
| 02. | Local Technology Solutions | 22 |
| 03. | Political Sensitization | 25 |
| 04. | Urbanization | 26 |
| 05. | Water Conservation | 28 |
| 06. | Environmental Awareness | 30 |
| 07. | Bio-diversity | - |
| 08. | Commercialization of Research | - |
| 09. | Plastic Bags | - |
| 10. | Integrated Water Management | - |

**4.4 Identification of Scenario Building Issues**

After an in depth discussion, keeping in view the importance and uncertainty, identified above, the panel identified the following two issues and drivers were considered for constructing scenarios.

**a) Local Technology Solutions**

**b) Environmental Awareness**

**4.5 Development of Scenarios**

The panel used the 2 x 2 matrix scenario to construct a scenario after selecting two major drivers, as shown in the figure below. In this scenario four profiles of alternative futures are formed. The other drivers are not ignored but are taken as a common background.

As indicated, in the diagram, the panel envisages that in years to come, there would be a general trend for seeing an Environmentally Clean Pakistan; this would, however, entail creating awareness within all segments of the society and increased reliance dependence on finding local solutions to local environmental problems.



**Conclusions and Recommendations**

**5.1 Conclusions**

As discussed above, the expert panel foresees an Environmentally Clean Pakistan with the proviso that proper awareness be created and that the technical solution to environmental problems be found through local or indigenized technology.

The panel feels that the Pakistan Council of Science and Technology (PCST) is in an ideal position to play a pivotal role in achieving these objectives; as Policy making institution it can influence the decision makers, and, through the scientific organizations in the country, in general, and through its sister organizations, within MoST (listed below) it can facilitate in the development of indigenous technological solutions to many of the current, or emerging, environmental problems. The MoST organizations, that could support the implementation of these recommendations include:

1. Center for Applied & Molecular Biology (CAMB)
2. Council for Work and Housing Research (CWHR)
3. National Institute of Oceanography (NIO)
4. National University of Science and Technology (NUST)
5. Pakistan Council for Renewable Energy Technologies (PCRET)
6. Pakistan Council of Research in Water Resources (PCRWR)
7. Pakistan Council of Scientific and Industrial Research (PCSIR)
8. Pakistan Science Foundation (PSF)
9. Pakistan Standards And Quality Control Authority (PSQCA)
10. Pakistan Council for Science and Technology (PCST)

**5.2. Recommendations**

The specific issues which may be addressed, under the broad categories of “awareness” and “Technology” are listed below:

**5.2.1 Addressing the Environmental Awareness Issue**

1. Identification of issues
2. Identification of target population
3. Stakeholder’s involvement
4. Awareness programs at each level

**5.1 Addressing the Local Technology Issue**

1. Identification of available technology
2. To promote commercially viable R & D
3. Commercialization of best selected technologies
4. Application of those technologies at each level
5. Formation of Environment Foresight Society

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**Annexure - I**

**Panel Members – First Meeting**

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