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National S & T Policy and A Plan of Action



NA-138

**DEVELOPMENT AND APPLICATION OF SCIENCE AND TECHNOLOGY
IN SRI LANKA**



NATIONAL S & T POLICY

and

A PLAN OF ACTION

PREPARED FOR MINISTRY OF SCIENCE, TECHNOLOGY AND HUMAN RESOURCES DEVELOPMENT

1995

Natural Resources, Energy & Science Authority of Sri Lanka
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EXECUTIVE SUMMARY

1. Role of Science and Technology in Development

In the context of globalization, Sri Lanka needs to industrialise rapidly and also gain a competitive edge in the world economy. Science and technology play a pivotal role in this process. Science and technology are central to national economic, social and industrial development. In the Sri Lankan context, while a combination of social, economic and political factors have led to the slow growth rate in the past, a critical contributory cause has been the failure to develop and harness science and technology on an adequate scale.

Over the years the science and technology institutions have been allowed to run down and scientists and technologists, especially of high and medium calibre, have been compelled to leave due to poor emoluments and working conditions (brain drain). Sri Lanka lags behind even Bangladesh in the investment on R & D (0.18% of GNP) and behind most Asian countries in the ratio of scientists engaged in Research and Development (R & D) (100 per million population as against 960 in Singapore and 1285 in Taiwan). Unless this dire situation is remedied rapidly, even the optimum benefit from the panacea offered "imported technology" cannot be obtained. The adaptation and modification of such technology to utilise our natural resources, as has been done in countries like Korea, will also not be possible.

The present government has set a target of an annual rate of economic growth of 7 - 8%. This development strategy relies heavily on an export led manufacturing sector. It is therefore a strategy of growth which will require a significantly higher input of science and technology than has been made in the past. The development of an adequate level of indigenous science and technology capability is vital for sustainable short, medium and long term economic development. This calls for a firm commitment by government to implement an enlightened and effective National Science and Technology Policy.

2. Ministerial Mandate

The Minister of Science, Technology & Human Resources Development, recognising the role that scientists and technologists can play in economic development, appointed a committee mandated to review past and existing policies for science and technology, and to make recommendations for a National Science and Technology Policy to be adopted by the government, through this Ministry. (See Chapter 2) An Action Plan to identify specific activities to be promoted by the Ministry of Science, Technology & Human Resources Development and its institutions was also within the mandate. (See Chapter 3)

3. Objectives and Scope of the Committee

The present document has been prepared with the following objectives -

3.1 Scope of the Committee

- strengthening inter-ministerial policy coordination and inter-institutional linkages so as to enhance the science and technology input in all areas of development, giving priority to industrial development.
- identifying structures, specific interventions and strategies to develop the national scientific and technological capability.

3.2 National Science & Technology Policy

An effective National Science & Technology Policy should include the following policy components.

- (1) The provision of adequate funds for science and technology and R & D freed from bureaucratic impediments. This is the biggest obstacle to progress. The private sector should also contribute.
- (2) A clearly defined National Development Plan to provide the guidelines for the science and technology policy. Science and Technology Planning should be integrated with National Development Planning at all levels - sectoral, intersectoral and national. Suitable mechanisms should be established for science and technology personnel to contribute to the process.
- (3) Programme for strengthening and upgrading of science and technology infrastructure which should focus on existing institutions so as to get maximal benefit at minimal cost to the state, allowing the management of science and technology institutions maximum flexibility.
- (4) Provision of better remuneration, reward systems and facilities to ensure retention and optimum use of science and technology personnel. [Not only does the country lack the "critical mass" (numbers) required, but it lacks high quality personnel too.]
- (5) Provision for the systematic development of a process of obtaining skilled science and technology manpower, which should commence with a revision of school curricula. The private sector too must be brought into this process.
- (6) Process for achieving greater cooperation and interaction between science and technology institutions, universities and the private sector. Collaborative research should be carried out on a priority basis so that maximum benefits are obtained from limited resources. While "curiosity" based research should be given a place, the emphasis should be on research that will have an impact on development.
- (7) Selectively acquiring and adapting scientific knowledge and technology from abroad is essential for modernising the national science and technology sector and for enhancing Sri Lanka's competitiveness in the world economy. International scientific links and exchanges are essential to keep abreast of international developments.
- (8) Building a National Science & Technology capability which will provide the foundation for developing local resource-based industry that would not be dependent on foreign inputs (which escalate in cost) and will therefore have longer term national benefits.
- (9) Establishing a science culture, among the workforce, administrators, policy makers and all sections of the community to improve productivity and the quality of life. The educational and training system and the mass- media should be effectively used for this purpose.
- (10) Establishing an ongoing national monitoring system to evaluate, modify and upgrade the science and technology system and assess its impact on the national development effort.

4. Features of the Action Plan

To meet the above mentioned objectives, five Strategic Thrusts have been identified with relevant strategic actions.

1. **Strategic Thrust I: Strengthening and modernising science and technology organizations with targeted development strategies and policy directions.**

- 1.1 Develop performance indicators to identify strengths and weaknesses of institutions.
- 1.2 Develop targets and "Business Plans" for science and technology institutions.
- 1.3 Establish interministerial communication networks, upgrade information exchange processes.
- 1.4 Clearly define national industrial development policy and integrate science and technology policy with industrial policy.

2. **Strategic Thrust II: Identifying strategic technology development areas and preparing the science and technology institutions for the delivery and transfer of technology.**

- 2.1 Undertake institutional development and modernisation.
- 2.2 Select technology areas with high growth potential.
- 2.3 Determine realistic research priorities.
- 2.4 Establish technology information systems.

3. **Strategic Thrust III: Developing human resources for maximum productivity in science and technology, and for its effective management.**

- 3.1 Conduct "Institutional Audits" for human resources development.
- 3.2 Review and provide for the training needs of industry and science and technology institutions.
- 3.3 Improve remuneration and introduce productivity based incentives.
- 3.4 Encourage private sector participation in human resources development.

4. **Strategic Thrust IV: Providing leadership and necessary mechanisms for the coordination of science and technology activities of institutions, and gearing them to the needs of industrial development.**

- 4.1 Develop policy frameworks for commercialisation of research.
- 4.2 Develop communication channels with representative industrial bodies.
- 4.3 Build research-industry-university linkages.

5. Strategic Thrust V: Building a scientific culture, promoting its application in private and public sector activity.

- 5.1 Encourage public awareness of science and technology.
- 5.2 Develop science and technology education curricula for children, and appropriate programmes for adults.
- 5.3 Strengthen science and technology libraries and information systems.

The relevant series of actions above associated with each Strategic Thrust will be initiated by the Ministry of Science, Technology and Human Resources Development, and its institutions. It follows that the collaboration of the other relevant ministries would be crucial and would greatly enhance the impact. Although the strategic thrusts and associated actions are primarily targeted for the Ministry of Science, Technology and Human Resources Development and its institutions, they are equally relevant to other ministries with a science and technology portfolio. Therefore, in the implementation of this Plan of Action, it would be necessary to seek the collaboration of other ministries and their relevant institutions. Adequate funds for the implementation of this Action Plan will have to be made available from the ministerial funds, institutional budgets and from external sources.

5. Mechanisms for Policy Formulation and Implementation

The science and technology dimension in national and sectoral policy must be clearly articulated and suitable mechanisms devised if a policy is to be successfully implemented. Towards this end, the following organisational framework for science and technology coordination and implementation is required.

- 5.1 The policy formulation and decision making on Science and Technology at the national level will need institutional arrangements which will provide every necessary access to the highest level of decision making.

The decision making process has to be carefully structured.

Every Ministry with departments or other bodies engaged in research has some internal arrangements for monitoring the work that is done. In the course of the Ministry's work there are many decisions made which involve science and technology. Most of these decisions would be made within the Ministry and implemented by that Ministry. However, in regard to matters of national importance and those that are necessary for planning, decisions and implementation would have to be made at the level of the Plan Implementation authorities under the leadership of H.E. the President.

The structure of decision-making would necessarily have to have two or three tiers in bringing the various branches of Research and Development into a harmonious and meaningful relationship with one another. The Ministry in charge of the subject of Science and Technology will help, with the concurrence of the relevant Ministries, to bring together the Ministries' scientific and technological personnel to enable them to function as a collectivity.

This collective organisation will clarify all aspects of matters brought up that are relevant to planning and implementation and send them up to be discussed between representatives of this collectivity and the planning authorities presided over by H.E the President. The arrangement should leave room for achieving clarification by reference back and forth without consuming too much time.

It is expected that this arrangement would help to -

- (1) Prevent matters of national importance being decided without the collective consultation of scientific personnel,
- (2) Prevent too many matters being passed "upstairs" for decision, and
- (3) Prevent adding unduly to the volume of work that devolves on Her Excellency the President.

At the same time the Science & Technology Faculties of the Universities and the NGOs that are involved in any way with Science & Technology as well as private sector establishments of Research and Development will be enabled to contribute to the Science & Technology programme of the country. It is hardly necessary to add that the Ministry of Defence will need to advise on the impact of all these deliberations on National Security.

In inviting the participation of organisations outside the government, NARESA today handles much work in this sphere. With the collaboration of NARESA or with any other more fruitful arrangement, the collective organization referred to here can bring these others outside the Public Sector for a rich and fruitful collaboration.

The end result should be a national consensus of scientific opinion available to Her Excellency the President, the Cabinet, the planners, Parliament and the public.

- 5.2 The present arrangement of facilitating inter- ministerial meetings in Science & Technology has been initiated by the Ministry of Science, Technology and Human Resources Development. This co-ordination between the Minister and the other concerned Ministers on an individual basis can promote collaboration on common problems and facilitate complementary efforts in Science & Technology.
- 5.3 Throughout the deliberations, it became evident that it would be necessary to restructure the budget for Science & Technology throughout all Ministries so that it can be a programme budget for Science & Technology.
- 5.4 Public/Private Sector Science & Technology Links (Advisory Committees)

Appropriate mechanisms could be established to facilitate regular consultation and collaboration between the state and private sector in all relevant science & technology matters to ensure that Science & Technology activities are adequately linked to private sector development. With small beginnings, larger involvement of the private sector could be expected.

CHAPTER 1

1.1 Background

The development and application of science and technology, for economic and social progress, has figured prominently in the agenda of all governments since independence. However the allocation of resources for science and technology, and the concerted will and effort for continuing action for developing science and technology, has received low priority in the national policies so far implemented.

Despite these constraints, Sri Lanka has succeeded in developing and sustaining a basic framework for science and technology. In spite of the inadequacy of the national science and technology infrastructure, scientists and technologists in Sri Lanka have made serious efforts to establish areas of excellence in selected fields of research geared towards the nation's economic development objectives.

The need to plan and focus science and technology activity towards national goals has been expressed and reiterated periodically over the years. Several attempts have been made towards defining both national as well as sectoral strategies for the development of science and technology. Among these are the National Science Policy for Sri Lanka 1986 and the Task Force Report of 1994. (Vide Annex I -p. 40)

Scientists and technologists in Sri Lanka have drawn attention to the fact that high economic growth rates require a rapidly rising level of scientific and technological capability within a nation. They have repeatedly urged the respective governments of this country, to pay adequate attention to the development and utilization of science and technology for national development. The present government has set a target of an annual rate of economic growth of 7 to 8%. This development strategy relies heavily on an export led manufacturing sector. It is therefore a strategy of growth which will require a significantly higher input of science and technology than has been made in the past, where a growth rate of only 4% was sustained over the long term.

Several inherent disadvantages and constraints characterise the case of Sri Lanka. Its per capita GNP was estimated at US \$ 540 for 1992. The economies of countries such as Thailand and South Korea, which were at comparable levels of per capita GNP in the 1960's have now surged ahead. These countries have sustained economic growth rates of 7 - 8% over long periods. The rate of growth of the Sri Lankan economy for the period 1970-1990 was in the region of 4%. This growth rate falls far short of the level required to deal effectively with the problems of high unemployment of nearly 14% of the current workforce, and absolute poverty which afflicts about 22% of the population. Sri Lanka has been widely acclaimed for its achievements in social development - an average life expectancy of 72 years which is close to that of the developed countries, and an adult literacy of 87% of the population. Nevertheless, when the indicators of high level human capital are applied to Sri Lanka, its performance is seen to fall well below that of countries such as Thailand and Malaysia. Despite the fact that the proportion of the relevant age group which has had a secondary education is much larger than that of Thailand, Sri Lanka has a much lower proportion of the relevant age group in tertiary education - an indication of a relatively low stock of human capital for science and technology. Further, the average productivity of the employed workforce has grown very slowly, at an annual average of approximately 1.4% during the period 1970/90. Again the growth of the manufacturing sector, which is a key indicator of structural change and technological transformation, averaged a mere 4 % during the same period.

The present government, through its Ministry of Science, Technology and Human Resources Development, has recognized the role the scientists and technologists can play in the economic and industrial development of the nation. In accordance with these policies the Minister of Science, Technology and Human Resources Development has appointed a Ministerial Committee on Science and Technology Policy, comprising the Board of the Natural Resources, Energy and Science Authority (NARESA), and select members of the scientific community as members. This Committee has been mandated to formulate a Policy for Science and Technology and propose an Action Plan to foster and develop science and technology in the country.

1. The Committee was entrusted with the following tasks -
 - a. To examine past and existing science and technology policies and policy initiatives and make recommendations for a Science and Technology Policy to be adopted by the Government.
 - b. To prepare an Action Plan to identify strategic actions to be promoted by the Ministry of Science, Technology and Human Resources Development and its institutions.

In the preparation of this document, the Committee has consulted the previous policy documents, as well as those sectoral policy documents prepared by various ministries and agencies. The major findings of these documents relevant to the present exercise are summarised in Annex I (p. 25)

The preparation of an effective policy requires the identification of weaknesses and strengths of the present science and technology system. In the preparation of this report the Committee has taken into account current economic and industrial development trends and the current status of science and technology. It has not been possible to make a comprehensive assessment of the status of the economy and science and technology activities in the short time available to the Committee. However, the report has attempted to provide overviews of the status in Annex 2 of this document. (p. 33)

Based on the investigations and findings by the Committee, the current document outlines a National Policy for Science & Technology development in the country. This policy is aimed at promoting and fostering science and technology development efforts, for the economy and society as a whole.

The Report proposes strategic thrusts in areas where the Ministry of Science, Technology & Human Resources Development can act to develop and strengthen science and technology in the country. The actions proposed do not attempt to encompass all that needs to be done in the area of science and technology in the country. The proposals focus only on selected shortcomings which are judged to be of critical importance to the national development effort.

The proposed Actions which derive from the strategic thrusts identified are, primarily those in which the Ministry of Science, Technology & Human Resources Development and the institutions within its purview can take a lead initiative. Science and technology are not confined within the jurisdiction of any one Ministry. The application of science and technology is an essential ingredient in the process of modernisation and in improving efficiency in all sectors of the economy. The application of science and technology will vary in significance and in intensity in the different sectors, being greater in some and less so in others. The development of science and technology requires a nation wide commitment and a system that ensures inter-sectoral cooperation. Therefore, in the implementation of the strategies and actions proposed, the Ministry of Science, Technology & Human Resources Development would need to develop and continuously activate such a system.

CHAPTER 2 - NATIONAL POLICY FOR SCIENCE AND TECHNOLOGY

2.1 Need for a National Science and Technology Policy

The magnitude of the challenge Sri Lanka faces in meeting the science and technology development needs was briefly discussed in the preceding chapter. In enhancing her capacity to compete in the world economy, Sri Lanka has to position herself in relation to the other economies in the region. Sri Lanka has to respond continuously to the dynamic structural changes that are taking place in these economies and build the capacity to take advantage of the shifts in comparative advantage that occur. Science and technology plays a crucial role in this process. Science and technology institutions have to be capable of identifying and responding to these challenges and providing a strong base for future national development strategies and development priorities.

For this purpose, there has to be an enabling environment of strongly supportive national policy. Strategic planning and policy formulation in science and technology in relation to development, requires an understanding of both long and short-term development strategies. A National Science and Technology Policy is required to give clear expression to the Government's commitment in this field and provide the directions for the development and application of activities throughout the national system.

2.2 The Main Elements of Science & Technology Policy

A national policy for science and technology has to foster, guide, and direct the development, selection, acquisition, diffusion and application of scientific and technological knowledge for the enhancement of the physical, social and economic well-being of the people. The National Science & Technology Policy has therefore to contain the policy components for -

- (a) Building and sustaining a human resources base, and a critical mass of manpower in the country by creating, developing and strengthening the national centres of science and technology in the sectors which have high priority for development;
- (b) Selecting, acquiring and adapting scientific knowledge and technology from the global system, which is essential for progressive modernisation of all sectors, and for maintaining and enhancing the country's competitiveness in the world economy;
- (c) Encouraging national technology development and utilisation;
- (d) Co-ordinating the science and technology efforts in various sectors to develop an integrated national strategy and effort;
- (e) Effectively applying the available science and technology in all sectors;
- (f) Diffusing and promoting scientific and technological knowledge and innovative skills to foster a science and technology aware workforce and society.
- (g) Developing mechanisms to generate funds required to achieve these objectives.

2.3 A National Framework for Policy Issues

The Committee recommends the following policies to be adopted as a national framework:

- (i) The development of a national system for building of science and technology capability and the successful application of science and technology for development.
- (ii) The identification of priorities for directing research and development

Among these are -

- (a) Identification of areas of strategic research and emerging technologies, which would yield the greatest social and economic benefits.

These areas identified should attract leading scientists and capable young scientists, who together would formulate acceptable proposals for R & D programmes. R & D programmes must also encourage the elements of "curiosity", as well as be executed as "demand from industry".

- (b) Encouragement of collaborative and multidisciplinary research and building up of collaborative research teams and networks.
- (c) Developing mechanisms to generate funds required to achieve these objectives.
- (iii) The enhancement of Government's commitment and investment on R & D and the development of mechanisms to channel funds for R & D from both the State and the Private Sector.
- (iv) The provision of appropriate reward systems and enhancement of the recognition for developing science and technology. Those participating in decision making in developing science and technology must be included in such recognition.
- (v) Policies and measures which promote co-operation between research institutes and universities in developing science and technology.
- (vi) The promotion of scientific knowledge, awareness, attitude and the use of scientific methodology throughout all sections of the community and increasing the public awareness of science.
- (vii) A scientific culture should be inculcated from childhood and should be an intrinsic part of learning and teaching in primary and secondary school levels. Scientific methodology must be diffused among all sectors of the community by increasing awareness and receptive attitudes towards the use of scientific information and thinking.
- (ix) The development of technology originating from within the national system, whilst supporting the adaptation, absorption and innovative development of imported technology.
- (x) The development of sectoral policies - (not necessarily on conventional sectors - but on specific areas to be selected in later discussion).

- (xi) The integration of science and technology planning with national planning and development of linkages among different institutions and ministries concerned with the development of science and technology.
- (xii) The development of human resources and stimulating science education through the inclusion of up-to-date curricula in schools, and by the more effective use of the media and the efficient distribution and dissemination of scientific information.
- (xiii) The development and promotion of basic science and technology through education accessible to all levels of the community.
- (xiv) The development of mechanisms and policies to meet challenges of retaining human resources in the country and recognising their contribution thereby preventing brain drain.
- (xv) The development of international links and exchanges of professional persons and the promotion of co-operation and access to global scientific knowledge and technology.
- (xvi) The development of a national system to monitor the decisions that affect and have significant implications for science and technology and communicate such decisions to responsible science and technology bodies.

2.4 Science & Technology Policy and its linkages with other national policies

A national science and technology policy of this nature implies that policies and programmes are being continuously evaluated for their consistency with the main objective of creating and enhancing the national science and technology capability and directing it towards the well-being of society as a whole. The analysis and evaluation of impact is a responsibility by itself. Macro-economic policies relating to import substitution, export promotion, foreign investment, trade and aid, all have major implications for the development and protection of this national capability. If these implications are not carefully examined, the opportunities for strengthening the science and technology capability might be missed, or, processes which inhibit the growth of such capability might be promoted. A wide range of incentives and policies might be designed to ensure that the outcome for national capability is positive. These could include incentives which ensure that there is a critical component of local participation in technology transfer, in as many cases as possible. The newly industrialising countries which have been able to progress rapidly have done so by a constant process of upgrading their technological capability and maintaining their international competitiveness. They have followed a pragmatic policy with an appropriate mix of transfer and absorption of science and technology alongside the strengthening of their own science and technology institutions.

2.5 Assessment of the state of Science & Technology

Such a national science and technology policy will also need to undertake a regular assessment of the state of national science and technology in relation to the advances of the global system and examine the ways and means as well as the feasibility of "catching up".

2.6 Application of Science & Technology

Most important of all, the national policy must strengthen the processes and mechanisms which will ensure the application of science and technology. This requires among other things -

(a) well developed systems of extension, (b) a structure of policy formulation and decision making in which the scientific and technological personnel will play a key role, to ensure that the science and technology dimension receives due attention, at all levels of policy making and policy implementation and (c) close collaboration between the public and private sectors.

2.7 General Policy making processes

The policy concerning the application of science and technology should be distinguished from the normal processes of policy formulation and decision making in which scientific and technological personnel participate and contribute their knowledge along with other professionals. Examples are the sectoral projects and programmes; scientists take part in the formulation of these, providing the necessary technical and scientific analyses and appraisals and often supervising and directing their implementation. The task of science and technology policy as such is therefore to improve the existing systems in order to strengthen the role of scientific and technical personnel in the processes of policy formulation, decision making and implementation, and in marketing and financing the necessary components.

- 2.8 The policy formulation and decision-making on science and technology at the national level will need institutional arrangements which will provide every necessary access to the highest level of decision-making.

The decision-making process has to be carefully structured.

Every ministry with departments or other bodies engaged in research has some internal arrangements for monitoring the work that is done. In the course of the ministry's work there are many decisions made which involve science and technology. Most of these decisions would be made within the ministry and implemented by that ministry. However, in regard to matters of national importance and those that are necessary for planning, decisions and implementation would have to be made at the level of the plan implementation authorities under the leadership of H.E. the President.

The structure of decision making would necessarily have to have two or three tiers in bringing the various branches of Research & Development into a harmonious and meaningful relationship with one another. The ministry in charge of the subject of science and technology will help, with the concurrence of the relevant ministries, to bring together the ministries' scientific and technological personnel to enable them to function as a collectivity.

This collective organisation will clarify all aspects of matters brought up that are relevant to planning and implementation and send them up to be discussed between representatives of this collectivity and the planning authorities presided over by H.E. the President. The arrangement should leave room for achieving clarification by reference back and forth without consuming too much time.

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At the same time the science and technology faculties of the universities and the NGOs that are involved in any way with science and technology as well as private sector establishments of research and development will be enabled to contribute to the science and technology programme of the country. It is hardly necessary to add that the Ministry of Defence will need to advise on the impact of all these deliberations on National Security.

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The end result should be a national consensus of scientific opinion available to H.E. the President, the Cabinet, the planners, Parliament and the public.

- 2.9** The present arrangement of facilitating inter-ministerial meetings in science and technology has been initiated by the Ministry of Science, Technology and Human Resources Development. This co-ordination between the Minister and the other concerned Ministers on an individual basis can promote collaboration on common problems and facilitate complementary efforts in science and technology.
- 2.10** Throughout the deliberations, it became evident that it would be necessary to restructure the budget for science and technology throughout all ministries so that it can be a programme budget for science and technology.

2.11 Public/Private Sector Business Links (Advisory Committees)

The institutional framework for science and technology policy must include mechanisms which ensure close collaboration between the public sector, and the business sector which is the main user of science and technology in the production of goods and services. There has to be a constant feedback of the demand and the growing market for science and technology. At present many of the important development sectors have established, or, are in the process of establishing institutions for regular consultation and collaboration. It should be possible to place science and technology issues as a major item on the agenda of these bodies and set up Committees within them to deal with the task of strengthening the public sector business links. The private sector could also be represented in the apex body at the official level.

2.12 Transfer of Technology

There should be a representative body to handle the transfer of technology. The Indian model is a recommendable one. Negotiation, estimating costs and training leading to collaboration in BOI or BOT projects could be better processed through such an organization.

CHAPTER 3 - ACTION PLAN

3.1 Scope and Purpose of the Current Action Plan

Science and technology has impacts on the eco-system and natural environment, various economic sectors such as agriculture and industry, on the economic infrastructure such as power and energy, transport and communication and on service sectors such as social welfare, education and health.

The development of all scientific and technological activities including social sciences cannot be dealt with in this document. The scope of this action plan is limited to remedying pressing problems and dealing with issues within the development strategies pursued by the present Government.

The actions identified are mainly those which can be promoted by the Ministry of Science, Technology and Human Resources Development with the assistance of other ministries, in particular that of Industrial Development and of Agriculture.

Once the proposed action is implemented and its objectives realised, the country can move on to other strategies for areas which are not covered in this plan. The action plan that is proposed has taken into account the limited human resource base available, the institutional constraints and the financial implications in the implementation process. Therefore, the plan has had to be selective in its approach and set its objectives on a scale which is capable of being achieved within a given framework.

In the implementation of this plan, the ministry responsible must ensure the availability of funds for its execution.

The objectives of the Plan are :

- a) To consolidate and focus science and technology development efforts by selection and prioritisation of tasks, and concentration of resources, that are most beneficial and effective, for the achievement of clearly defined national and social development objectives, particularly industrialisation.
- b) To improve the quality and to increase the stock of human resources as a whole for development, by deploying a resourceful workforce for science and technology activities,
- c) To provide high quality leadership for improving the effectiveness of the national science and technology system, to overcome duplication, lack of coordination and wasteful diffusion of national efforts,
- d) To target utilisation of resources based on the rationalisation of operations and organisational structures, and regular accounting of the performance of the institutions to rectify inadequacies and operational weaknesses of science and technology institutions,
- e) To upgrade the level of knowledge, understanding, and application of science and technology among the public, in the system of education, and in society as a whole, by policies, programmes and incentives designed for that purpose.

3.2 Structural Weaknesses and Major Thrust Areas of the Action Plan

3.2.1 This Plan identifies the structural weaknesses and five strategic thrusts which are central to the development of the science and technology structure.

3.3 The Structural Weaknesses

3.3.1 Scientific and technological activities are developed through various interventions. In designing the interventions which are of critical importance it is necessary first to identify the structural weaknesses of the existing science and technology system. The past efforts have been focussed mainly on the needs and the development of the agricultural sector. The development of industrial technology has been relatively neglected with poor infrastructure, inadequate human resources and poor linkages with industry. Although some areas of science and technology infrastructure and personnel are relatively stronger than other areas, general weaknesses exist in the entire system. These can be attributed to :

3.3.2 Inadequate recognition of the contribution of science and technology to development and the lack of the necessary degree of commitment to use science and technology for development

3.3.3 Lack of leadership, support, direction and weak linkages between science and technology activities and between science and technology and the economic system.

3.3.4 Diffuse efforts in technology development and inadequate resources, poor targetting and less than optimal use of resources.

3.3.5 Weak science and technology infrastructure and management capability.

3.3.6 Inadequate human resources and deficiencies in their development, management and retention.

These weaknesses need to be remedied through a set of strategic actions which are effectively co-ordinated at the national, sectoral and institutional levels. The recommended actions taken together constitute the national plan of action to be implemented with the participation of various agencies.

3.4 Strategic Thrust I: Strengthening and modernising science and technology organizations with targeted development strategies and policy directions.

3.4.1 Structural Weakness

Inadequate manpower and financial resources limit the capacity of scientific and technological institutions to participate in international frontier research even in those areas most relevant to the country's needs.

Such institutions while striving to develop excellence in their specialised areas will also have to attempt to develop a special niche in the arena of R & D in the country. It is important that each institution assesses its strengths and weaknesses and develop a strategy that will assist its link up with national development objectives.

There is a need to rationalise the activities in scientific and technological institutions. Institutions not achieving targeted objectives must be re-examined and re-structured, amalgamating functions where necessary. Institutions could also be mission oriented or run as corporate bodies on a commercial basis.

The Ministry responsible for science and technology should develop policies in infrastructure management aimed at strengthening existing institutions. The selection of these programmes should be made in consultation with other relevant ministries such as Trade, Agriculture, Finance, Industry and private sector organizations.

3.4.2 Strategic Actions

3.4.2.1 Develop performance indicators for assessment of outputs of scientific and technological institutions with a view towards identifying organizational strengths and weaknesses.

Procedure for accountability of the performance must be introduced allowing for flexibility in the research functions carried out. Researchers must be given assistance and adequate support to achieve the expected targets. Remedial measures to combat repeated failures should be put in place.

3.4.2.2 Formulate "Institutional Development Plans" for each institution. These should identify programmes and targets to be agreed to by the minister responsible for the institutions.

All institutions should develop science and technology plans outlining expected outcomes. Representatives from industry should be consulted in the development of such plans. Institutions should be supported in the commercialisation of R & D results, in particular those working closely with export oriented industry. A Ministry Unit should be set up to assist in the marketing of the products resulting from the technology developed.

3.4.2.3 Establish institutional linkages and networks for transfer and sharing of knowledge and information.

All key ministries involved in economic affairs, trade and science and technology development, should be linked through planning and monitoring units, for the purpose of information sharing. This will be an advantage in the formulation of national development plans.

3.4.2.4 Strengthen the science and technology policy planning, and policy evaluation and monitoring capability.

A unit to formulate policy and for policy analysis must be established to assist science and technology advisers. Links should be established between the Ministry of Science, Technology and Human Resources Development and other ministries to coordinate science and technology with development policies and plan implementation.

3.5 Strategic Thrust II: Identifying strategic technology development areas and preparing the science and technology institutions for the delivery and transfer of technology.

3.5.1 Structural Weakness

In the past many science and technology institutions have been constrained in the ability to select high growth areas for research, and thus acquire opportunities for the advancement of their institutions. Science and technology institutions need to act positively to develop and evolve as productive organisations. They should engage in contract research on a commercial basis, generating income which should be invested in institutional development. The institutions must be encouraged to recruit staff with entrepreneurial flair, strong management skills and qualities of leadership which complement the technical skills required by the organisation.

The Heads of the institutions must set development targets for the institutions in line with the objectives set out in Government policy directives. Government must provide the initial assistance to realise these targets.

3.5.2 Strategic Actions

3.5.2.1 Undertake institutional strengthening and define the roles and tasks of institutions. Conduct a national audit to identify areas that have been neglected such as trade and investment linkage, intellectual property protection and the development and commercialisation of research results.

All science and technology institutions should identify mechanisms to steer their activities towards national development objectives with the assistance of the Ministry of Science, Technology and Human Resources Development. However, management should be allowed a degree of independence, and not be subject to political patronage and politicisation. Management should also be freed from bureaucratic constraints, specially in matters of finance and recruitment.

3.5.2.2 Select Technology Areas with High Growth Potential

It is desirable that the Ministry of Science, Technology & Human Resources Development in consultation with other relevant ministries should identify national technology development strategies in areas related to industrial development.

3.5.2.3 Determine realistic research priorities

Scientific and technological institutions should continuously upgrade their expertise and capability and attempt to link up with international technology developments. They should rationalise their activities, setting targets based on established priorities.

3.5.2.4 Establish technology information systems

Information systems of institutions should be interlinked to enable scientists in both industry and elsewhere to access technical information as and when needed. Patent systems should be upgraded encouraging innovations and inventions.

Appropriate action must be taken to analyse the direction and the growth area of current investment in industry and determine the future directions of technology development applicable to Sri Lankan industries. On the basis of such studies, special R & D programmes should be developed with the participation of the private sector.

3.6 Strategic Thrust III

Developing human resources for maximum productivity in science and technology, and for its effective management.

3.6.1 Structural Weakness

A fundamental constraint in the existing science and technology system is the limited qualified manpower available, that is the lack of the "critical mass" needed. Besides the available human resources are spread too thinly across various science and technological institutions. Most institutions lack adequate numbers of trained staff in critical areas, and as a result performance could fall below international standards. Incentives for the motivation of staff are inadequate. The working conditions need considerable improvement. The number of post-graduate and post-doctoral trained staff available to provide the scientific leadership is limited. The proliferation of institutions has drained scarce human resources from existing institutions correspondingly reducing their capabilities. The performance level of senior science and technology personnel is curtailed by an excessive load of routine work.

The difficulty of recruitment, training and retention of competent managerial and technical personnel is a major constraint. Human resource development is not confined to training. It includes making a workplace a living organization, building a better relationship between the employer and the employees, and creating a well motivated working community.

3.6.2 Strategic Actions

3.6.2.1 Conduct an "Institutional Audit" of science and technology institutions.

Institutional audit programmes should be the responsibility of the Ministry of Science, Technology and Human Resources Development. The Ministry should also be charged with the task of reporting to H.E. the President/Prime Minister/Cabinet, on the outcome of these audits. The medium and long-term requirements for science and technology at both national and sectoral levels would be determined on the basis of these audits.

3.6.2.2 Review training needs of science and technology institutions and develop programmes for providing adequate training for personnel at all levels.

Scientific and technological institutions, in collaboration with training organizations, like universities, vocational training institutes, should develop programmes for training and staff development, and report to the Ministry of Science, Technology & Human Resources Development and the relevant line ministries.

A balance of short and long-term training at the degree and vocational levels must be attained. Adequate numbers of employees should be trained at various levels such as high, middle and low, to achieve development objectives. In addition to technical training, a variety of other functions such as project and financial management should be included within the training programmes.

3.6.2.3 Provide for better remuneration to scientists and technologists and develop incentive schemes of promotion which recognise specialised skills, productive performance; and make provision, whenever feasible, to attract back to the country, Sri Lankan scientists and technologists now working abroad.

Incentives for the motivation of staff are crucial for the creation of an environment which is conducive to the growth of science and technology. A system of schemes and rewards should be developed and implemented so as to motivate achievement and promote excellence. These schemes should give due recognition to the specialised skills. Institutions should formulate and implement strategies for staff development. These should be based on guidelines developed by the Ministry of Science, Technology and Human Resources Development.

The remuneration paid to scientists is not in keeping with their training or importance to the country and its economy. It compares poorly with the remuneration afforded to other professions such as accountancy, medicine and law, and is well below world market rates for comparable expertise. This is a major factor that contributes to the "Brain Drain".

3.6.2.4 Upgrade management training programmes for researchers and technologists

Modern organizations must respond to changing national and international climates, and managers need to improve their management skills to cope with changing conditions. Accordingly, heads, research leaders, and administrative and project managers, should undergo short modern management skills. They should acquire the capacity to -

- identify areas of strategic research and emerging technologies which would yield the greatest social and economic benefits.
- attract leading scientists and capable young scientists who, together would formulate acceptable proposals for R & D programmes. R & D programmes should also encourage "basic" research, research which is driven by curiosity, as well as research which responds to demand from industry.
- strengthen linkages between the users and the producers of R & D e.g. industry and science and technology institutions.
- promote and organise collaborative and multi-disciplinary research.

3.6.2.5 Promote the participation of the private sector in Human Resource Development

The private sector must be encouraged to develop in-house training and skills-upgrading programmes within their institutions. Priority should be given to the establishment of a Skills Development Fund with the private sector.

3.7 Strategic Thrust IV

Providing leadership and necessary mechanisms for the coordination of science and technology activities of institutions, and gearing them to the needs of industrial development.

3.7.1 Structural Weakness

Science & Technology institutions, presently operate within the purview of several ministries. Coordination and linkages between them are weak, and institutions operate independently of one another.

These weaknesses should be rectified by forging links and improving mechanisms of coordination, as well as by monitoring the scientific and technological outputs at national and sectoral levels.

3.7.2 Strategic Actions

3.7.2.1 Apex Body

The Ministry in charge of the subject of science and technology will help, with the concurrence of the relevant Ministries to bring together the Ministries' scientific and technological personnel to enable them to function as a collectivity.

Matters relevant to planning and implementation and other ministries will be discussed between representatives of this collectivity and the planning authorities presided over by H.E. the President.

Periodic national and sectoral evaluations of the state of science and technology should be prepared by the apical body mandated with science and technology policy. Reports of these evaluations should be issued annually.

3.7.2.2 Develop coordinated programmes for utilising the results of research in science and technology.

The present arrangement of facilitating inter-ministerial meetings in science and technology has been initiated by the Ministry of Science, Technology and Human Resources Development. This co-ordination between the Minister and the other concerned Ministers on an individual basis can promote collaboration on common problems and facilitate complementary efforts in science and technology.

Sri Lanka needs to concentrate on areas of research that are relevant in both the short and the long-term. At the current stage of industrial development, it can ill-afford to channel resources for research at the frontiers of science and technology. What is essential for industrial development is the enhancement of the knowledge base and system of information to facilitate the transfer and adaptation of technologies, in accord with our requirements and resources.

Funding should be directed to special collaborative research programmes which are developed with inputs from Government, private industry, universities and research institutions. -The national science and technology system should focus on incremental innovations that are essential for small and medium enterprise (SMEs) development.

Science and technology programmes specially focussed on SMEs should be developed to solve specific technological problems faced by these enterprises.

Science and technology needs new policy initiatives aimed at increasing the scientific knowledge base, whilst taking cognisance of the existing information.

3.7.2.3

A policy for commercialisation of R & D should be introduced. This policy should be such that it addresses the requirements of national development programmes. It should be developed in consultation with industrial, agricultural and other relevant interests.

3.7.2.4

A research grant scheme should be developed with guidelines for the basis on which research would be funded. These guidelines should indicate the research priority areas, in keeping with established policies. The budget for science and technology throughout all ministries will be restructured so that it can be a programme budget for science and technology.

3.7.2.5 Develop communication channels with special industrial bodies and establish a government-industry forum. Establish institutional linkages with trade and export agencies and economic bodies.

Hitherto the expenditure on science and technology has been completely borne by government. The policy at present, is to regard the private sector as a primary agency for industrial growth. Accordingly, a mechanism should be put in place for the private sector to undertake its part of the responsibility for the science and technology component that is required to support industry. This means the substantial support of research programmes, the results of which will bring benefits to private sector industry. In order to fulfil this requirement, a dialogue should be established with industrial bodies, such as, the Chambers of Industry, the Export Development Board, and the Development Banks, so that even medium and long term research programmes of definite benefit to industry may be collaboratively conceptualised, planned, funded, and implemented in our research and development framework.

3.7.2.6 Build Research - Industry interactions and linkages.

The linkages between industry, university and research institutions are crucial for the effective application of science and technology in development. Their activities must be clearly identified as a major component of the science and technology strategy and should be regularly evaluated and monitored. Research institutions should establish units for the commercialisation of research. The functions of these units should be to develop commercialisation strategies, to liaise with industry, and with international agencies. The government will need to provide an initial grant to establish these units, which should then continue to run on commercial lines. These units should assist with the effective transfer of technology. Private venture capital that performs this function in developed countries should be gradually incorporated into these programmes.

- Special budgetary provision should be made in government sponsored R & D institutions for research, leading to technology which could have a positive impact on the national economy.
- Joint venture programmes should be developed between government institutions and the private sector. These could include training attachments and consultancy services to industry. Research programmes directed towards the value addition to primary products should be strongly supported.

3.8 Strategic Thrust V

Building a scientific culture and promoting its application in private and public sector activity.

3.8.1 Structural Weakness

The non-availability of an acceptable level of education in the practical sciences to large segments of the population necessitate the development of science awareness programmes for the general public.

Most small and medium industries require an understanding and infusion of the elements of science and technology to enable them to improve their productivity, supported by modern methods of communication and management.

3.8.2 Strategic Actions

3.8.2.1 Encourage public awareness of science and technology through launching of public awareness programmes.

It is necessary to encourage the dissemination of information and a knowledge of science and technology as widely as possible, to develop a science and technology oriented society.

Science and technology must be taken to the people by innovative means. Effective use of mass media is vital for this action. Scientific programmes for such dissemination need to be developed. Scientific material must be produced at low cost. Besides material published in English, efforts must be made towards publishing material in Sinhala and Tamil as well. These publications should not be only translations. Original material should also be published.

English is substantially the language of science and technology. Every effort should be made to ensure that adequate levels of English are taught in the science streams.

Science Centres should be developed by the Ministry of Science, Technology and Human Resources Development, with the support of the scientific community and non- governmental organizations.

3.8.2.2 Develop Science & Technology education programmes for the public and children of all ages.

It is necessary to initiate a programme of Science Education for the public. Increased attention must be paid towards developing vocational skills. There should be incentive schemes for developing programmes for the popularisation of science.

School curricula should be strengthened and improved to promote a scientific approach to learning, even at pre-school level. Innovative toys, books and teaching methods should be provided for such projects.

Science and technology teaching is presently written examination oriented. Attempts should be made to develop a scientific milieu in the schools. Scientific reading material should be exempt from duty allowing for wide availability.

To promote the practical application of the scientific method, science projects should be promoted and science examinations must include practical tests.

3.8.2.3 Strengthen Science & Technology libraries and promote programmes for Science & Technology education with award schemes and studentships.

Libraries and information technology programmes should be developed to provide scientists and technologists and the general public with up-dated information on new developments in science and technology. A scheme of studentships in science and technology, within the country should be initiated. International studentships should also be awarded, in subject areas of relevance to the development programmes of the country.

3.9 Concluding Remarks:

The objectives of this Plan are to stimulate a political will and commitment to the development and utilization of science and technology and to create a national interest in and a commitment towards developing a modern science and technology based socio-economic structure. A clear and firm

commitment at the highest level of government as well as in all other sectors of the community is critical if the needs as addressed in this Plan are to be implemented. The Plan advocates the upgrading and gradual development of a science and technology competence. It emphasises the need to target the utilization and development of scientific knowledge towards national development strategies. It stresses that participation by the private sector is vital, if the strategies for the application of science and technology are to show positive results.

The development of a science and technology capability is an arduous process. It requires a strong commitment from and the determination of scientists and technologists. The recognition of their services and adequate remuneration are important for sustaining the momentum of growth.

The Plan also recognises the critical role of human resource development and management in the science and technology development process. It recognises that investment in human resource development is an essential investment cost and emphasises that the retention and further improvement of skills are equally important.

The plan also recognises the need to restructure existing science and technology institutions and to focus their activities towards well defined and achievable objectives. The plan recommends those actions needed to modernise and strengthen the existing institutions. New institutions should not be created without strong justification.

The realisation of this plan requires government funding, a consensus building process, a strong commitment from the government, and a coordinating body to oversee the implementation process. The office of Science Adviser of the Ministry can play an important role in this regard.

A concerted effort is needed to implement these strategies and actions which will remedy at least some of the major impediments and structural weaknesses of the science and technology system in Sri Lanka. This plan provides a launching pad and a way ahead for technology-led development in the country.

Annex 1 - HISTORY OF SCIENCE & TECHNOLOGY PLANNING

Key Role of Science & Technology

1.1 Historical Achievement

Sri Lanka's rich culture, industrial workforce and technical achievement are evident in the historical monuments in cities like Anuradhapura and Polonnaruwa.

1.2 Key Role of Science and Technology

Science and technology development does not take place in a vacuum. It is a complex process requiring government intervention and the participation of the nation. Organisational reforms and well defined policies are central to this process of change.

The formulation of a strategic plan also requires an accurate assessment of the current situation of science and technology organisation.

1.3 Previous attempts in Science Planning

In the past, several attempts have been made to develop a national strategy for science and technology. The National Science Policy in 1987; Industry Policy and Strategies for Industrialization in 1990; Forestry Master Plan of 1988 and subsequent documents; Coastal Zone Development Plan and Coast Conservation Plan in 1988; Agriculture Master Plan in 1988 and subsequent documents; finally the Presidential Task Force on Science & Technology Development in 1991 are some of the inputs into policy making processes. Scientists made a valiant effort to convince the Government of the need for investment in science and technology, economic and social development.

1.3.1 1944 CAAS ESTABLISHED

The need for science planning and a policy for science and technology in Sri Lanka was recognized as early as the mid- forties. The earliest lobby for science in Sri Lanka was the Ceylon Association for the Advancement of Science established in 1944 (CAAS). This body a non governmental organization agitated early in its history for the establishment of a National Body charged with the responsibility for the formulation and implementation of a National Science Policy. These agitations came in the wake of an international movement, directed towards the need for planning for science and technology. The Sri Lanka movement was inspired to a large extent by the classic Science Policy Statement enunciated by Indian Prime Minister Jawaharlal Nehru to the Indian Parliament in 1947.

1.3.2 1966 NSC set-up

A result of this agitation was the eventual creation in 1968 of the National Science Council of Sri Lanka by an Act of Parliament. The NSC Act was subsequently amended and in its place the Natural Resources, Energy and Science Authority of Sri Lanka was established (Act No. 7 of 1981).

1.4 Science & Technology Policy formulating Initiatives

- 1.4.1** The National Science Council which functioned as the focus for science and technology development in Sri Lanka took early initiatives towards formulating a National Science Policy for the country.

Two science and technology policy documents - National Policy Statement and Aspects of a National Science Policy prepared by a working committee of the National Science Council, were presented to the Minister of Scientific Research and Housing. No action on these reports followed.

A seven point proposal, to serve as a National Science and Technology Policy Statement was prepared by a statutory Working Committee of the NSC (Working Committee on Science Policy Research). This proposal was submitted to and accepted by H.E. the President J.R. Jayewardene. The Science Policy Statement promulgated by the President, when he addressed the SLAAS Sessions in December 1978, was based on this proposal.

The failure of this initiative has been attributed to a lack of legal and financial provision in support of it.

- 1.4.2** There are two major reports outlining a Policy for Science in Sri Lanka with strategies for its implementation: - First, a comprehensive nine volume document, published as Sessional Paper No. V of 1986, was the report of a National Science Policy Co-ordinating Committee (NSPCC) headed by Prof. Cyril Ponnampereuma. This document was prepared on a directive by the then President, the Hon. J.R. Jayewardene, to the Ministry of Plan Implementation, requesting the formulation of a National Science & Technology Policy for Sri Lanka.

NSPCC was set up as an ad hoc Committee, which drew on scientists from the Public Sector, the Universities and the Sri Lanka Association for the Advancement of Science (SLAAS) for its inputs. Over a hundred scientists were organized into nine Sectoral Committees, viz. (i) Agriculture Forestry & Fisheries, (ii) Agriculture Research Complex, (iii) Science Policy in Industry, (iv) Electronics and Computer Science, (v) Energy, (vi) Environment, (vii) Science Education, (viii) Health & Nutrition, (ix) Social Infrastructure.

These sectoral reports were detailed studies of the existing climate of science and technology, in the country at that period of time. The recommendations made in all sectors emphasized the lack of organisation and leadership in the scientific sector and the lack of recognition of the role of the scientists in the country's strategies for development.

This report outlined the basic science inputs that should go into policy making and development planning, emphasising the need to evolve an integrated science-based approach to policy planning.

The strategy this report recommended was:- An apex structure for each sector with a mandate for the projection of needs of the sector, for monitoring and co-ordinating research and development within the sector and for advising the Government on issues related to the sectors needs be established. Examples of such bodies as given in the report were :- An Agricultural Research Council, Medical Research Council, Industrial Research Council, Council for Science Education and Research, and a Land Use Authority.

It recommended that the directorates of these bodies be constituted to include scientists, planners and decision makers at ministry level.

The ultimate recommendation was that a Presidential Science Advisory Council be set up; its members to be drawn from among the directorates of the sectoral apex organizations. This body could also include as members distinguished scientists, drawn from the general scientific community. All members were to be appointed by the H. E. the President.

This report was never implemented. One of the major criticisms levelled against it was that the recommendations veered towards the establishment of new organizations rather than towards strengthening R & D capability within those already in existence. The lobby against its acceptance was great and as such this report was never formally accepted by the Government as a National Science & Technology Policy.

1.4.3 The second major and most recent document is the Report of the Presidential Task Force on Science & Technology Development. This Task Force was appointed by Presidential directive in May 1991. Its terms of reference were -

(1) **"To examine"** - the needs for Science & Technology Development in Sri Lanka in the light of the Economic Policies of the Government, including its strategies for industrialisation, for agriculture, and for market driven and trade-led growth,

(2) **Make recommendations -**

"(a) on a Science & Technology Policy for the 1990's

(b) on appropriate strategies for giving effect to such a policy, and

(c) on the legislative, institutional and other reforms that need to be effected to support implementation strategies."

The deliberations of this Committee were to take into account proposals set out in a document titled "Development of Science & Technology in Sri Lanka", which was submitted as an annexure to the Presidential directive, appointing the Task Force.

The Task Force sought written representation from forty seven organizations involved in science and technology. The media was used to seek representation from the general public. Twenty six governmental and non- governmental organizations responded. Thirty six representations from individuals and Trade Unions were received.

The Task Force presented its report in November 1991. This report dealt with industry, agriculture, unemployment, income distribution and poverty in the context of the country's (then) current development plans and policies.

1.4.4 Summary recommendations of the Task Force -

The Task Force identified eight areas of constraints to the development of science and technology. Among these were -

- Inadequate planning for and co- ordination in science and technology,
- Inadequate investment in science and technology,
- The brain-drain,
- The demoralisation of science and technology personnel,
- Weaknesses in the education system,
- The lack of a goal oriented approach within the R & D institutions and the weakness of their links with industry,
- Inadequate mechanisms for the facile transfer of technology to industry,
- A lack of a knowledge and appreciation of science and technology among the general public.

The adoption of a ten-point science and technology policy by the Government and the rationale for the policies and implementation strategy were outlined, together with a proposal for the establishment of an institutional framework "required to foster and promote Science & Technology activity".

Agriculture

In the section Science and Technology for Agricultural Modernisation, the report identified a series of needs for development. Among those highlighted were -

- the need to improve linkages and information flow between the different R & D institutions dealing with aspects of agricultural research. It was recommended that these improvements be directed towards organizing joint research programmes which permitted co-ordinated research activity.

Industry

In respect of the linkages between industry and research institutes, the Task Force Report notes "Industry in general appears not to concern itself much with the utilization of scientific research for its own development". The weakness of the R & D units within both the public and private industrial sector are highlighted in this report.

The special report on a "National Science Policy for Sri Lanka" published as Sessional Papers No.V (1986) also emphasizes (in a sectoral report on Science Policy for Industry) the need for re-orientation of R & D in this sector towards the needs of the productive sector

- to quote: "Research institutes should be encouraged to conduct in-depth studies on projects that are product and mission oriented in areas of direct importance to the country's industrial programmes".

Brain Drain

The Presidential Task Force report includes a note on the "Brain Drain".

The Task Force observed, in the course of its visits to the institutions (government controlled/sponsored) that "scientists have a defeatist attitude. They feel that there are insurmountable barriers (mainly administrative) affecting their career development, job satisfaction and working environment, which effectively stifle any real contribution to the national effort. This feeling of hopelessness and stagnation has led many scientists, even at the managerial/directorate levels to adopt negative attitudes".

The report identifies some of the reasons for this stagnation and in conclusion states " that a positive benefit that may emerge from the establishment of a science-based Industrial Park in Sri Lanka is a reversal of the brain drain".

Science & Technology Bill

A Bill for Science and Technology Development was presented to Parliament in January 1994.

This was to -

"provide for the development of Science and Technology in Sri Lanka". Within it were provisions to re-constitute some existing R & D institutions viz. CISIR, NARESA and Computer and Information Technology Council of Sri Lanka and Arthur C. Clarke Centre for Modern Technologies.

The Bill was based on a document, the objectives of which were -

- (i) To identify the policy goals for a Science & Technology policy for Sri Lanka to meet Sri Lanka's future needs. and
- (ii) Elucidate an organizational structure within the (then) Ministry of Industries, Science & Technology, to achieve these goals.

The Policy goals as set out in this paper were (then) more specific:

- (a) Development of scientific knowledge in Sri Lanka to international standards,
- (b) Application of technology to stimulate economic growth and improve the quality of life,
- (c) Develop technology in priority areas,
- (d) Develop vernacular knowledge fields and systems,
- (e) Strengthen scientific and technical co-operation with other countries, and
- (f) Popularise science and technology among the people.

The paper dealt with achieving policy goals, policy formulation, with the establishment of an Apex body- The Science and Technology Development (STDC). The STDC Apex Organization was to be responsible for advising the Government on -

- (a) Policies and Plans for Science & Technology
- (b) Application of technology to stimulate growth through better products and services,
- (c) Review of Science & Technology programmes,
- (d) Effectiveness of R & D institutes and
- (e) Impact of Science & Technology on the efficiency and competitiveness of the economy.

STDC was to be composed of scientists as well as persons engaged in commerce, industry and agriculture.

A section on Sectoral Organization dealt with the re-structuring of existing institutes e.g. CISIR, NERD, SLSI and the formation of the Sri Lanka Technology Development Corporation (SLTDC) and with the establishment of science communities. A new concept was the proposal for setting up a "Science City", in which existing Government research organizations were to be re-located. It was envisaged that private R & D organizations could be encouraged to re-locate in this site. A research complex, a science park and a residential complex would form the nucleus of this site.

For the Agricultural Sector, the document recommends the establishment of an Agricultural Science Network (ASN) in Kandy. This Network would link the Agricultural Science Institutes, the IFS, the Agricultural Faculty at Peradeniya University and the Post-graduate Institute for Agriculture.

The recommendations of these major reports and the Science & Technology Bill had all envisaged the creation of an apex body NASTEC to advise the Government. These reports moreover envisaged the re-structuring of the existing R & D institutes and the creation of new organizations.

1.5 Other relevant Reports and Documents

1.5.1 An Industrial Policy Statement issued by the Ministry of Finance and Planning. Section 12 - Science & Technology of this report directed specific recommendations towards stimulating a demand for technology. It included two financial incentives -

- (i) The use of transferable credit to subsidize R & D by enterprises,
- (ii) The establishment of a Technology Development Enterprise, Venture Capital Fund, to make finance available on a grant, concessionary or equity basis for productivity and product improvement programmes and for ventures emphasizing the introduction of new technologies and products.

Specific proposals for R & D included the setting up of a committee on Transfer of Technology and Quality Control (TTQC) to be set up within the Ministry of Industries and Scientific Affairs to co-ordinate the activities of 'domestic' R & D institutions.

The most important measure proposed in this policy statement was the increase of private and public R & D expenditure in G.D.P. to be increased from below 0.2 percent to at least 1.0 percent.

These proposals were based on the recommendation of the Sectoral Report on Industry in the Final Report of the Science Policy Co-ordinating Committee. This policy statement is one which clearly identified a financial measure for implementation.

1.5.2 The Ministry of Lands and Land Development Report on a Master Plan for Forestry for Sri Lanka is among the major sectoral policy documents prepared.

In 1979 the World Bank carried out a Forestry Review for Sri Lanka. This report identified as the main constraints to development -

- (a) a lack of a reliable data base
- (b) absence of a basic planning capacity
- (c) a severe shortage of trained personnel.

In 1982, the Forest Resources Development Project (FRDP) was formulated with the objective of providing Sri Lanka with a Master Plan for Forestry and a Detailed Investment Programme, spanning an initial period of five years. The Forestry Master Plan was presented to the Government in 1986.

This Master Plan is a comprehensive document which embodies both policy and implementation strategy. Forestry as a contributor to the national economy, structure of ownership within the sector, product pricing, (then) current development projects and development options were given due consideration in the report. Forest resources and forest management, extension services and research into both forestry and wood utilization have warranted in-depth study and in the final chapters on economic analysis, the funding requirements, implementation of the investment programme, a profitability analysis, and national economic impact it sets out to justify the additional funding required by the programme.

A risk noted in this report concerns the funding for strengthening the Forest Department. The concern here is that inadequate local funding would result in dependence on foreign aid funded development projects. Such projects have only a temporary effect and it was cautioned that it could be possible that a major part of potential forest field may be lost due to poor management. The improvement of existing industries and the building of new mills to utilize wood from plantations for example rubber wood and coconut wood, were an essential part of the plan. The report warns that if these improvements did not materialize, the inefficient use of wood, would give lowered returns on investment. Overall, the report advised on the need for control of the sector by appropriate policy measures if risk factors are to be minimised.

A new National Forestry Policy has been formulated by the Ministry of Agriculture, Lands and Land Development in 1994. In keeping with this policy, a new Forestry Sector Master Plan has been developed and is in the final stages of a Draft Plan. This Plan replaces the Forestry Master Plan that was presented in 1986. The earlier Plan had some positive features of data collection and training, some of which are already being implemented, but was criticised by scientists, NGOs and even foresters for -

- having too narrow a scope
- not dealing adequately with environmental aspects
- failing to involve key parties in the planning process.

The new Forestry Sector Master Plan (FSMP) unit was set up in 1993 and the Plan has been produced with joint participation and consultation with the Forestry Planning Unit, the Forest Department, representatives of other departments, scientists from universities, NGOs and national consultants. The emphasis has been shifted to: conservation of natural forests, biodiversity, watershed protection and prevention of soil loss; encouraging participatory forestry with people and rural communities; building partnerships with the private sector for establishment of forest plantations; developing home gardens and agroforestry systems to meet local timber needs.

1.6 Concluding Remarks

Science and technology policy making process is not new to the scientists in Sri Lanka. Available policy documents and policy processes provide a rich source for the current document. The lack of political commitment to implement previous policies has been a major frustration of scientists and technologists. It is important that proper science and technology policies are developed and appropriate actions are implemented without delay.

ANNEX 2 - Status of Economy and Science and Technology

2.1 The State of the Economy and Society

Sri Lanka had a population of 17.8 million in mid 1994 with a per capita Gross National Product of US\$578, well above the per capita of neighbouring India and well below the dynamic economies of South East Asia like Thailand and Malaysia. Sri Lanka falls into the category of low-income economies as defined by the World Bank.

In real terms G.N.P. per capita has risen by 6.4 percent in 1993 and 3.9% in 1994. The Gross National Product recorded an average rate of growth of 4.5 percent for the period 1982-94. The Gross Domestic Product also grew at the same rate during this period. This was much lower than the growth rate of our neighbouring Asian economies such as Thailand, Indonesia and Malaysia. On the whole Sri Lanka has had a much poorer economic performance than the dynamic economies of East and South East Asia, although at the time of independence in 1948 she enjoyed a higher per capita income than other developing countries in the Asian region, with the exception of Malaysia.

	1992	1993	1994
Rate of growth of GDP % at constant 1982 factor cost prices	4.3	6.9	5.6
GNP per capita at current factor cost prices, in Rupees	21,786	25,377	28,843
In US\$ at current exchange rate	473	512	578

From the time of independence until 1977, the economic policies of successive governments have alternated between those which tended to rely on the private sector and the market to those which employed extensive state regulation and promoted public enterprise. Upto 1977 policies of all governments were heavily biased towards import substitution in both industry and agriculture. From 1977 onwards the government has undertaken a major programme of economic restructuring which has been implemented in phases. The major macro economic policies since 1948 can be summarised as follows:

1946-56 Open economic policies; a relatively liberal regime in imports and foreign exchange; policies supportive of the private sector with a small component of public sector industry; import substitution in rice in small-holding agriculture.

Major social welfare programme in free education, free health and food subsidies.

1956-65 Increased public sector involvement in industrialisation. Nationalisation of several major economic sectors such as public passenger transport, import and export restrictions, tighter foreign exchange controls, private sector investment in import substituting industry. Increase of social welfare and continuation of import substitution in rice.

- 1965-70 Policies veer towards the market and private sector. Increasing dependence on foreign aid. Efforts to liberalise parts of the economy through a dual exchange rate system.
- 1970-77 Return to socialist-oriented policies with further growth of the public sector and stronger control and regulation of the economy by the state; nationalisation of the plantations
- 1977- Far-reaching economic reforms to liberalise the economy by relaxation, and progressive removal of all import and exchange controls, reform of the tariff and tax structure, devaluation of the rupee, reduction of subsidies and privatisation of public sector enterprises; the private sector recognised and supported as the main engine of growth with policies to attract foreign investment.

Export-oriented manufacturing has become the lead sector in the post-1977 strategy of development. During the preceding three decades the primary products sector dominated the economy with agriculture accounting for 25% of GDP and manufacturing for 15% in 1976. The recent trends indicate that the structure of the economy is beginning to change significantly with the share of manufacturing increasing to 19.7% of GDP in 1994 and that of agriculture dropping to 20% in 1994. The rate of growth of manufacturing has steadily increased from an annual average of 2% for the 1970-80 period to 7.4% in the period 1982-94. In comparison the rate of growth of agriculture remained at around 2.5% during the two periods.

The manufacturing sector relies heavily on low technology industries. Nearly 63% of the value added in manufacturing originated from the sub sectors such as food, beverage and tobacco (34%) and textile and clothing (29%) in 1994.

There have been far-reaching changes in the composition of exports. The share of agricultural exports has declined from 88% of the total in 1970 to 21.9% in 1994 while the share of industrial exports has substantially increased from less than 10% to 73% during the same period. The changes in economic policy have also been able to attract a much higher level of direct foreign investment, which has risen from SDR 42 million in 1981 to 111 million in 1994. With increased exports and inflows of direct foreign investment, the potential for technology transfer is high. The technology development effort of the nation has to give high priority to export industries. The major share of the exports of manufactured goods (nearly 52%) came from the textile and clothing sector in 1992. A low level of activities was recorded in technology intensive export sectors such as machinery, chemicals, electrical and electronic equipment.

The macro-economic problems underscore the persistent weakness of the Sri Lankan economy. The current account deficit in the balance of payments excluding official grants has been reduced from nearly 10% in 1985 to 5.3% in 1993. It however rose to nearly 8% in 1994. The net inflows of capital combined with IMF support has enabled Sri Lanka to increase its gross external assets which were sufficient to finance 5.9 months of imports at the end of 1994. The foreign debt servicing capacity has also continued to improve and debt service payments as a ratio of exports of goods and services and private transfers declined from 11.8% in 1993 to 11.1% in 1994. The total external debt was Rs. 300 billion at the end of 1994 - approximately 51% of GDP at market prices or 190% of the total value of exports in 1994.

The economy still depends on a substantial flow of foreign aid both to balance its external account as well as to finance its public investment programme. The overall budget deficit continues at a high level ranging from 11.6% (excluding grants) in 1991 to 7.3% in 1992 and 10% in 1994. The government budget remains one of the critical problems of macro-economic management, drawing heavily on private savings as a source of finance and thereby adversely affecting private sector investment and growth.

In the human resource front, Sri Lanka has shown a decline in population growth rate from a rate of 1.6% for the period 1970-80 to 1.4% in 1980-94. Average life expectancy had risen to 72 years by 1992. The total fertility rate had declined from 3.35 in 1974 to 2.2 in 1993.

The labour force also shows a decline in the annual average rate of growth from an estimated 2.3% in 1970-80 to 1.6% in 1980-94.

Given the economic performance described above, the development of science and technology requires well focussed, selected and concentrated efforts. Sri Lanka has to develop a long-term vision and adopt an effective policy framework to sustain an annual growth rate of about 8% over a long period. This requires a high rate of growth of about 12% in the manufacturing sector and a growth rate of about 4.5% in the agricultural sector. The development and application of science and technology and the facilitation of technology transfer must be regarded as an integral part of such a national development effort.

2.2 The National Science & Technology System

2.2.1 The outline

Governmental science and technology is spread among its many ministries, each taking responsibility for the implementation of projects and programmes within the different Departments, Corporations or Authorities falling within its purview.

The influence of a National Science Policy is therefore diffused within this structure. It will only be effective if firm inter and intra ministerial links can be forged and strengthened.

In the current government structure, the science and technology effort is divided among ten ministries out of a total of twenty four. Science and technology in this context requires active co-operation between these different ministries and the Ministry of Science, Technology & Human Resources Development which is charged among its functions, with the formulation of programmes and projects based on national policy in respect of Science, Technology and Human Resources Development. Included among its subjects are Science and Industrial Research, Manpower Development and Apprentice Training. Scientific and technical Departments or Agencies come within its jurisdiction.

2.3 Institutional Linkages

2.3.1 Institute of Fundamental Studies (IFS)

The Institute of Fundamental Studies (IFS) was established by an Act of Parliament in 1981. The Board of Governors of the IFS include H.E. the President (as Chairman), the Prime Minister, the Leader of the Opposition and the Chairman of the University Grants Commission. The IFS has developed a good basic infrastructure for research and has developed collaborative links with Universities and Research Institutes.

2.3.2 Plantation Industry and Scientific Services

The major R & D institutes in the country dealing with the plantation tripod, Tea, Rubber and Coconut come under the Ministry of Public Administration, Home Affairs, Plantation Industries and Parliamentary Affairs.

Within this Ministry also fall the Scientific and Engineering Services Boards, the Sri Lanka Cashew Corporation, Palmyrah Board, Sri Lanka Sugar Research Institute, and the Dept. of Wild Life.

The linkages between the research institutes within this Ministry and the Ministry of Science, Technology & Human Resources Development can be clearly delimited. However, the linkages, between the Scientific and Engineering Services Boards which are concerned with all administrative and personnel management functions relating to the Science and Engineering services and the Ministry of Science, Technology & Human Resources Development have still to be clearly defined.

2.3.3 Department of External Resources and Ministry of Science, Technology & Human Resources Development

A major link which must be forged if the Action Plan is to be successful is that between the Ministry of Science, Technology & Human Resources Development and the Department of External Resources of the Ministry of Finance, Planning, Ethnic Affairs and National Integration. Strangely the National Health Council also falls within this Ministry as do the private sector companies - Grain Elevators Ltd. and Prima (Cey.) Ltd. both dealing with major food commodities.

The importance of firm links between the Ministry of Science, Technology & Human Resources Development and the Department of External Resources cannot be stressed too strongly. The allocation of foreign aid on which the Science & Technology institutions depend for additional funding is controlled by the Department of External Resources. Strong links between these (units) must be forged, if any Action Plan for Science & Technology Development is to be successful.

2.3.4 Agriculture

The Ministry of Agriculture, Lands and Forestry is totally responsible for programmes and projects based on national policy in respect of Agriculture, Lands and Forestry and for the direction and implementation of such programmes and projects. The Department of Agriculture, Export Agriculture National Agricultural Diversification and Settlement Authority, ARTI, CARP, Survey Department, Forest Department and State Timber Corporation fall within this Ministry. All of these have a component of R & D in their programmes. Strong links between this Ministry and the Ministry of Science, Technology & Human Resources Development must be maintained for successful implementation of the Action Plan.

The policy objective of the Ministry of Agriculture, Lands and Forestry is directed towards transforming subsistence agriculture into a profitable commercial venture. Towards this end the Ministry has formulated a 'National Policy Framework' (NPF) for Agriculture, Lands and Forestry and other allied sectors such as Irrigation and Livestock Development. The Agricultural sector NPF identifies five major concerns. Agricultural research policies and programmes have been designed towards meeting the objectives identified in the NPF. The allocation of resources for the implementation of these policies will be determined by the Council for Agricultural Research Policy (CARP).

Strengthening of linkages between the Ministry of Agriculture, Lands and Forestry and other allied ministries which have interconnecting links with NPF will be effected through inter-ministerial consultancies.

2.3.5 Industry

The industrial sector in Sri Lanka has a bifurcated structure. The Ministry of Industrial Development has in its Policy Statement stated that its main objective is an effort directed towards "the increase of people's incomes by generating employment opportunities". It aims to accelerate industrial development through "market orientation, increase in efficiency, stimulation of investment and industrial diversification".

The policy statement with reference to the private sector states "The private sector will be the engine of industrial growth". This statement refers only to the capital investment by the sector, but does not allude in any way to the need for investment by the private sector in the R & D necessary to sustain a productive industrial sector. In respect of the linkages between Industry and the Research Institutes- the Task Force Report of 1991 notes "Industry in general appears not to concern itself much with the utilization of scientific research for its own development". An earlier report (1986) of the Asian and Pacific Centre for the Transfer of Technology referring to R & D within the private sector remarks "R & D in the private sector is weak, and in most part confined to local subsidiaries or joint ventures with multinationals e.g. Lankem (Shell), Lever Brothers (Unilever), Ceylon Tobacco Co. (Imperial Tobacco Co.); Glaxo to name a few. All these companies rely on their parent organizations for their R & D input.

This situation has not changed appreciably even today. The other arm of the bifurcation of the industrial sector is "Rural Industry". This sector falls within the Ministry of Livestock Development and Rural Industries.

A Ministry report on 'Policy Issues' for this sector states that the liberation of the economy has had an adverse effect on the Rural Industrial Sector.

"Small industries," it states, "have failed to take advantage of the opportunities opened up by liberalization and have in fact been harmed by it in many cases".

The constraints as regards the policy environment for this sector were identified as (i) government's policy being biased in favour of the large industries, (ii) the absence of a package of incentives in support of rural based industries, (iii) a weak data base related to this sector and (iv) most important, the widening gap in inter-industry linkages.

In the formulation of a strategy for development in its implementation programme, this Ministry stresses the importance of technology as a factor that determines the quality of life of a society.

It states that "policies in the field of technology will need to be geared towards a search for better alternatives and the development of technologies appropriate to the requirements of the small and cottage sector".

The salient features of the new policies and programmes for the rural industrial sector are -

- (i) the provision of an economic environment conducive to the growth of the industry,
- (ii) the identification of industries based on local raw materials and the provision of special facilities for their development,
- (iii) identification and development of local industries with proven records of excellence.

The need for a body to co-ordinate the work done by the various technological institutes in the field of rural technology is strongly recommended in this report.

2.3.6 Fisheries & Aquatic Resources Development

The Ministry of Fisheries & Aquatic Resources Development has developed a detailed 'Action Plan' for implementation of its policies. The fisheries sector development project is funded as an ADB project (Rs 285 million is the ADB loan and Rs 60 m. comes from the Consolidated Fund). Coast Conservation, another major activity within this Ministry also carries an R & D component.

2.3.7 Environment

Environmental issues fall within the purview of the Ministry of Transport, Environment and Women's Affairs. The programmes on Environment are heavily funded by foreign organizations, e.g. The Environmental Protection Programme, including elements for Environmental Research, is funded by NORAD. An 'Action Plan' for 1995 defines clearly the activities within the Ministry and their funding.

2.3.8 Education Sector

Policy for Education is the function of the Ministry of Education and Higher Education. The success of a National Science & Technology Policy requires accurate projections of numbers of graduates, skilled technicians and others for at least a minimum five year period. The output of graduates and their competence become important factors in the formation of an effective Science & Technology Action Plan. Training courses in science and technology must be designed to engender the interest and enthusiasm of students, towards the frontiers of research; to new developments in technology, on issues relating to the environment and its protection and towards possible career opportunities.

These issues have not been addressed in the Action Plan of the Ministry of Education and Higher Education, and should therefore be accommodated within the Action Plan for Science and Technology.

The responsibility for Tertiary and Vocational Training falls within two departments of the Ministry of Labour and Vocational Training, i.e. (1) Tertiary and Vocational Education Commission and (ii) Department of Technical Education and Training.

Links between these Ministries and the Ministry of Science, Technology & Human Resources Development on whom falls the responsibility of apprenticeship training, should be strengthened.

2.3.9 Health

Ministry of Health, Highways and Social Services

The programmes of the Ministry are geared towards the provision of better facilities for medical and health care.

Indigenous medicine falls within the purview of the Ministry of Co-operatives, Provincial Councils and Indigenous Medicine.

Medical research is not a priority area in the programmes of these Ministries.

2.3.10 Energy, Power and Construction

These areas fall within two Ministries -

- (1) Ministry of Housing, Construction and Public Utilities and
- (2) Ministry of Irrigation, Power and Energy.

2.3.11 Government Analyst's Dept. is under the Ministry of Justice and Constitutional Affairs

2.3.12 Institutions assigned to the Ministry of Science, Technology & Human Resources Development

1. **Atomic Energy Authority**
Established by Act No. 19 of 1969
2. **Arthur C Clarke Centre for Modern Technologies**
Established by Act No. 30 of 1984
3. **Computer & Information Technology Council of Sri Lanka**
Established by Act No. 10 of 1984
4. **Ceylon Institute of Scientific & Industrial Research**
Established by Act No. 15 of 1955
5. **Department of Meteorology**
6. **National Engineering Research & Development Centre**
Established by the State Industrial Corporations Act No. 49 of 1959
7. **Natural Resources, Energy & Science Authority**
Established by Act No.78 of 1981
8. **Sri Lanka Standards Institution**
Established by Act No. 06 of 1984
9. **Human Resources Development Council**
(Act in preparation)
10. **National Apprentice & Industrial Training Authority**
Established by the Tertiary and Vocational Education Act No. 20 of 1990

2.4 National Investment for Science and Technology

In Sri Lanka, support for science and technology activity is mainly governmental. No private foundations or enterprises are engaged in or support science and technology to any appreciable extent. Foreign funds for research and development are for the most part channelled to individual organizations through a central planning authority. Unfortunately, research programmes funded by foreign aid have the disadvantage of these funds being temporary, not allowing for effective management within an institute's R & D budget.

2.5 Concluding Remarks

The state of the economy and science and technology suggests that weak linkages, continue down grading of science and technology institutions, and human resource development and management constraints have retarded both development and application of science and technology in economic and social development. Although Sri Lanka has a vast science and technology infrastructure, the effective integration of the economic state and science and technology requires considerable effort. The lack of integration between economic and science and technology activities has weakened the growth of both economic and science and technology activities. A considerable effort is required to upgrade institutions and develop human resources in science and technology organizations.

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ACKNOWLEDGEMENTS

The Science & Technology Policy document has been compiled with the co-operation of the Committee on Science & Technology Policy, including consultation by Dr. Shantha Liyanage, Senior Lecturer, Technology Management Centre, the University of Queensland, Australia and Mrs Marina Wijesekera.

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