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INDUSTRIAL RESEARCH INSTITUTES:
Their Role in the Application of
Appropriate Technology and Development

SRI LANKA:
The Ceylon Institute of
Scientific and Industrial Research

Donald D Evans

A series prepared by the
University of Denver
Denver Research Institute
Office of International Programs
under the sponsorship of the
U S Agency for International Development
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INTRODUCTION

INDUSTRIAL RESEARCH INSTITUTES

In many countries the creation of a viable indigenous industrial sector has long been considered one of the key elements to economic development. Consequently, an industrial research capability is of significance in defining the industrial needs and priorities of a country or region and matching them with appropriate technologies. An industrial research institute (IRI) has been defined as a technical organization established to make direct contributions to industrial development in the private and public sectors¹. In this context an IRI differs from private research entities which have no proclaimed mandate or responsibility in the practical application or adaptation of technology to their countries' development needs. Frequently industrial research institutes are in some manner government funded and are therefore closely allied to the economic, social and political climate of that government. Ideally, IRIs play a supporting role in the design and implementation of national policies that reflect economic development and growth, while functioning autonomously. In reality, however, government usually plays a substantive role in research institute operations. In any case, compatibility and cooperation among government agencies should be preserved, and selection of industrial research programs should reflect needs of both the public and the private sector.

In many instances, the IRI acts as liaison between government and industry. Ideally and particularly in less developed countries (LDCs), the IRI acts as an intermediary in determination of the need for and the subsequent creation, adaptation or transfer of technology. In fact, the study of technological opportunities or the choice of appropriate technology for development is one of the major functions of the industrial research institute.

In comparison to other technologies, appropriate technology represents the social and cultural dimensions of innovation². As a mediator in an innovation process, a research institute's task is to identify the real needs of the local community, develop or introduce technologies and organizational means which can meet these needs and initiate a process of development based on the internal innovative forces of the local community³. In this manner, the IRI addresses the issue of appropriate technology and its role in the development process.

However, opportunities for innovation do exist in areas other than just industrialization--increasing agricultural productivity, developing

¹ United Nations. Industrial Research Institutes, United Nations Publication No. E.70.II B.21. New York: UN, 1970, p. vii.

² Nicolas Jequier, Appropriate Technology: Problems and Promises. Part I, The Major Policy Issues, 1976, Development Center of the Organization for Economic Cooperation and Development (OECD). p. 9.

³ *Ibid.*, p. 36.

FOREWORD

This case history has been written to assist development planners, personnel of industrial research institutes, and USAID mission personnel in understanding the role that IRIs can and do play in the application of technology to development. This case history is one in a series of eight prepared by the Denver Research Institute under the sponsorship of USAID/Office of Science and Technology (contract AID/ta-C-1337).

The cases in this monograph series first appeared in another DRI publication, Appropriate Technology for Development: A Discussion and Case Histories, edited by Donald D. Evans and Laurie Nogg Adler (Boulder, Colorado: Westview Press, 1979). This book was sponsored by the USAID Office of Science and Technology in preparation for the United Nations Conference on Science and Technology for Development (UNCSTD).

rural technologies, and offering incentives for small industrial projects are also duties that a research institute is likely to perform.

The methods by which IRIs assess technological choice and stimulate innovation are varied. Most often development strategies would include a combination of the following:

- Survey, study and develop uses for local raw materials.
- Develop new processes and improve existing ones.
- Develop new products and recognize new uses for existing ones.
- Improve industrial and agricultural productivity.
- Study the technological and socioeconomic feasibility of industrial and agricultural projects.
- Develop standards and specifications.
- Determine choice of technology and scale of operation.
- Determine industrial location and site.
- Conduct marketing research⁴.
- Acquire and disseminate scientific and technological information.
- Systems design and management of development programs.
- Evaluate a chosen technology and its relationship to local economic and cultural traditions.

To establish solutions to identifiable problems, the research institute often adapts foreign technologies to suit local conditions and offers incentives to small industries to create new technologies. Technological innovation is accomplished in a variety of ways from actual adaptation of a chosen technology to training of researchers and engineers for institution building and infrastructural support, to establishment of extension services to help define and fulfill needs.

The creation of linkages between research institutes has allowed increased communication and the transfer of information and technologies, not only between developed and developing countries, but among developing countries as well. In a few instances, regional research

⁴ United Nations. Proceedings of the Interregional Seminar on Industrial Research and Development Institutes in Developing Countries, Beirut, Lebanon, 30 November-11 December, 1964. Vol. 1, New York: UN, 1966. p. 45.

institutes or networks of institutes have been established to facilitate development in common geographic and cultural areas. (ICAITI in Guatemala representing Central America is such an example.) Similarly, an international IRI organization called WAITRO (World Association of Industrial and Technological Research Organizations) has been created.

Industrial research institutes tend to become the foci for national S&T development and have offered essential infrastructural support. Research institutes, therefore, may play a very important role in mapping the future economic growth and development of a country. With this increasing responsibility, an IRI's task becomes more complex and difficult, particularly when original development goals are overwhelmed by other considerations. Factors such as politics, financial risk, societal or cultural considerations, legal restrictions, staffing problems, marketing problems, fear of change, and sheer inertia may impede or block the transfer process and thus weaken or negate its economic effect⁵.

CASE HISTORIES

Much can be learned about development from the investigation and analysis of industrial research institutes. The Office of International Programs (OIP) at the Denver Research Institute (DRI) has initiated linkage activities with a variety of research institutes worldwide over the last decade under the sponsorship of USAID's Office of Science and Technology. Through these linkage activities, choice and adaptation of technology, training of researchers and engineers, exchange of information and help in the management of research institute affairs have occurred. A dynamic process of communication has been established through DRI's relationship with each research institute, and much knowledge has been gained about the development process by all those involved.

Realizing the value of imparting research institute experiences to others in the development field, DRI has gathered several case histories of industrial research institutes' endeavors in the area of technology transfer. The cases were collected for the most part by OIP staff (often assisted by IRI colleagues) who acted as impartial reporters when collecting the information. The goal of the research was not to select cases that showed only successful adaptation of technology, but to show ways and means by which IRIs must operate to encourage and achieve progress in the development scheme. There are, in fact, examples where a transfer of technology is considered unsuccessful or unsatisfactory.

The case Sri Lanka: The Ceylon Institute of Scientific and Industrial Research, written by Donald D. Evans, reports on CISIR, which in its twenty-third year had many technological advancements to its credit, but over its history has had internal and external problems

⁵ James P. Blackledge, The Industrial Research Institute in a Developing Country: A Comparative Analysis. Washington, D.C.: USAIS, 1975. p. 19.

that are characteristic of research institutes in many countries. These involve staffing, training, equipment, government and industrial relationships, and finance.

**SRI LANKA:
THE CEYLON INSTITUTE OF SCIENTIFIC
AND INDUSTRIAL RESEARCH**

Donald D. Evans

INTRODUCTION

The Ceylon Institute of Scientific and Industrial Research (CISIR) is a government-sponsored industrial research organization that was established twenty-four years ago to identify, acquire, develop, and apply technology for the benefit of the country. The existence of more than eighty such institutions in as many different countries forms a significant international "community of interest" dealing with the institutional approach to the application of technology to the problems of development.

SETTING

Ceylon gained its independence from Great Britain in 1948, at which time the country's name was changed to Sri Lanka. Sri Lanka has one of the highest standards of living in Southeast Asia due to the tea, rubber, and coconut plantations. The population of Sri Lanka is concentrated in the moist southwestern one-third of the 270-mile-long island. The dry zone elsewhere flourished milleniums ago under a remarkable irrigation system, but warfare led to neglect. Today, the nation works to reirrigate the dry zone and thus reduce the food that it must import to feed its growing population. The island itself is located twenty miles off the tip of India and comprises 25,332 square miles. The population, composed of 71 percent Sinhalese and 20 percent Tamils, with large Hindu, Christian, and Moslem minorities, reaches near fourteen million. Agriculture employs half of the working force, but industry is growing. The country ranks second in the world in tea production and fourth in rubber production. Gem and graphite mining is also an important industry. The major city, capital, and principal

port is Colombo, with a population of 618,000.¹ It is within this environment that the CISIR is located and where it has pursued its objectives laid down a quarter of a century ago.

BACKGROUND

The International Bank for Reconstruction and Development (the World Bank) was invited by the government of Ceylon (later to become Sri Lanka) in 1952 to conduct an overall study of the economic situation of the country and to make recommendations that would lead to rapid development and relieve the residual negative effects of the colonial period. Subsequently, against a background of an unindustrialized, agricultural economy, a Bank team of eight members of varying professional backgrounds produced a comprehensive study of the Ceylonese situation. Among the more significant of the recommendations for change was the establishment of an industrial research organization.

Although organizations directed toward researching the "plantation crops" of rubber, tea, and coconut had been established under the British, in the view of the Bank team a highly pragmatic research and development, industry-oriented group was needed. The Bank report recommended an institution that would be as autonomous and free from direct governmental supervision as possible and that would be able to attain financial independence in as brief a time as feasible. It was thought at the time that such self-sufficiency could be gained in as little as five years, if the institute's development and growth were nurtured in the meantime by a government grant.

Consequently, under legislation passed in 1956, the CISIR was established with the following objectives:

- (1) To undertake testing, investigation, and research in such manner as the institute may deem advisable with the object of improving the technical processes and methods used in industry and of discovering processes and methods which may promote the expansion of existing or the development of new industries or the better utilization of waste products.
- (2) To advise on questions of scientific and technological matters affecting the utilization of the natural resources of Ceylon, the development of her industries, and the proper

¹Adapted from the National Geographic Atlas of the World. Washington, D.C.: National Geographic Society, 1975.

coordination and employment of scientific research to those ends.

- (3) To foster the training of research workers.
- (4) To foster the establishment of associations of persons engaged in industry for the purposes of carrying out scientific and industrial research.
- (5) To undertake to collaborate in the preparation, publication, and dissemination of useful technical information.
- (6) To cooperate with departments of government, universities, technical colleges, and other bodies in order to promote scientific and industrial research and the training of investigators in pure and applied science and of technical experts, craftmen, and artisans.
- (7) To assist otherwise in the advancement of scientific and industrial research and technical training.²

PROBLEMS OF THE CISIR

That the CISIR may not have been totally successful in its pursuit of its objectives may be deduced from these statements: "When the CISIR was established in 1955, its principal objective was to further Ceylon's productive development through applied research and technology. However, the several directors of the late 1960s and 1970s and the successive governing boards appear to have not had the capacity to appreciate the significance of the contribution of applied research in the development of a technological capability within the country. Under their stewardship, the institute has veered away from applied research to fundamental or basic research."³ "The impact that a single institution (the CISIR) with limited resources could have on the entire industrial sector is . . . limited. Moreover, the R&D efforts of the CISIR are mainly on a laboratory scale and do

²The Economic Development of Ceylon - International Bank for Reconstruction and Development, Washington, D.C., 1952

³Member of CISIR governing board to governing board, letter, November 1977.

not generally extend to scaling up into industrial prototypes and processes.⁴

In 1976 the chairman of the CISIR and concurrent vice chancellor of the University of Sri Lanka was quoted as saying: "The CISIR had at that time (1955) the ambitious intention of generating its own finances, by assisting local industry through research, advice, and the testing of industrial products, but for several reasons these ambitions did not materialize."

The director of the CISIR, Dr. Mervyn Wijeratne, expressed the belief that the institute had indeed failed to live up to its initial promise and that this was a great loss in view of the opportunities and needs that continued to face the nation and in which an institution carrying out the mandate of CISIR could make such important contributions. However, he expressed conviction that the organization could be brought into a much more productive role and essentially fulfill its mandate if certain internal conditions could be improved and if the environment within which CISIR existed could change.

Although the CISIR has encountered problems of organization, staffing, facilities development, information acquisition, client relationships, program planning, public attitudes, and research application--problems that are common to this community of institutions--at the present time it is especially concerned about its relationship with the government in Sri Lanka and with the attitudes of governmental officials in the Ministry of Industry and Scientific Affairs. Another difficulty of first-rank importance is the blight of "brain drain" that has afflicted the CISIR, especially in recent years. The institute is seeking ways to strengthen its most valuable resource (in the view of Wijeratne and others)--its staff--and to reduce the rapid turnover rate. Wijeratne and his deputy, Dr. Edwin E. JeyaRaj, also are concerned with updating the facilities of the institute and with providing further education and advancement to the professional staff. Also, the institute's research output and technical capabilities need to be utilized to a greater extent by the industrial community.

Sharing in these feelings of need were the majority of the professional staff of the CISIR, as was disclosed in a series of informal meetings with small groups of the staff members.

⁴Sri Lanka National Paper for the United Nations Conference on Science and Technology for Development. (Colombo: Production and Printing Unit Industrial Development Board of Ceylon, October 1979): 16.

DESCRIPTION OF THE CISIR

In 1979 the institute was composed of 70 professionals and 100 supporting staff, housed in four principal buildings in a pleasant and well-established section of Colombo. Two multistory laboratory buildings had only recently been completed. Other facilities included: conventional chemical laboratory spaces and equipment; a small but diversified machine shop and fabrication facility; some pilot plant spaces; a technical information center that was reputedly one of the best in the country; and the usual ancillary spaces.

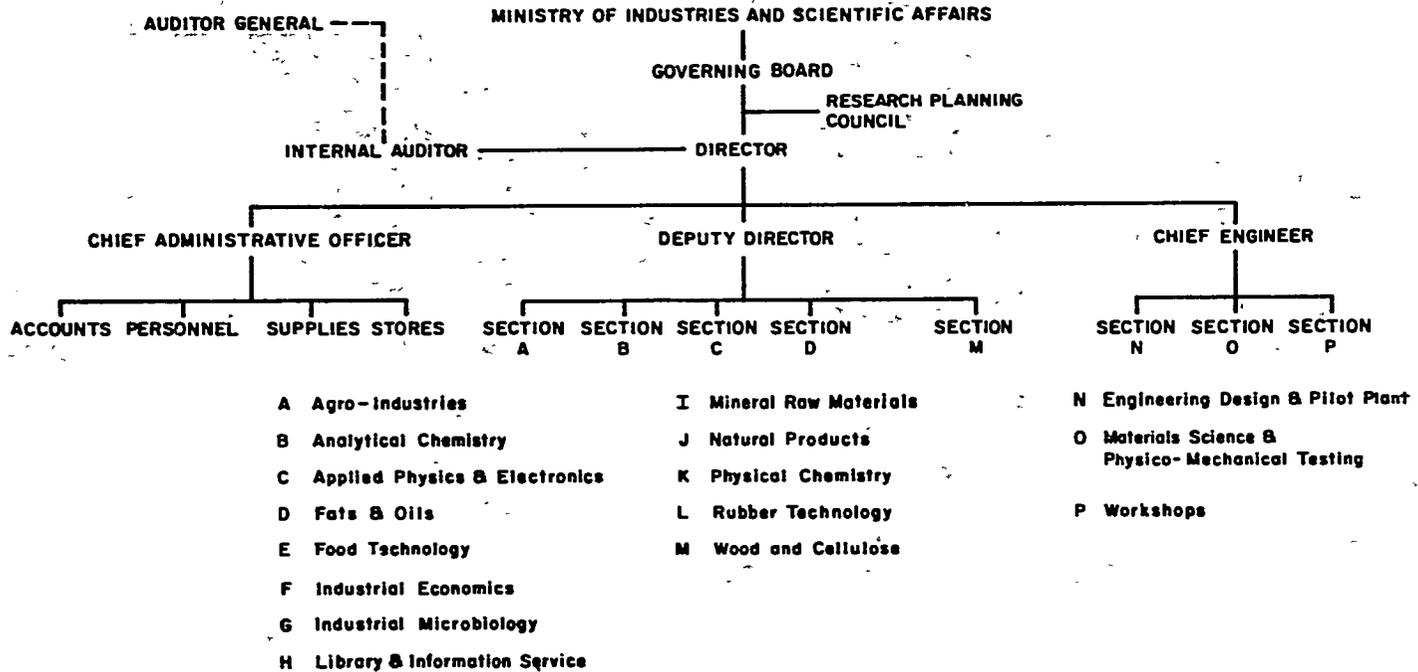
The research equipment, except for some recent additions, was rather old and obsolescent. Various members of the professional staff complained that they were unable to carry out satisfactory research because of equipment limitations and especially because of the long delays in getting replacement parts from foreign sources. Obtaining the "hard currency" needed to pay for foreign imports was vexing until recently, when the government liberalized foreign exchange negotiations. (Thanks to the foresight of the planners of CISIR, the institute had been granted relief from customs duties and taxes.) Other younger staff members complained of problems in getting colleagues to share equipment because of shortages and supply difficulties.

Other problems resulted from the deficiency of pilot plant capability. One industrialist and member of the CISIR governing board stated: "As projects mature to pilot-plant scale and to the level of development of industrial prototypes, a heavy demand will be foisted on the pilot plant and designs section. If this vital section remains understaffed all research results will be consigned to files and archives, and no take-off into industry and commerce will result."

Several staff mentioned the inadequacy of their information resources. Director Wijeratne stated that the budget for library periodicals and new acquisitions had been cut for the fiscal year 1979 by some uncomprehending official in the ministry who apparently had little concept of the great need for access to contemporary science and technology information by a professional research staff. The library itself was housed in crowded spaces but was to be relocated to more spacious quarters within a short time.

Another difficulty was maintaining adequate laboratory atmospheric control in Sri Lanka's hot and humid climate, which affected various pieces of delicate laboratory equipment and reference standards. Air-conditioning equipment was generally hard to obtain even if ministry sanction could be obtained for this "status symbol" appliance that generally is reserved only for the offices of higher-level government officials.

**FIGURE 1
ORGANIZATION CHART OF CISIR**



The Professional Staff

Perhaps the most significant characteristic of the CISIR professional staff was its age structure. The senior and more experienced members were both relatively few in number and separated widely in age from the far more numerous younger members. Adequate numbers of intermediate-aged individuals were lacking. This reflected the fact that virtually no research staff were hired for over twelve years after the establishment of the CISIR. Thus, in 1979 no experienced, intermediate-age cadre of qualified persons were available for management responsibilities. The result, as expressed by one of the young women professionals, was a lack of direction and participation in research activities by more senior and experienced supervisors. The director himself had been surprised by the statement of a junior staff member that it was felt he was "too lenient" and that the staff would welcome "more explicit direction." At the same time he was concerned that perhaps the staff held too much confidence in his ability to influence the external forces that affected the operations of the institute.

It was also felt by some staff members that there were far too many active projects in the institute at any one time. The ratio of staff members to projects (approximately one-to-one) meant that only insufficient and long-protracted attention could be devoted to individual projects. An informed outside observer of CISIR commented that because of such understaffing, projects were requiring six to eight years for completion instead of two to three, which should be the maximum.

Opportunities for overseas training of the staff were considered by the director and by members of the National Science Council as being too few and often inappropriate. The director explained that this was largely the result of CISIR's lack of decision-making authority with regard to how many staff members would receive overseas training and in what subject areas. Such decisions were made by the Ministry of Education and the Foreign Ministry, which administered the training assistance grants accorded to Sri Lanka from foreign sources. Wijeratne observed that the CISIR representative in the Ministry of Industry and Scientific Affairs was not of comparable rank to those who were responsible for other technical institutions in the country; therefore, CISIR did not receive a share of training opportunities commensurate with the size and needs of its staff.

On the other hand, when staff members did receive overseas training, negative consequences sometimes resulted. For instance, there was a discouragingly high rate of resignations. Notwithstanding the fact that those going on training assignments in foreign countries had to sign an

agreement that they would return to Sri Lanka to serve a specific number of years at CISIR, significant numbers of Sri Lankans were managing to circumvent this provision either by paying the stipulated amount to discharge their obligation early or simply by remaining overseas. More recently, many educated and skilled Sri Lankans have been leaving the country for periods of two years and longer to take high-paying positions in the Middle East Organization of Petroleum-Exporting Countries (OPEC) nations, where they are very much in demand due to their high educational levels and their especially good command of English.

CISIR has found it particularly difficult to recruit and retain engineers, whether they are fresh out of the technical universities at home or abroad or are qualified persons with experience and knowledge of the Sri Lankan industrial environment. As noted in the Sri Lanka national paper for the United Nations Conference on Science and Technology for Development (UNCSTD): "For the LDCs, this is a significant loss of human capital and a substantial reduction in their technological capacity. For the receiving developed countries, such inflow has helped to increase and diversify their own technological manpower base. Brain drain of this type is essentially a reverse transfer of technology. It is ironic that through this process, the poorer LDCs pass on a substantial part of their technological assets each year voluntarily to the rich countries." "The institutions and workshops available in Sri Lanka for training this grade of manpower are quite inadequate to produce them in the numbers required to compensate the loss." (The paper proposes that some type of financial compensatory system be established to which the recipient developed countries would contribute for the benefit of the donor LDCs.)

The CISIR staff is organized in discipline-oriented groups, a fairly typical kind of organization in similar institutions of other countries. However, the director and a concerned ministry official noted that such a structure tended to discourage the interdisciplinary research that was badly needed to confront the country's increasingly complex and interactive problems. In fact, critics of the CISIR stated that the institute was too concerned with basic science, especially chemistry, and was not diversified enough in other subject areas, particularly engineering. At the recommendation of a Soviet team that assisted the institute during 1974 to 1976, an industrial economics unit was established within the CISIR. However, in 1979 there was evidence that this activity had gained little acceptance among the "hard scientists" on the staff or among industry and other potential users on the outside.

With regard to personnel problems, probably the most difficult aspect to overcome is the markedly deficient compensation schedule for the staff. In the view of Director

Wijeratne, this underreward for services rendered has been the major cause of problems within the CISIR. He noted that part of the problem results from the circumstances of the institute's first five years. At that time the staff was paid substantially more than those employed in government agencies. When at the end of the first five years financial self-sufficiency had not been attained (by a large margin), the government political forces brought CISIR under the direct control of the Ministry of Industry. This, of course, violated the objective of the CISIR to be autonomous, and the budget for the institute was reduced to conform to that of other government agencies. A management report dated July 1978 stated: "The research staff at CISIR work under constraints of limited facilities, and yet strive to work out new processes or improve existing ones. They cannot also be expected to work for lower pay than their colleagues in other institutions whose academic achievements are often lower than their own." Notwithstanding the efforts of CISIR's management, over one year later the recommended salary increases had not been granted.

In a discussion with junior staff members it was disclosed that several of them had outside sources of income, and they felt that only because of this were they able to maintain a suitable standard of living. One stated: "I happen to own a small plantation, and even that returns me several times what I earn at the CISIR." Another said that he was unable to get married because his salary was his only income and would not allow an adequate living standard for a family. Loyalty and satisfaction in doing research even under difficult conditions were the principal reasons why the junior staff chose to remain at the institute.

Some staff members also indicated dissatisfaction over their lack of opportunity to interact with peers in other countries. They felt that, as a result, they were not able to maintain a contemporary awareness of developments in their fields.

Director Witjeratne pointed out other personnel difficulties that hindered operation of the institute. These ranged from a proscription on the payment of stipends to board of governors members (other state institutions were able to do so) to the unavailability of English-speaking/writing secretaries due to a government policy that promotes the use of the national language (Sinhala).

Notwithstanding these critical comments, it was both stated and observed that the staff felt very favorable toward the director and his deputy, both in terms of their skill and efforts at management and on a personal basis. These two men had been at the institute since its inception, had risen "through the ranks" to their present posts, and therefore had a comprehensive knowledge of the evolution of the CISIR and of its staff members.

Project Selection and Research Operations

One knowledgeable critic of the CISIR stated: "The research planning council (an internal body of the institute comprising senior research staff members) appears to have planned the institute's research program with little concern towards the resource base of the country and the priorities in relation to national economic goals."

In the national paper prepared for the UNCSTD it is maintained that: "The scientists from Sri Lanka carrying out postgraduate research in developed countries use sophisticated and advanced techniques and naturally work on problems most often unrelated to the problems of Sri Lanka but related to advancing the science and technology of those countries. Quite often, such scientists find it difficult and disturbing to return home, where funds allocated for scientific research are low, the apparatus and equipment available are of a basic nature, and scientific literature is scarce."⁵

The program of research at the CISIR is noticeably directed toward the development of products and processes based on the country's plant resources, and the staff's professional qualifications show a predominance of organic chemists and life scientists. Following is a partial list of ongoing and completed projects, which gives an impression of the characteristic content of the research activity:

- (1) Instant tea (from green leaf)
- (2) Bottled coconut cream
- (3) Removal of H₂S from arrack (a distilled liquor)
- (4) Ebonite (latex + kaolin) as a PVC substitute for fan blades, etc.
- (5) Improved stills for the distillation of essential oils
- (6) Chemistry of Sri Lanka essential oils
- (7) Cassava detoxification
- (8) Preservation and bottling of young coconut water
- (9) Elimination of Salmonella in dessicated coconut
- (10) Carbonated lime tea formulation

⁵Ibid., p. 24.

- (11) Cashew nut wine manufacture
- (12) Osmotic dehydration of fruits and vegetables
- (13) Technical and management assistance to the Oils and Fats Corp.
- (14) Development of a method for relining electrolytic cells with rubber compound.

Despite the apparent practicality and relevance of these research subjects, a ranking official of the Ministry of Industries and Scientific Affairs noted that in the past the CISIR had been viewed as a collection of "academics" "living in white towers." He continued that it was difficult to evaluate the work of the institute because there was little planning against which to measure results. It was noted that the research tended to be too basic-oriented and that the institute had "not met expectations" in terms of its research output. He felt that the research program had not benefited from a careful examination of the national development plans and that therefore the research output sometimes tended to digress from what was most needed for the country.

In a report to the board of governors, a member of the board noted: "as at present (for year ending 1976) about 75 percent of the operational expenditure for research has been incurred on projects in the class of fundamental or basic research. This class does not in the short term assist government to mobilize national resources in a productive way." In response to this charge, the research planning council of the CISIR noted that its definition of "basic" versus "applied" research differed substantially from that of the board member. On the basis of the council's definition, "the CISIR did not exceed 10 percent of the total operational expenditure" in basic research, and "hence the council does not agree with the statement that 75 percent of the operational cost during the year 1976 has been spent on what has been referred to as fundamental or basic research."

Director Wijeratne emphasized that this difference of opinion was typical of the climate within which the Institute operated. He stated that there was a disconcerting lack of common definition of goals and objectives between the management and staff of the CISIR and those in the public and private sectors who have an interest in CISIR programs. Wijeratne continued that the management of the institution had not in the past been adequately attentive to communicating with influential persons in the public and private sectors and that he was seeking to overcome this discrepancy.

The research council's rejoinder went on to state: "If the CISIR has not made an impact on the industrial development of the country at a level envisioned, it is because of the lack of an overall plan to expand the activities of the institute to a higher scale. What is required is a fully equipped pilot plant to undertake upscaling of processes worked out in different sections such as Food Technology, Industrial Microbiology, and Natural Products. For this heavy investments are needed."⁶

Staff and management of the institute both acknowledged that insufficient attention was paid to project development and to external relations of the organization. The CISIR had no organized marketing activities, and each principal investigator was left largely to his or her own devices in terms of gaining user acceptance of research results. For example, a promising process for the manufacture of a bottled carbonated tea drink was developed after long and intensive effort by the staff. After a series of ineffectual and frustrating efforts to enlist a manufacturer for this product, including the filing of patent applications in many foreign countries, the product ultimately failed in the Sri Lanka market despite the intrinsic flavorful appeal of the beverage.

A lack of planning was viewed as another problem in research operations. In the opinion of the present management of the institute, previous directors of CISIR generally had been negligent in terms of planning for and developing basic staff capabilities; this should have been possible even with the financial constraints that were experienced intermittently by the institute. For instance, some felt that better use might have been made, of the opportunities for foreign training through various assistance programs available to Sri Lanka.

Further reference to institute planning was made during a discussion with a ministry official. He said that under the aegis of the present minister notable improvement had been made in the "team approach" to research problems, although the national development plans had not been studied sufficiently and integrated into the research plan. He said that it was necessary for the institute to "plan-up" to meet the "plan-down" efforts of the government and noted that, in general, the technological institutions of the country under his and other ministries had not been adequately involved in development plans. He did feel, however that "the role of institutions (such as CISIR) in decision making is increasing." (It was during this discussion that the ministry

⁶"Observations of the Research Planning Council," 24 October 1978, p. 2.

official learned from Director Wijeratne that the Finance Ministry had reduced next year's budget for CISIR from the approved (by the Ministry of Industry and Scientific Affairs) Rs. 10.6 million to Rs. 4.52 million.

Financial Matters

Under terms of an agreement between Sri Lanka and the All Union Corporation of the Union of Soviet Socialist Republics (USSR), a Soviet industrial economist, Dr. V. Lats was seconded to the institute from 1974 to 1976. In the course of his stay, Lats analyzed the income and expenditures of the CISIR for the preceding twenty years, Lats pointed out: "The CISIR was setup with an initial government donation of Rs. 5 million spread over the first five years, the bulk of which was expended on capital expenditure on building and equipment. Initially, it had been hoped that at the end of the five years, the institute would be in a position to operate on its own income by the sale of services to both the public and private sectors. However, this hope was not fulfilled and now it is obvious that it cannot be fulfilled, at least in the near future.

"Even in a highly industrialized capitalist country it is known by experience that a minimum of five to ten years is essential to make a research institute self-supporting. In a developing country an even greater period of time may be required together with an assurance of financial stability which would produce a feeling of confidence in the staff, the sponsors of research, and the whole technical community. There is no magic way of predicting the time for reaching self-supporting status of the research institute. This period would depend on a number of factors and primarily on the level of technical development in a given country."⁷

The essential correctness of his observation can be deduced from the events at the CISIR when, in 1960, the annual stipend of Rs. 5 million came to an end and the institute was required to go to the government for its annual grant. This, however, was not forthcoming for some two years. The institute consequently was placed under heavy financial strain, resulting in reduction in staff and no expansion of programs. As Lats pointed out: "From the financing standpoint, the second five-year period was the hardest time in the institute's life. Financial constraint had caused a considerable delay in its development."⁸

⁷Memorandum, Lats to Governing Board, 10 September 1975, p. 2.

⁸Ibid., p. 18.

Also during this period, the original autonomy of the institute was abridged significantly by legislative amendment. As a result, the government took a much more active financial and operational role in CISIR programs. According to Director Wijeratne, at this juncture the CISIR became more typical of R&D institutions in the other developing countries in terms of its relationship to and control by the government. Direct government audit of accounts was required, and new ex-officio government members were placed on the governing board. Since funding was only on a year-to-year basis, the institute was not able to initiate, with confidence of completion, any programs that could not be completed within a single budget year.

In his conclusions and recommendations, Lats stated: "For proper research planning, it is necessary that the institute should be aware of the funds (including foreign exchange) that are likely to be available to it for the next five years and should in turn communicate this information to its constituent sections." He also noted, "The budget should be 'project-oriented' and not 'expenditure-oriented', so that funding would be related to the actual project requirements."

Despite the presence of a notably efficient and comprehensive cost accounting system (given the lack of attention that this subject receives in similar institutions in most other developing countries), Mrs. da Silva, the chief accountant, related a story of failing to get the professional staff to account regularly for how their time was spent on projects. The feeling prevailed among the staff that since the institute was sustained by an annual budget, "there was no utility in determining exactly how much was spent on each project or activity."⁹

Much of the CISIR's funding comes from its charges to outside organizations (see Table 1). However, it was stated that the charges for these services and the development of this aspect of the institute were inadequate. It was also disclosed that payment for these services was frequently delayed; many customers felt that services should be free since the CISIR was a public-supported institution. Conversely, various of the professional staff felt that the provision of testing services by the institute was not consistent with its role as an R&D organization and that the sooner these activities were divested, the better.

In September 1975, Lats concluded: "The immediate tasks facing the institute are to continue recruitment of necessary manpower and acquisition of facilities. Emphasis should be on selection and training of qualified research

⁹Ibid.

personnel. The laboratory equipment and plant must be continually upgraded to enable the staff to improve its productivity." In 1979 Director Wijeratne discussed the requirements of the CISIR in these same terms, indicating that no great progress had been made toward these fundamental goals. In fact, he observed that after its auspicious initial five years, the CISIR had fallen into a mode of operation that was generally stultifying and nonprogressive, although there had been periods of greater activity. With regard to the contemporary situation, he said, "We're back to square one."

TABLE 1
CEYLON INSTITUTE OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Year	Total operational expenditure Rs	Expenditure on salaries and wages Rs	Income from Services Rs
1955	1,004,813	21,140	3,303
1957	444,785	304,390	360,847
1958	485,935	348,755	292,088
1959	553,158	407,331	290,894
1960	719,410	537,069	429,006
1961	774,090	606,758	402,242
1961-62	1,222,750	785,806	508,175
1962-63	858,437	492,615	321,108
1963-64	900,816	519,741	322,003
1964-65	974,316	541,719	161,429
1965-66	983,757	530,304	348,000
1966-67	1,157,826	703,242	415,621
1967-68	1,426,576	874,278	524,175
1968-69	1,645,914	1,010,310	624,703
1969-70	1,670,762	1,095,817	596,529
1971	2,391,625	1,356,399	966,394
1972	2,167,528	1,264,156	281,517
1973	2,263,469	1,580,004	203,628
1974	2,565,761	1,816,025	242,318
1975	2,859,303	2,005,501	179,757
1976	4,055,002	2,199,715	219,300
1977	4,728,797	2,619,138	315,175

Foreign Assistance

"The Sri Lanka Government believes that the strategies adopted during the last decade will have to place a high priority on training and developing the human resource infrastructure necessary for full utilization of science and technology for development. This means incorporating

effective training components in all plans and programmes, and making full use of experts (foreign and local) in special training programs bringing to the forefront the problems, prospects, and solutions regarding science and technology for development."

Beginning with its first director who came from the U.S., the CISIR received assistance from several foreign sources: the government of the USSR; the University of Uppsala, Sweden; the Tropical Products Institute of London; and the Indo-Sri Lanka Science and Technology Programme in collaboration with the government of India. These all benefited the institute, and the general attitude by its management and staff toward foreign assistance was favorable.

Some problems existed however. Director Wijeratne, for example, observed that the CISIR had only indirect access to the sources of such foreign assistance and that the institute had to negotiate such programs through the intermediation of governmental agencies. This inhibited the clear definition of problems and the determination of optimum assistance programs. The staff felt that intermediaries in the ministries were not sufficiently familiar with the problems of research institutions to make judicious choices of assistance options.

Concurrently, Wijeratne emphasized the importance of the foreign inputs to the CISIR, stating that the institute could not survive in a vacuum and that frequent working-level contact with peers in foreign (particularly developed) countries was vital to the professional growth of the staff. Wijeratne particularly pointed out that it was highly desirable for the institute staff to gain industrial experience. He believed that this was a serious deficiency in their experience background hampering effective relationships with industry. This was especially true of the younger professional members, many of whom had had no direct industrial experience. He felt that if the foreign assistance encompassed direct industrial experience, he would be willing to exchange formal postgraduate training for such experience. At the same time, Wijeratne pointed out that staff members with this kind of background--especially under present conditions in the country--were likely to be "pirated away" by local industry, which was experiencing a growing shortage of such qualified persons.

The CISIR and External Factors

The utilization of science and technology for the development of Sri Lanka may be summarized as follows:

"Sri Lanka is today classified as a less developed country (LDC) on the basis of its GNP per capita (Rs. 1,754 or US \$200 in 1976). The rate of economic growth has been

materials for building that could be mass-produced at low cost.

"Development in the sphere of energy will consist mainly of increasing hydroelectric power generation and extending the program of rural electrification. Programs of forestation to provide the future needs of fuelwood (at present, fuelwood and agricultural residues account for 60 percent of the energy consumed) would be implemented.

"The sustained development of Sri Lanka's economy will depend heavily on the building up of a fully effective indigenous scientific and technological infrastructure and capability. The deficiencies that now exist, and the problems encountered in developing self reliance in S&T are as follows:

- (a) Inadequate capacity in R&D resulting in deficiencies in the transfer, adaptation, and innovation of technology
- (b) Inadequate managerial capacity
- (c) Lack of easy access to scientific and technological information
- (d) High cost of books, periodicals, and scientific equipment
- (e) The heavy exodus of trained manpower—doctors, scientists, engineers, technicians, and skilled workers; the expertise available in the country is of a very high standard, but the numbers are diminishing due to the exodus ("brain drain")
- (f) The inadequacy of training facilities for increasing the numbers of skilled personnel, particularly at the technician level."¹¹

In this environment, the CISIR follows its mandates involving the creation and improvement of industrial processes, the development of new products and the substitution of imported ones, the training and development of manpower, the provision of testing services, the dissemination of information, cooperation with other related public and private bodies and the advancement of science and technology.

¹¹Ibid., passim. This paper was prepared by L.C.A. des-Wijesinghe, acting secretary-general of the National Science Council of Sri Lanka.

slow (3.1 percent average annual increase in the GNP in the decade 1968-1977), and there are about one million unemployed in a population of fourteen million. In contrast to this situation, Sri Lanka's Physical Quality of Life Index is much higher than that of most other less developed countries.

"Agriculture is the mainstay of the economy, accounting for one-third of the GNP, and it is mainly confined to tea, rubber, coconut, and rice. The first three crops account for the major foreign exchange earnings, while rice is the staple food. Sri Lanka is still an importer of rice; the highest annual production was in 1977, when 80 million bushels, equal to 75 percent of the national need, were produced. Research and development in agriculture will also focus on other crops besides rice. These include the spice crops, legumes, coarse grains, sweet potatoes, chillies, sugar, cocoa, and coffee.

"In the industrial sector, significant development took place only after the independence in 1948. Since then, several industries have been established (e.g., paper, tires, rolled steel, sugar, etc.), but the growth of the sector has fallen far short of planned targets. The main unsatisfactory feature of the sector is the high dependence on imported raw materials and machinery. Both research and development are inadequate in this sector, but more particularly, the development component, resulting in shortcomings in regard to the transfer, adaptation, and innovation of technology.

"The main development envisaged for the industrial sector is the establishment of the Export Processing Zone (EPZ), which is expected to attract foreign capital and would result in increased employment and foreign exchange earnings. Outside the EPZ, efforts will be made to increase production, to reduce the dependence on imported raw materials, and to effect process improvements in the industries that have already been established. The establishment of new industries which are labor intensive and suitable for setting up the rural areas will be encouraged.

"In the sphere of health, there has been a sharp decline in infant mortality (from 140 per 1,000 live births in 1946 to 43 in 1971) and an equally spectacular increase in life expectancy (from forty-four years to sixty-four in the same period). The main health problems at present are the incidence of preventable diseases such as bowel infections, diphtheria, whooping cough, tetanus, malaria, etc., and the lack of adequate potable water. Malaria, which had almost been eradicated in 1960, is of serious concern again.

"In the housing sector, the main thrust will be towards providing a greatly increased number of housing units, encouraging private house construction by providing incentives, and pursuing research on developing alternative

In undertaking these tasks, the institute encounters a wide range of circumstances and problems that are typical of similar R&D organizations in other developing countries. These stem generally from lack of public and industry understanding of the functions and possibilities of R&D; difficulties with the political process and the governmental systems; shortages of skilled manpower, equipment, and facilities; a dearth of technical and other information; and problems related to the growth rate of the economy.

Industry, primarily the food processing industry, was the principal beneficiary of the efforts of the CISIR. Unfortunately, certain situations and attitudes that seriously hampered the efforts of the institute existed in industry. Perhaps first among these was the strong preference for foreign technology. Until recently, government policy had been to severely restrict importation of products and processes, and this had stimulated the establishment of domestic industries utilizing their own technology. However, recent loosening of restrictions on imported products and technology had resulted in their reintroduction in the domestic market. One senior CISIR staff member pointed out the effect of this had been to drive the domestic producers from the scene. He said that even with a 100 percent import duty on various items, it was still not possible for local manufactureres to match the imports either in price or quality. He attributed this to two essential facts: the domestic market was so small that it could not support an efficient scale of production for most products, and the supply and quality of components from local secondary suppliers to the final manufacturers was inadequate.

In this regard, the Sri Lanka National Paper for UNCSTD stated: "Industrialization based on import substitution may look attractive in principal, but in practice, if not properly controlled, can lead to a situation where industries may be developed in which the local effort consists merely of assembling components (e.g., radios) or only of packaging the finished products imported in bulk (e.g., pharmaceuticals, milk foods). This results in industries being set up where the import content is very high and the foreign exchange costs of keeping the industries going are unduly high. With regard to technology, this situation will not boost the science and technological capability of the country towards using local raw materials and/or local talent in place of imported ones. From the economic standpoint, import substitution of this kind will not bring the expected relief to the balance of payments."¹² (At another point in the national paper, however, it is stated that the official

¹²Ibid., p. 6.

government policy recognizes this effect and states the intention to minimize it.)

Governmental policy during recent months strongly encouraged the importation of foreign technology for certain uses, such as for export production in the recently established EPZ, where the principal domestic input would be labor. It is asserted that local industrialists and investors there show a strong preference for foreign "turnkey" technology.

In any event, as the CISIR staff member pointed out, the effect of foreign technology importation generally is to reduce the demand for indigenously produced technology. In this way, the situation of CISIR is greatly affected.

Another aspect of the institute's relationship to the industrial sector concerned a lack of confidence by industry management in the capabilities and experience of the CISIR. Director Wijeratne pointed out that the severe financial constraints of the institute make it virtually impossible to hire and retain highly qualified engineers with broad industrial experience. This was becoming increasingly important as the attitudes of younger, well-educated persons in the country leaned progressively toward professional mobility. Industry simply could provide greater compensation and material status than the research institutes. Thus, a principal problem of the CISIR was to develop career models and methods that would offer younger professionals sufficient inducements, including compensation, to attract them to and keep them within the organization.

Industrialists in Sri Lanka, as elsewhere, regarded return on investment as the principal criterion of success. (They recognized, though, that there are many other measures of organization success.) Nevertheless, the need to optimize return on investment usually corresponds to an unwillingness to invest in R&D, where the return typically is lower than other alternatives (at least in the short run), and where the results are much less predictable than when acquiring a demonstrated foreign technology (which, incidentally, frequently comes with a package of management assistance that the research institute cannot supply).

As Professor Brian Quinn of Dartmouth University has pointed out, the propensity for making long pay-back investments diminishes exponentially with the linear increase in interest rates. Thus, in the Sri Lankan relatively inflationary economy (11.5 percent per annum), investors do not have much incentive to take the risks of R&D.

One observer, a well-known scholar of Sri Lankan history said that private industrialists were prejudiced against science and technology because the traditional English manner in which many had been educated emphasized the liberal arts rather than technology. Thus, the management of domestic industry, in his view, lacked understanding

of the role and utility of science, but especially of technology, in the conduct of business ventures. Evidence indicated that this attitude also prevailed in Sri Lankan higher education circles. A Sri Lankan country paper prepared for a 1976 United Nations Economic, Scientific and Cultural Organization (UNESCO) seminar in India on management of R&D institutions pointed out: "It is worth mentioning that the only University in the country has not yet produced a single graduate in chemical engineering."

Evidence in Sri Lanka business circles also indicated a high degree of circumspection, if not to say apprehension, concerning government-sponsored institutions, particularly when they function in such arcane (to the average businessman) areas as science and technology. Government traditionally has intended to influence or constrain the business community, and the CISIR as a government institution appeared to be affected by business' attitudes. As previously mentioned, the management of the institute admitted that they had not effectively directed their activities toward creating bridges of understanding and mutuality with the industrial sector.

Judging by the comments of persons both within and outside the CISIR, the institute was not and had not been sufficiently attentive to those organizations and individuals on the outside who influenced the acceptance and utilization of the institute's research products and affected operations funding. One small but significant example of the current management's interest in overcoming this deficiency was the publication of a small quarterly newsletter, with a mailing list drawn from this external community.

The same foreign observer noted that senior members of the industrial elite of Sri Lanka and other Asian countries had a traditional paternalistic, hegemonic attitude that also influenced the board of governors of the CISIR. In the past, the board consequently had gained an undue amount of operational control, which tended to diminish the influence of the director and principal management staff. This violated commonly held views of Western business theory that the board should restrict itself to policy matters. Director Wijeratne, with some reluctance, admitted that this was a notable factor in his efforts to bring the CISIR out of its past deficiencies and into a more effective role and force for development.

A foreign diplomat who had been present at the inception of the CISIR commented that the institute's first director, an American, had been very effective and exemplified the benefit to be gained through a careful matching of foreign experts with local human and material resources. He felt, however, that in the Sri Lankan society there was a certain lack of appreciation for "inventiveness." Such a lack

must necessarily work somewhat against the success of an innovation-oriented institution such as the CISIR, he believed.

The foreign observer described the general atmosphere of the country as "an ambivalent, rich tapestry" of sometimes conflicting social and cultural influences, which makes the operations of the CISIR more difficult than would be the case in a more homogeneous society. Sri Lanka he characterized as a "two-tier" society with a very small economically affluent elite, in contrast to a poverty-immersed mass of the population; he expressed concern that policies relating to industrial development and the inducement of foreign investment would result in further accentuation of this stratification, as it had in many similar societies. He felt that the CISIR, ideally, could do much to spread the beneficial effects of technology broadly throughout the society, but thought that the institute theretofore had not been particularly effective in doing this.

With regard to technology, he noted that the current enthusiasm for "appropriate technology" could have a number of benefits, but he also felt that this should not be at the expense of the introduction and utilization of technology of whatever sophistication is necessary to accomplish rational development goals. "Of course job creation is of very great importance, but that does not mean that this is the sole or paramount purpose for the use of technology." In Sri Lanka, he believed, there were clearly differing views within both the public and private sectors with regard to this question. "There are those who say 'use labor at any cost', versus others whose view is that the only basis for rational choice of technology is the comparative cost/benefit ratio."

One of this expert's principal concerns was that with the liberalization of foreign investment and import controls, various important development-related decisions might be made, de facto, by foreigners whose interests were primarily in the present and who therefore were largely motivated by considerations of short-range economic return.

The charter of the CISIR provided for exchange of board of governors' memberships with the Development Finance Corporation of Ceylon (DDCF). Considering that the DDFC was continuously reviewing loan applications for projects having significant technology components, and that it was the original intent of the World Bank proposal for these two institutions to collaborate in technology-related matters, it was concluded to discuss this institutional relationship with Donald W. Kannangara, general manager/director of the DFCC.

He stated that the relationship between the two organizations had been allowed to languish and that he, for one, felt that an active association should be established,

although he did not at that time mention in what specific ways he felt such a collaboration might be implemented or for what purposes. It was his feeling though, that the CISIR represented "a considerable resource of which we're not making adequate use."

The DFCC received its foreign currency from sources such as the Asian Development Bank and the World Bank. Local currency was provided through the commercial banking institutions of Sri Lanka and occasionally directly from government, but not often. The DFCC made loans only to firms that were predominately (80 percent or more) owned by private sector interests. It was noted that the government was moving to establish its own development banking institution that would serve primarily the public sector companies and help finance state-owned infrastructure elements (dams, roads, water systems, etc.).

With regard to the DFCC's involvement with questions of technology, Kannangara indicated that they were "passive," although they had a small review staff that examined projects (sometimes in conjunction with consultants) to determine if the planned technology met world standards, was in wide use, and came from a reliable source. When asked if a DFCC policy existed with regard to utilization of indigenous technology, he replied that at that time there was none but that it had been considered. He went on to say that any effort to stress the use of indigenous technology through the mechanism of the corporation's industrial loan activities would have to come as a policy decision on the part of the government.

It was stated that in receiving secondary financing from regional and international sources, such as the Asian Development Bank, they were occasionally asked to reserve a certain amount--perhaps 10 percent--to support small-scale business in the country, but that no other policy on the part of the international banking community had been established calling for specific encouragement of indigenous technology.

It was noted that by the time the loan applications reached the DFCC, the technology had usually been decided. He said that perhaps this situation called for establishing an intermediary organization, but he did not elaborate on this idea.

In reflecting on the effects that technology had had on Sri Lanka, Kannangara recalled the "chekku" units of his youth, which were buffalo-powered stone mortar-and-pestle devices used to extract coconut oil. He noted that these had disappeared entirely, to be replaced by modern, electric- or diesel-powered machines in the larger cities; he was gratified at the role played by his organization in bringing about this evolution.

With regard to the interaction of the government with the CISIR, two senior staff members of the institute voiced the opinion that far too little attention had been paid to the CISIR by the Planning Ministry and that the institute should be brought into the national development planning process on an active and continuing basis; it was believed that science and technology were not factored into national development plans to the extent necessary. It also was observed that science and technology were "magic words," and were often invoked by politicians who did not have an adequate understanding of the implications and significance.

A predisposition to create new, faddish S&T-based institutions had recently become evident with the announcement that the government was going to sponsor the creation of a basic research institute. This left questions in the minds of the CISIR staff concerning what this would mean for their own research activities. According to one senior staff person, Sri Lanka was too poor to afford much, if any, basic research; he would consider a new basic research institution to be a waste of scarce resources for a nation that could barely feed its own people.

The director and his deputy agreed that the CISIR had not functioned effectively in its past relationships with government entities that were important to the institute's growth and viability. They had not "played politics" with sufficient adroitness, although one director, in their view, had concentrated entirely too much on this aspect to the detriment of his management effectiveness. Examples were given of other government-sponsored institutions that had fared appreciably better because they had been more alert to the political dynamics and had been less self-effacing in presenting their qualifications and needs to the various entities influencing their budgets.

Concerning the lack of scientific manpower in the country, both men felt that this problem was of first-rank priority and indicated that foreign assistance for this purpose had always been welcome and would be even more so in the immediate future. Also of great importance would be the provision by the government of more modern laboratory and pilot plant equipment.

It was felt that the institute had lost considerable momentum and freedom as a consequence of its takeover by the government in 1962 and that any subsequent inadequate performance of the CISIR was largely the result of budget deficiencies and changing government policies.

Recent governmental decisions had resulted in the establishment of the Industrial Development Board and the National Engineering and Research Center, both of which had scopes of activity that significantly overlapped those of the CISIR. Some CISIR staff members felt that these were

redundant and posed a threat to the CISIR's continued activity. In commenting on this situation, Director Wijeratne wrote in 1979: "The areas of activity of the three organizations therefore are fairly clearly defined even if not strictly demarcated. There is clear understanding within the organization of their objectives and functions. It is impossible, however, to prevent any of these organizations from occasionally indulging in working on ideas which may strictly speaking lie within the province of another organization, particularly when the subject is of topical interest. Such cases however are few and not of significance."

It is not generally appreciated that applied research...is a profession in itself, to be distinguished from the more academic fundamental scientific studies. We must emphasize that neither money alone nor the mere creation of scientific councils and organizations will solve any research problems, either now or in the future. The entire success of this program, with its intangible training aspects, will depend upon the most skillful selection of personnel. Next to this in importance is the freedom of the research men to pursue their investigations to a practical conclusion without interference; it has been wisely said that 'the main job of a research director is to protect the research men from those who want to direct them.

Source: The Economic Development of Ceylon. International Bank for Reconstruction and Development, 1952.

Scientists and technologists have always delivered the goods if there is a national recognition of the concept that the development of science and technology is essential for socioeconomic progress. The Government of Sri Lanka has accepted that our goals of economic and social development can only be achieved through the application of S&T, and will therefore do everything possible to encourage the development of a strong scientific and technological capability within the country.

Source: Sri Lanka National Paper - United Nations Conference on Science and Technology for Development - 1979.

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PERSONS INTERVIEWED

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Deputy Director General
Greater Colombo Economic Commission

Donald W. Kannangara
General Manager/Director
Development Finance Corporation of Ceylon

E. E. JeyaRaj
Deputy Director
CISIR

Mervyn Wijeratne
Director
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Dr. E. R. Jansz
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Dr. A. S. L. Tirimanne
Senior Research Officer
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Dr. Erma Lord
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Dr. Onil Perera
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Dr. W. Howard Wriggins
Ambassador of the United States
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John Ericcson
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L. J. Fernando
Additional Secretary
Ministry of Industry and Scientific Research
Colombo

Clark Billings
USAID
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Dr. P. M. Jayatissa
Research Officer
CISIR

4. Is the present management making the best decisions and efforts in view of the circumstances?
5. What could be recommended to the CISIR with regard to extending its contacts with the user community? What should be done in view of the recent decisions to permit foreign technology to enter the country with little restraint?
6. What approach might be taken in consideration of the staff compensation schedules? Should there be greater effort to generate outside income from sponsored projects?
7. What could be done to gain more experience for the staff in the realities of industrial operations? What formal training is indicated, if any?
8. What is the role of the industrial research institute in the appropriate technology concept, and how does the CISIR conform to this?