Administrative Staff College of India

ASCI OCCASIONAL PAPERS

STUDIES IN SCIENCE AND TECHNOLOGY
FOR INDIA'S DEVELOPMENT No. 1

SCIENCE IN INDIA

Administrative Staff College of India

ASCI OCCASIONAL PAPERS

JITENDRA SINGH
General Editor

I STUDIES IN SCIENCE AND TECHNOLOGY FOR INDIA'S DEVELOPMENT

No. 1 Science in India: Institution-Building and the Organizational System for Research and Development by Ward Morehouse

II STUDIES IN INDIAN ENTREPRENEURSHIP

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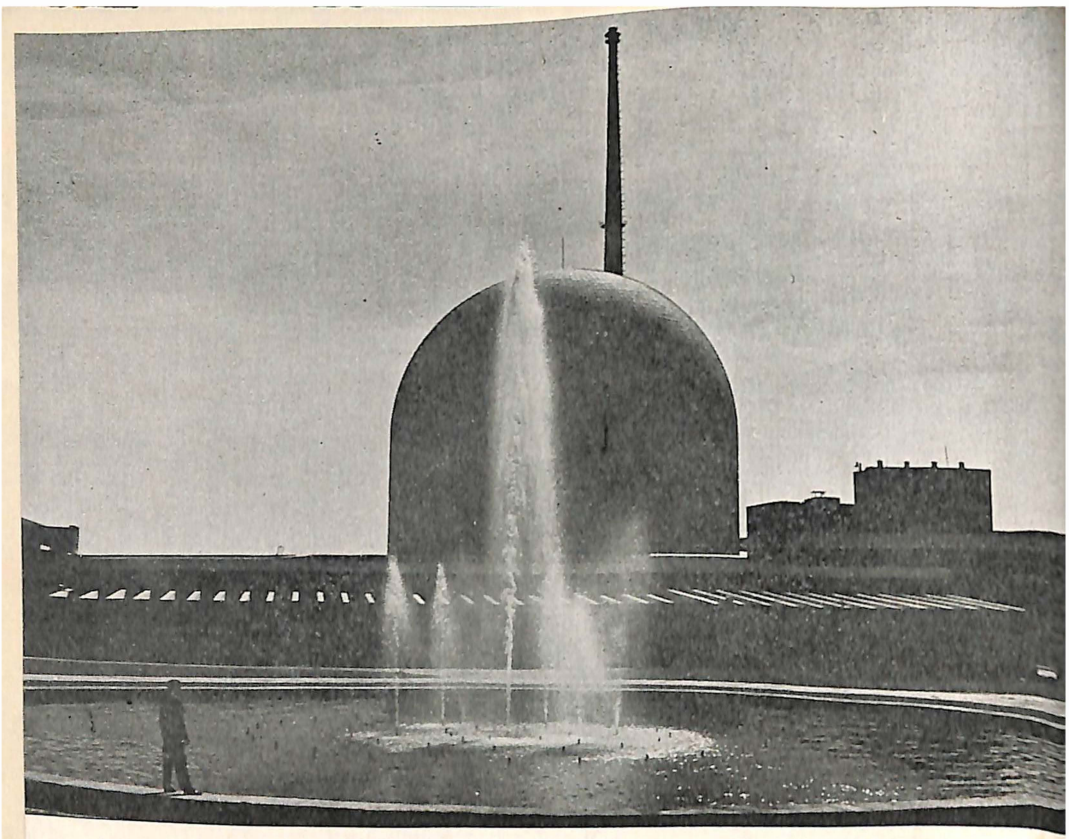
IV STUDIES IN THE MANAGEMENT OF FAMILY PLANNING PROGRAMMES



CIRUS Reactor, Bhabha Atomic Research Centre, Trombay

ASCI Occasional Papers

SCIENCE IN INDIA

Institution-Building and the Organizational System for Research & Development

Ward Morehouse

Published for the
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NOTE: *The expressions "lakh" and "crore" indicate* 100,000 *and* 10,000,000 *respectively.*

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Foreword

SINCE ITS establishment over 12 years ago, the Administrative Staff College of India has been concerned with the improvement of administration, whether in government or in industry, as a critical factor in advancing the economic and social development of the nation. This overriding concern with national development led to the organization by the Staff College of a Research Division in 1969. Through a varied programme of policy-oriented social science research, the Research Division is seeking to enlarge understanding of the processes of economic and social change through the conscious and deliberate use of innovation in organization policy and the application of new knowledge.

Although established only a few months ago, the Research Division is already embarked on several major investigations and is actively exploring other areas of possible interest. Among these is the Inter-Institutional Project on Indian Entrepreneurship, a three-year programme to analyse the characteristic modes and behaviour of Indian entrepreneurs; this project is being undertaken in collaboration with the Indian Institutes of Management at Ahmedabad and Calcutta, the Birla Institute of Technology and Science in Pilani, and Dartmouth College at Hanover, New Hampshire, in the United States. Other Research Division projects now in progress include studies of the decision-making process in a state education agency, the impact of computers in Indian industry, managerial appraisal in public sector undertakings, and administration of programmes of family planning.

Modern science and technology are important instruments of innovation, and it is natural that the Staff College Research Division should have as one of its major foci from the beginning a concern with government policy and problems of

organization and administration of research and development. The political leadership of independent India has long recognized the potential significance of modern science and technology in contributing to India's economic and social advance. Even prior to independence, plans were being developed on the initiative of Jawaharlal Nehru and others to shape the post-independence organization of India's scientific effort.

This publication is the first in the *Administrative Staff College Occasional Papers* on science and technology policy. It provides a framework for further analysis of India's research and development effort and a handbook on the organizational system of Indian science, with basic factual and statistical data on scientific work in the country.

The Administrative Staff College Science and Technology Programme is actively engaged in trying to provide more and better answers to some of the critical policy and management issues related to the utilization of science and technology for economic and social progress. Dr. Jitendra Singh, the senior member of the Staff College faculty, responsible for organizing the Research Division, is engaged in a detailed examination of the process of institution-building in relation to India's atomic energy programme. This will shed further light on the role of leadership and the other internal variable in the institution-building process, as well as the relative significance of different kinds of external linkages between a scientific organization and the society in which it exists.

External linkages, particularly social, between the scientific community and Indian society, as well as the internal environment of a cross section of scientific institutions, are being explored by G. S. Aurora, another member of the Research Division, in a series of studies in the sociology of Indian science. In this, he is collaborating with Professors John and Ruth Useem of Michigan State University and others in a cross-national survey of the attitudes and values of scientific communities in India, Indonesia, and the Philippines. And Ward Morehouse, Visiting Professor at the Staff College during the 1969-70 academic year, is undertaking studies of problems of measurement of scientific research and development and of efforts to bridge the "development gap" between the research

laboratory and industry through pilot plants and the work of National Research Development Corporation; these studies, oriented toward the policy implications of the problems being examined, should contribute to better understanding of economic and political linkages between scientific organizations and government and industry.

Other studies in the Staff College Science and Technology Programme also reflect a concern with the transference of technology, science policy problems, and their implications for policy making and more effective management of research and development. Thus, G. S. Aurora is engaged in a study of the transference of technology at the Central Mechanical Engineering Research Institute in Durgapur, while Jitendra Singh is examining organizational patterns and obstacles in the Council of Scientific and Industrial Research. In short, the Science and Technology programme is now well under way, and we anticipate its further development into an active and continuing centre for science and technology policy studies and administration of research and development.

In its various activities, the Administrative Staff College Science and Technology Programme is drawing upon the work of and seeking collaboration with others similarly concerned. The range of interest in studying science and technology policy questions is still small, given the magnitude of India's scientific effort and the potential importance of this effort to her future growth, but there are several centres of existing concern, some of which have undertaken considerable work in this field. Among these are the Scientific Research Division in the Planning Commission (which now serves as the secretariat for the Committee on Science and Technology to the Cabinet), the Research, Survey and Planning Division of the Council of Scientific and Industrial Research, the Programme Analysis Group in the Department of Atomic Energy, the Department of Social Sciences and Humanities at the Indian Institute of Technology, Delhi, the Science and Government Unit of the Indian Institute of Public Administration, and the Institute for Applied Manpower Research. Linkages are being maintained with these and other centres of interest in India, as well as those abroad such as the Science Policy Research Unit at the University of Sussex, the Policy Research Programme at the

University of Lund in Sweden, the Cross-Cultural Study of Scientific Communities at Michigan State University in the United States, the UNESCO Science Policy Division, the Organization for Economic Cooperation and Development (OECD), and the United Nations Research Institute for Social Development at Geneva.

The Administrative Staff College hopes, through its Science and Technology Programme and other activities, to continue to make significant contributions to India's national development. The possibilities which the application of modern science and technology offer to the solution of India's economic and social problems have nowhere been better expressed than in these words by the late Prime Minister Jawaharlal Nehru.

> I do not see any way out of our vicious circle of poverty except by utilizing the new sources of power which science has placed at our disposal.[1]

N. P. SEN
Principal
Administrative Staff
College of India

Bella Vista
Hyderabad
April, 1970

1. "The Tragic Paradox of Our Age", *New York Times Magazine*, September 7, 1958, p. 111.

Preface

THE OBJECTIVES of this publication are two-fold. The first is to suggest a way of looking at the organizational system of Indian science, to pose some hypotheses subject to subsequent verification, and to indicate some of the kinds of investigations which are needed to test these hypotheses.

The second objective is to bring together some of the basic data on the organization of Indian science and its growth since independence over two decades ago. As the magnitude of scientific endeavour in India has increased, the organizational complexity of this endeavour has also grown. Consequently, there is need for a "hand-book" which sets forth the main outlines and gives some of the essential details regarding research and development in India.

Several efforts have been made in the past along these general lines, although each has differed in a number of important ways from what is attempted here. With the scientific scene changing so rapidly, furthermore, any attempt of this character which is more than a year or two old is likely to be significantly out of date, at least with respect to quantitative data on personnel and expenditures. (Most of the data appearing here on budget and personnel for individual research institutes, for example, were collected in 1968 and 1969 by INSDOC and will certainly have changed by the time this publication is issued. In several cases, furthermore, the lists of institutions included in the tables are not complete.) But the past efforts to provide a synoptic view of Indian science have been of great assistance in preparing this version, and my indebtedness to them should be acknowledged.[1]

1. Among the various previous efforts to provide a synoptic view of Indian science, the following may be mentioned: (i) Council of Scientific and Industrial Research, *Science in India*, New Delhi: The Council,

The framework for further study presented in the first section of this publication, "Institution-Building and Indian Science", is preliminary and subject to further refinement as more evidence is accumulated. But in the meantime, several studies are going forward which will help to enlarge our understanding of different aspects of the institution-building process in Indian science. Those in which my colleagues at the Administrative Staff College and I are involved are mentioned in the Foreword..

A word needs to be said about the use of such terms as "science" and "scientists", technology" and "technologists" "research" and "development". Each of the words in certain contexts has a quite distinctive meaning in contrast to other related but different terms. Furthermore, a complex and not fully understood relationship exists between science and technology. It may well be that we are not very much farther along in defining with any uniformity the line of demarcation between research and development. I have chosen, therefore, to use the words "science" and "scientists" for the most part in their most inclusive sense, even covering certain kinds of activities or certain individuals that, by any strict definition, probably would not be considered as "science" or scientists" at all. Upon occasion, however, where the context required more specificity, I have used these terms in their more particular meanings. I think the context will make this clear. I defend this rather loose use of terminology both for stylistic convenience and because, as I read the debate on just what these forms of activity mean in relation to one another, I sense that there would probably be widespread agreement only on certain polarities but not on precisely where research

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1966. (ii) Government of India, Cabinet Secretariat, Committee on Science & Technology, *Report on Science and Technology, 1969,* Delhi: Manager of Publications, 1969, (iii) A. Rahman (in collaboration with an assistance of H. V. Ranga Rao, K. D. Sharma, and M. A. Qureshi), *Report on Financing of Scientific and Technological Research in Respect to India* (Draft), March 1969 (unpublished manuscript). (iv) Earnest C. Watson, *Organization of Scientific Activities in India,* (International Science Report No. 1), Washington: Office of International Science Activities, National Science Foundation, 1962. (v) T. S. Rajagopalan and R. Satyanarayana, *The Directory of Scientific Research Institutions in India, 1969,* Delhi: Indian National Scientific Documentation Centre, 1969.

becomes development, where a scientist becomes a technologist, or where science becomes technology. A similar observation can be made about phrases such as "basic" or "fundamental" or "pure" science on the one hand and "applied" science on the other.

This publication was first written as a chapter in the draft manuscript of a more extended study of government policy toward scientific research and development in India which I am now preparing for publication and which is tentatively entitled *Sarkar aur Vigyan: Problems of Government and Science in India.* A revised and expanded version was presented to the January, 1970, colloquium of the Administrative Staff College Research Division. This version has been extensively revised again in the form in which it appears here. I am indebted to more individuals than I have space to mention for comments and reactions made during this protracted process of creation, but I would be remiss if I were not to mention G. S. Aurora and Jitendra Singh, my colleagues at the Administrative Staff College, A. Rahman of the Council of Scientific and Industrial Research, A. N. Pandeya of the Indian Institute of Technology, Delhi, and Brijen Gupta of the University of Rochester, for their suggestions.

I want also to express my thanks to M. V. K. Sivamohan, Research Associate in the Science and Technology Programme for his assistance in preparing the tables and charts, to my wife, Cynthia T. Morehouse, for her help with bibliography, to my son, John T. Morehouse, for his assistance in proofreading, and Ramdas Bhatkal of Popular Prakashan for his role in arranging to bring this publication out promptly and in an attractive format. Needless to say responsibility for the contents is mine alone.

The more recent stages of preparing this manuscript were undertaken while on sabbatical leave from my post as Director of the Center for International Programs and Comparative Studies, State Education Department, University of the State of New York. During this period of leave, I have been provided with intellectual companionship, logistic support, and many other amenities by the Administrative Staff College. Critically needed research assistance was made available by the Educational Resources Center of the University of the State of

New York which I am serving as a special consultant in preparing source material such as this for use in seminars and other programmes conducted by the Center for American teachers and faculty members. And the first draft of the manuscript was prepared in 1967 when I was a Senior Specialist at the Institute for Advanced Projects of East West Center in Honolulu. To all of these institutions and organizations, I am most grateful for the support provided to me.

No one who has had the opportunity to explore to any significant degree the complex area of human activity contained within the organizational system of Indian science has any illusions about reaching hard and final answers which will withstand further and more intensive scrutiny as we broaden our all too limited knowledge about the role of science and technology in India's development. I am certainly under no such illusions regarding this effort which I offer in the hope that it will provoke others to come up with better ways of deepening our understanding of Indian science.

WARD MOREHOUSE

Administrative Staff College of India
Hyderabad
March, 1970

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Between pages 24 and 25

Central Food Technological Research Institute, Mysore

Headquarters of the Council of Scientific and Industrial Research New Delhi

Tata Institute of Fundamental Research, Bombay

Department of Zoology, Delhi University, Delhi

Library Building of the Indian Agricultural Research Institute, New Delhi

On the left, indigenous variety of wheat which has lodged; on the right, high-yielding new variety

Laboratory of the National Institute of Nutrition

Headquarters of the Indian Council of Medical Research, New Delhi

Hindustan Aeronautics Ltd., Bangalore, which is now manufacturing Indian designed fighter-bombers

Main Building of Indian Institute of Science, Bangalore

Headquarters of Indian National Science Academy, New Delhi

Hindustan Lever Research Centre, Bombay

Agricultural Research Institute, Andhra Pradesh

Central Secretariat Building, Government of India, New Delhi

I

Institution-Building and Indian Science - A Framework for Analysis

GOVERNING ELITES in India since independence have committed themselves, albeit in different ways and with varying degrees of intensity, to the achievement of two inter-related goals of "modernization"—nation-building and socio-economic progress. The achievement of these goals, whether in India or elsewhere, depends in considerable measure on the ability of the society's leadership to design and build a network of viable organizations which mobilize and develop the nation's physical and human resources. In other words, one of the most critical elements in achievement of national goals in a country like India is the process of institution-building.

Modern Science, National Goals and Institution-Building

Governing elites in India have also seen modern science and technology as crucial instruments in the achievement of the two goals of nation-building and socio-economic progress. No one perceived the significance of this instrumentality for independent India more clearly or more eloquently than the individual who dominated national political life for almost the first two decades of independence, Jawaharlal Nehru:

> It is science alone that can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people. Who indeed can afford to ignore science today? At

every turn we have to seek its aid. The future belongs to science and to those who make friends with science.[1]

On another occasion Nehru observed:

I do not see any way out of our vicious circle of poverty except by utilizing the new sources of power which science has placed at our disposal.[2]

If India's political leadership has attached this kind of significance to modern science and technology in the achievement of national goals and if the process of institution-building is one important way of achieving these goals, it is surely a worthwhile exercise to look at the growth of Indian science since independence within the context of the institution-building process. That is what this essay attempts to do.

After describing the variables in the institution-building process and setting for a model of the institution in relation to society, the essay goes on to explore organizational patterns in Indian science and some of the internal and external variables which determine how scientific organizations become "institutionalized". Finally, a series of hypotheses on the growth of the organizational system of Indian science is advanced as a basis for further investigation in this significant, but little understood, and highly complex dimension of contemporary Indian society.

It should be emphasized that this essay is intended to present a conceptual outline or framework for further study rather than a detailed application of this framework to Indian scientific organizations, a task requiring far more space than the modest dimensions of the present publication. The conceptual approach outlined in the paragraphs following has grown out of my efforts over the past several years to fashion a coherent and meaningful way of looking at the organizational complexities of Indian science. Further empirical studies are necessary to determine the utility and relevance of the hypotheses included

1. As quoted in the Nehru Commemoration Number, *Science Reporter*, July-August, 1964, Vol. I, Nos. 7-8, p. i.

2. "The Tragic Paradox of Our Age", *New York Times Magazine*, September 7, 1958, p. 111.

in this approach for understanding scientific endeavour in modern Indian society.

The Institution-Building Process

An institution is a social system which embodies a number of different interacting variables, among them leadership, policy, programme, resources, and internal structure. The institution also interacts with the environment in which it is placed through linkages of different kinds. These linkages exist with the social order as a whole and with the social, economic and political systems which make up society at large. Each of these systems has its own sets of interacting internal variables and its own linkages with other systems in society. To add to the complexity of the situation, these internal interactions and external linkages are constantly changing over any given period of time.[3]

What we have, then, is a three-dimensional matrix. The first dimension is the structure or the patterns of formal organization of Indian science. The second dimension is concerned with function or process, both internally within the organizational system of science and externally through linkages with other systems in society. And the third is the time dimension, since structure and function are constantly changing as they interact with one another over a period of time.

The first two of these dimensions can be outlined as a schematic model in the following manner.[4]

INSTITUTION	LINKAGES	SOCIETY
Internal variables—leadership policy, internal structure, programme, resoureces, etc.	Functional and normative.	Political system,-economic system, social order, cultural values.

3. Milton J. Esman and Hans C. Blaise, *Institution Building Research: The Guiding Concepts*, Pittsburgh Inter-University Research Program in Institution Building, Graduate School of Public and International Affairs, University of Pittsburgh, February, 1966, *passim*.

4. See Ward Morehouse, "Plato and the Sarkari Scientist: Government Administration and Scientific Research in India", *Journal of Administration*

The vital element which this diagram does not indicate is the process over time by which an organization, through the interaction of internal variables and external linkages with society, becomes "institutionalized". Following the conceptual approach of Esman, Blaise and other social scientists who have been working on the institution-building process, a fundamental distinction must be made between an organization and an institution. All institutions are organizations but not all organizations are institutions, if by institutions are meant "organizations which incorporate, foster and protect normative relationship and action patterns and perform functions and services which are valued in the environment".[5]

Institution-building can then be described as a process by which organizations become institutions. That a number of scientific organizations have been established in independent India is incontrovertible. Whether these organizations have yet become institutions is another question.

Institution-building, in the words of Esman and Blaise, "has been accomplished when it can be demonstrated that the organization embodies social and technological innovations, that at least certain relationships and action patterns incorporated in the organization are normative both within the organization and for other social units, and that support and complementarity in the environment have been attained".[6] Institutionality, they go on to observe, is a matter of degree.

---

staff College Association, March, 1970, p. 38. This model has been adapted from Esman and Blaise, *op cit.* The major difference between my "schematic outline" or model as given here and that used by Esman and Blaise is that I have made "Society" (and its major subsystems—economic, social, and political) the other major element (in addition to the institution itself) in the "institution-building universe" with linkages of different kinds providing the context for interaction between the institution and different aspects of the society of which it is a part. I have also tried to use what seemed to me to be more straightforward language in identifying the different kinds of linkages (e.g., "direct" and indirect" instead of "enabling", functional, "normative" and "diffused"). By contrast, Esman and Blaise consider linkages themselves to be the other major element in the model, placing more emphasis by implication on the interactions. These interactions they call "transactions", a term which I avoid because of its particular psychological connotation.

5. Esman and Blaise, *ibid.*, p. 1.

6. *Ibid.*, p. 5.

There is no way of stating in absolute terms at what point in time an organization becomes an institution. It may, however, be possible to identify trends through the analysis of certain criteria of "institutionalization".

Among these criteria is the organization's ability to survive. Thus far, all the major components of the post-independence organizational system of Indian science have survived, although the time span is a short one. Survival alone, of course, is not enough. It is always possible that the organization may survive only at the cost of giving up all or most of its innovative elements. This might be described as organizational hardening of the arteries. It is particularly important to scientific institutions engaged in creative work at the frontiers of knowledge, where "biological aging" of their scientific staffs is a constant preoccupation.

Another criterion of the "institutionality" of an organization is the extent to which it is viewed by its social environment as having "intrinsic" value. Among the ways of attempting to assess this quality is to look at factors such as organizational autonomy, where the record of scientific organizations in India is clearly mixed, and the ability of the organization to exert influence on its environment. This influence in turn can be assessed by the extent to which the organization influences decisions made in its functional area, whether directly applicable to it or not, and the extent to which the organization is able to enlarge its sphere of action in the broader social environment in which it exists. Once more the picture presented by Indian science over the past two decades is mixed.

A final criterion suggested by Esman and Blaise is whether the "specific relationship and action patterns embodied in the organization have become normative for other social units".[7] This involves efforts to measure the impact of innovations introduced by the organization being analysed and bring us to the troublesome problem of measurement of the results of research. For while considerable progress has been made in systematic analysis and measurement of the inputs for scientific research in recent years, precious little progress has been made on the other side of the equation in measuring output.[8]

7. *Ibid.*, p. 7.
8. " . . . as an increasing number of countries gain experience of regular

In short, while scientific organizations have been created in large numbers in India and an elaborate organizational system for scientific research has come up in a relatively short period of time, this system is by no means "institutionalized". In other words although formal organizational structures for Indian science have been established on a broad scale, the process of institution-building is still going on.

Organizational Patterns in Indian Science

Before turning to a consideration of some of the variables in the institution-building process as they pertain to Indian science, let us look briefly at organizational patterns and arrangements in Indian science. Chart No. 1 outlines the organization of scientific research and development in the central government, which accounts for over 85 per cent of the total estimated expenditure on research and development in the country as a whole (Rs. 119 out of Rs. 136 crores), according to the Cabinet Committee on Science and Technology.[9] The remaining sectors of scientific activity are state government-supported research institutions and industrial research and development units which are not reflected in this chart.

Another way of looking at the organization of scientific work in India is through such factors as relationship to other scientific organizations and to different elements in the "chain

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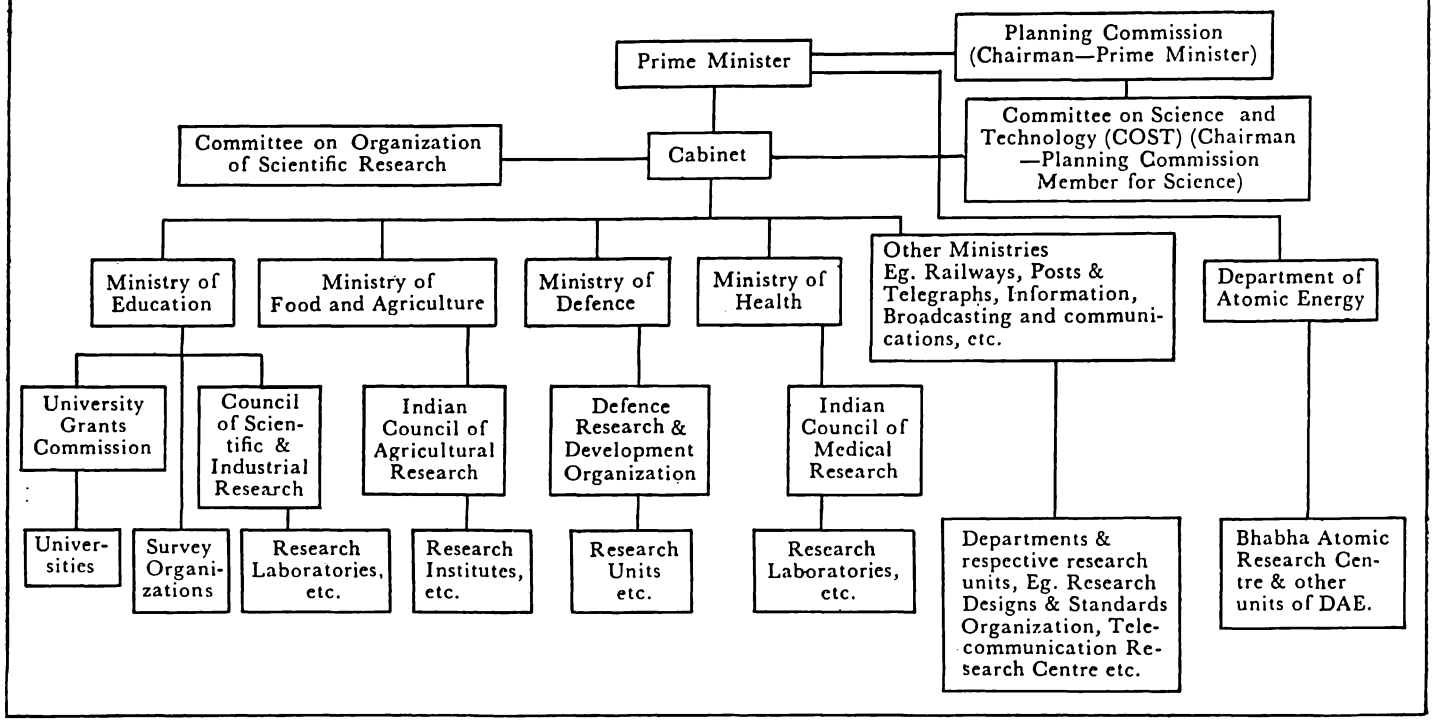
statistics of R & D manpower and expenditure . . . it will be possible to use a fairly wide range of moderately accurate and comparable statistics of R and D *inputs*. . . . The position with regard to measurement of R and D *outputs* is completely different. There is no *nationally* agreed system of output measurement, still less any international system. Nor it does seem likely that there will be any such system for sometime to come. At the most, it may be hoped that more systematic statistics might become possible in a decade or two." Christopher Freeman, *Measurement of Output of Research and Experimental Development: A Review Paper* (Paper Prepared for Working Group on Statistics on Science and Technology, Statistical Commission and Economic Commission for Europe, Conference for European Statisticians, Geneva, 2-6 June, 1969, Paris; United Nations Educational Scientific and Cultural Organization, April, 1969 (Com/Conf. 22/8), p. 5.

9. Government of India, Cabinet Secretary, Committee on Science and Technology, *Report on Science and Technology, 1969*, New Delhi: Manager of Publications, 1969, p. 59.

Chart No. 1: Organization of Scientific and Technical Research and Development in Government of India



of innovation" from discovery of new scientific knowledge to its utilization in the form of technology. Scientific organizations can be broadly differentiated into "task co-ordination bodies" and "task implementation bodies". The former are concerned with initiation, planning, and co-ordination of organizational units in which scientific work is actually undertaken. The latter are those organizational units in which research and development activities are performed.

The category of "scientific-technological inclusiveness" reflects the circumstance that within the same organizational framework several elements in the innovation chain are present. The best example of this is the Department of Atomic Energy which includes within its scope everything from fundamental research, applied research, and some of the critical raw materials such as minerals from which nuclear fuels are extracted, to some of the key outlets for utilization of its research and development such as atomic power plants. In short, the Department of Atomic Energy is concerned with different aspects of the "innovation chain" from discovery of new knowledge to actual utilization.

Also in the same category of "scientific-technological inclusiveness" are industrial enterprises with their own R and D units and "non-scientific" government departments with their own research organizations. These organizations are typically spread over a much smaller segment of the "innovation chain" than the Department of Atomic Energy, as they have little to do with the beginning of the chain, concentrating on the development and utilization phases. But research units in these organizations do have direct organizational ties with those units concerned with utilization of the results of their research and development work. It should not be assumed, however, that simply because the organizational links exist, the process of utilization is automatic. Indeed, the fact that organizational entities like industrial firms and government departments have primarily non-scientific-technological functions to fulfil often means that the research component is relegated to a relatively minor position in the total scheme of things.

The obvious alternative to "scientific-technological inclusiveness" is "scientific-technological exclusiveness". Most "task co-ordination" bodies in Indian science fall into this category.

This is simply another way of saying that they deal with only a small segment of the innovation chain (ordinarily applied research and development, although in some cases also related fundamental research, is carried on). Rarely are they directly involved in the utilization phase. These different categories have some practical implications in terms of linkages with society as we shall see in a moment.

At the task implementation level of organization, scientific organizations can be broadly divided into two categories again —those characterised by "scientific isolation" and those enjoying "scientific togetherness". These terms describe obviously contrasting organizational situations. On the one hand, some units of scientific activity are part of larger organizational entities, the primary purpose of which is something other than research and development. On the other hand, some scientific organizations are directly linked with other scientific organizations at the operational level or through the task co-ordination body of which they are a part. These differing organizational statuses also have implications for the institution-building process.

Table No. 1 is an outline of scientific organizations in India in terms of the categories described in the preceding paragraphs. The second section of this publication, "The Organizational System for Research and Development", provides considerable data and background material on the major sectors of scientific activity in the country.

TABLE NO. 1

Organizational Levels and Characteristics of Scientific and Technical Research and Development in India

A) TASK CO-ORDINATION BODY

Scientific-Technological "Inclusiveness"

Department of Atomic Energy (DAE)
Industrial enterprise with R and D unit
Non-scientific government department with research unit—e.g., Ministry of Railways

Scientific-Technological "Exclusiveness"

Council of Scientific and Industrial Research (CSIR)
Defence Research and Development Organization (DROD)
Indian Council of Agricultural Research (ICAR)
Indian Council of Medical Research (ICMR)
University Grants Commission (UGC)

B) TASK IMPLEMENTATION BODY

Scientific "Isolation"

University science departments
Industrial R and D units
Research units in non-scientific government departments—e.g., Telecommunications Research Centre of the Posts and Telegraphs Directorate, Research, Designs and Standards Organization of the Ministry of Railways, state agricultural research stations attached to state departments of agriculture.

Scientific "Togetherness"

Bhabha Atomic Research Centre and other research units and institutions supported by DAE
National laboratories and research institutes of CSIR
Defence research establishments of DRDO
Agricultural research institutes of ICAR
Medical research laboratories of ICMR

"Institutionalization" in Indian Science Organizations

The value of organizational tables and charts, aside from helping to describe a rather complex organizational system for scientific work which has grown up in India in the past two decades, lies in what they can tell us about the process of "institutionalization". This in turn should lead us to a better understanding of the ability of scientific organizations to contribute to the national goals of nation-building and socio-economic progress.

The only major scientific organization which combines scientific-technological "inclusiveness" and scientific "togetherness" is the Department of Atomic Energy. In the judgement of some observers, the Department of Atomic Energy, although certainly not without its difficulties and limitations as would be inevitable in any large complex organization, is the most effective major segment of scientific work in India today.[10] The organizational "inclusiveness" is more likely to lead to a higher degree of utilization of applied research and development while the "togetherness" is more likely to result in an internal environment conducive to effective scientific work. These two

10. Kurt Mendelssohn, "Science in India", *The Listener*, September 24 1964, pp. 457-459.

variables interact positively on one another. Thus, the more propitious internal environment leads to fundamental and applied scientific work of higher quality, and the direct organizational relationship between scientific activity and eventual utilization encourages more purposeful development of technology, which enhances the rate of utilization.

By contrast, one of the perplexing and continuing problems confronting scientific organizations in the category of scientific and technological "exclusiveness" is how to develop better links with those segments of society which represent potential users of the research and development activity conducted by organizations like Council of Scientific and Industrial Research and Indian Council of Agricultural Research. The whole question of CSIR linkages with industry is a subject of continuing discussion and concern. And while in more recent years agricultural research institutes, notably the Indian Agricultural Research Institute in Delhi, have fared somewhat better with the utilization of their research, in part at least because of the involvement of research scientists in "selling" their research to potential users through the National Demonstration Scheme, many of the same problems afflict agricultural research institutes which are dependent upon other organizational entities engaged in agricultural extension work to disseminate the results of their research and to assure its utilization.

For all of the difficulties in establishing links with potential users which policy-making or "task co-ordination" organizations like CSIR and ICAR have, their "task implementation bodies" —that is, the individual research institutes and laboratories— are linked together in a common organizational framework, the primary purpose of which is to engage in scientific research and technological development. By contrast, the scientifically isolated units are often submerged in an organizational environment which is directed primarily toward non-scientific purposes and in which scientific activity is regarded as a very minor and unimportant part of its total effort. Even the university science departments, while not totally isolated from one another, are part of institutions serving varied purposes. While simple causality should not be inferred as Indian universities confront many other problems in their linkages with society, science in

Indian universities is frequently labelled as one of the most neglected aspects of scientific endeavour in the country.[11]

The formal ties which are reflected in the organization chart for scientific activity in the Government of India create opportunities for certain kinds of potentially meaningful political linkages. Thus, the Department of Atomic Energy is the only major scientific organization tied directly through a ministerial portfolio to the political head of the national government, namely, the Prime Minister. The only other scientific organization with any kind of direct tie to the Prime Minister is the Council of Scientific and Industrial Research, of which the Prime Minister serves as President of the Governing Body.[12]

These kinds of organizational characteristics and arrangements do have a bearing on the external linkages of scientific organizations with society. The degree to which a scientific organization has access to the highest levels of political leadership in society can be a potent factor in its ability to command support for its work. Similarly, the degree to which it has control over or is able to influence directly utilization of the results of its research and development strengthens its economic linkages. By the same token the extent of "togetherness" or "isolation" may have a bearing upon social linkages; thus, university science departments, according to one survey, have become much more closely linked to linguistic and cultural regions in the country than any other segment of Indian science, except state-supported research institutes.[13]

But the internal variables also have an impact on these linkages. Without question the most important is the quality

11. Mendelssohn, *ibid.* See also B. R. Seshachar, "Science Teaching and Research in Indian Universities", in Ward Morehouse, ed., *Science and the Human Condition in India and Pakistan*, New York: Rockefeller University Press, 1968, pp. 33-57; Edward Shils, *The Intellectual Between Tradition and Modernity: The Indian Situation* (Comparative Studies in Society and History, Supplement No. 1), The Hague: Mouton, 1961.

12. While formal organizational ties create opportunities for certain relationships between scientific officials and political leaders, the significance of these relationships depends on the individuals involved. Thus, CSIR's experience has been variable, as noted subsequently in this essay.

13. Unpublished Survey of Geographical Origins of Scientists in Selected Universities and Research Laboratories in India by Brijen Gupta and Ward Morehouse, 1967.

of leadership. The relationship of Homi J. Bhabha, the founder and head of India's atomic energy programme until his death in a plane accident in 1966, with Jawaharlal Nehru was an important factor in the ability of the Department of Atomic Energy to attract support for its work. CSIR, by contrast, has had more variable leadership, but certainly its first Director-General, S. S. Bhatnagar, and to some degree also its third Director-General, Hussain Zaheer, also had effective relationships with the same level of political leadership, i.e., with Nehru as Prime Minister.

It is sometimes observed that the explanation for the development of India's atomic energy programme lies in the twin circumstances that Bhabha was Bhabha and Nehru was Nehru. While these circumstances were certainly relevant factors in the growth of the atomic energy programme, they constitute an oversimplified and insufficient explanation for a much more complex process.

It was not just Bhabha's relationship with Nehru which mattered. At least as important was Bhabha's capacity to attract scientific talent and to give this talent optimal conditions for growth within the organization, while simultaneously establishing an unusual degree of organizational autonomy in contrast to other scientific organizations in the country.

Bhabha did not, at the outset, have any special ties with Nehru; S. S. Bhatnagar, the then Director-General of the Council of Scientific and Industrial Research, was a key individual in bringing them together. Bhabha had crucial backing in the early stages from the House of Tata, notably through the establishment of the Tata Institute of Fundamental Research. Bhabha himself, furthermore, grew with the atomic energy programme. He learned how to build alliances with key elements in the various decision-making processes which affected the atomic energy programme. He also fought hard, especially in the early stages, for the autonomy which the Department of Atomic Energy enjoys today but which certainly did not come easily or naturally.[14]

14. I am indebted to my colleague, Jitendra Singh of the Administrative Staff College, for many helpful insights into the development of India's atomic energy programme and the role played by Bhabha in this programme.

Some Hypotheses about Institution-Building and Indian Science

Further analysis of all of these factors—organizational levels and characteristics, internal variables, and external linkages—will lead us to a more precise understanding of the nature and extent to which various elements in the organizational system of Indian science have become "institutionalized".

In considering this question, some hypotheses about the growth of Indian science in the two decades since independence and its prospects for further development in the years immediately ahead suggest themselves as the basis for further study. These are offered as hypotheses, subject to further verification as analyses of the institution-building process in Indian science are undertaken.

The organizational system of Indian science which has developed so rapidly in the past two decades has not become sufficiently institutionalized for modern science and technology to function as major factors in the achievement of the national goals of nation-building and socio-economic progress. "Institutionalization" is a process changing over time, rather than an absolute condition in a steady state, so that some scientific organizations are more "institutionalized" than others. But the fact remains that of the major tests of institutionalization, aside from mere organizational survival (not very meaningful in this context because the time span is so short), most scientific organizations have achieved relatively little autonomy, have limited influence on decisions related to their areas of scientific and technological concern, and have had relatively limited impact on important segments of society through innovations in the development of which they have played a major role (the most notable possible exception being agricultural technology).

There appears to be a positive correlation between scientific and technological "productivity" on the one hand and clear

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His forthcoming study on the process of institution-building in the Department of Atomic Energy will shed light on a highly significant but little examined aspect of the organizational growth of Indian science since independence..

and urgent national objectives on the other. One of the classic examples in the Indian situation is the development of optical glass, a material of considerable strategic importance, over a relatively short period of time by the Central Glass and Ceramic Research Institute in Calcutta. In a broader context, India's atomic energy programme may represent another case, for even the non-military character of India's work in atomic energy contributes not only to socio-economic progress (through generation of electric power, development of the electronics industry, and nuclear applications in agriculture and medicine) but also to the enhancement of national power (India is a "nuclear-capable" country in a military sense, even if she has not joined the "nuclear club"). The drought conditions in the mid-1960's and the sharp drop in food grain production may have had a similar impact on agricultural research, although it is too early to tell; certainly the introduction of changes in Indian agriculture through the use of modern technology has been greatly accelerated since then.

In the early stages of organizational growth of scientific research and development in India, the political linkages are more important than the social or economic linkages. Social and economic returns on scientific work, which are essential to the development of these linkages, take a long time to achieve. Somewhat in the manner of "infant industries" requiring tariff protection in their early stages of growth, so also do scientific organizations, particularly those which seek to command public resources of any magnitude, need "protection" by political leadership in the early stages in order to give time for the economic and social linkages to develop. By and large, this function was performed by Nehru as Prime Minister while he was alive in a general way for all kinds of scientific work in the country but more specifically for those two scientific organizations with which he was directly connected, the Council of Scientific and Industrial Research and the Department of Atomic Energy, particularly the latter. The picture is less clear since his death, although we are so close to this period that the perspective necessary to reach firm conclusions is hard to achieve.

Of the several internal variables affecting the "institutionalization" of scientific organizations, the one that matters most

is the quality of leadership, whether for the "task implementation body" or the "task co-ordination body". The research institutions and laboratories which have been most productive in a scientific and technological sense are almost invariably those which have had strong leadership for important periods of their organizational existence. The same appears to be the case with the major research councils. The Department of Atomic Energy again stands out, although there have been periods in which CSIR has also had energetic and effective leadership.

But the importance of leadership should not be allowed to obscure the equally important process of "institutionalization". While creative leadership can make a poor organization more effective, strong leadership in an organization well along on the process of "institutionalization" can do much better. And mediocre leadership in such an organizational setting may at least "break even", whereas the result might be considerably less productive without well established and effective organizational patterns.

When one adds a significant time dimension, however, the critical importance of "institutionalized" organizations becomes more apparent. If organizational patterns are well established internally and strong linkages have been developed externally, a scientific organization acquires a certain "self-generating" quality of its own and may survive a period of weak leadership without too much danger to the effectiveness of the organization. This is perhaps the most critical problem of all facing Indian science—how to attract and keep strong and creative leadership for long enough periods of time to assure organizational continuity and growth even during a period of less effective leadership or during a period when some of the organization's external linkages, particularly political, change adversely.

Possibilities for Further Investigation

To test and extend such hypotheses, a variety of studies of different aspects of the institution-building process in Indian science are required. We need, for example, a number of case studies of scientific organizations at the "task implementation"

and "task coordination" level in the different categories set forth in Table No. 1 on organization levels and characteristics of Indian science. These studies should look at both internal variables and external linkages in relation to "scientific effectiveness". If we want to understand better the process of "institutionalization", it is critically important that such case studies focus on the organization as a whole, attempting to analyse the interplay of internal variables and external linkages.[15]

We also need more investigations of the external linkages between the organizational system of Indian science and Indian society. Thus, we should know much more than we do about the social environment for scientific work in India, including organizational patterns and relationships within the "scientific community" and between that community and the rest of the society. What impact, for example, do region of origin, mother tongue, caste, and family occupational background have on the work of the individual scientist and the way in which he

15. The study of atomic energy programme now in progress by Jitendra Singh, will shed light on the institution-building process in Indian science. The work of Robert Anderson from the Department of Anthropology at the University of Chicago, who has been investigating the Tata Institute of Fundamental Research and other scientific institutions, will also be useful in this connection as well as in understanding the "social environment" for Indian science. The earlier work by Surajit Sinha on various scientific institutions in Calcutta, now about to be published through the India International Centre, should also be mentioned. Two useful studies already published on the Atomic Energy Commission and the Ahmedabad Textile Industry's Research Association are:

Kamla Chowdhry and Vikram Sarabhai, "Organization for Developmental Tasks: Atomic Energy Commission in India", *Indian Journal of Public Administration*, Vol. XIV, No. 1, p. 1-22.

Kamla Chowdhry, "Institution Building and Social Change: The Ahmedabad Textile Industry's Research Association", *Indian Journal of Public Administration*, Vol. XIV, No. 4, pp. 943-61.

The research work cited in this and succeeding notes is not intended to be a systematic and detailed review of the "state of the art" in studies of interaction of science, technology and society in India. For an earlier but now outdated set of papers on this general subject, see Ward Morehouse, *Understanding Science and Technology in India and Pakistan: Problems of Research in the Social Sciences and Humanities. (Occasional Publication No. 8)*. New York: Foreign Area Materials Center, University of the State of New York, State Education Department, 1967.

in turn interacts within a specific organization and the scientific community at large?[16]

In a similar fashion, the whole of process of utilization of the results of research needs to be studied intensively and extensively as a critical determinant in the economic and social linkages of Indian science with Indian society. The steps involved in "bridging the development gap" between the industrial research laboratory and industry need to be analysed. This will lead to consideration of a complex but little understood aspect of public policy in India—viz., government policy toward technology. Here both economic and political considerations are involved in the continuing competition between indigenous and foreign technology, in the relationship of public and private sectors, and in the relative roles to be played by small, medium and large-scale industry.[17]

If the hypothesis that political linkages are the most important external factors bearing upon development of Indian science in the early years of its exponential growth since independence, analysis of this dimension to the organizational system of Indian science assumes particular importance. Studies of political decision-making affecting scientific work and public policy toward science and technology need to be undertaken. We should try to enlarge our understanding of how political leadership perceives scientific activity and the pay-off to society from the investment of public resources in research and development. The changing character of the Indian political system with an "emerging mass political culture" replacing the "elite political culture", which played such a dominant role in the struggle for independence, is bound to have an impact on scientific work, the more so because

16. The Study now being initiated by G. S. Aurora on the social environment of Indian science at the Administrative Staff College will help to illuminate the whole dimension of "social linkages" between the organizational system of Indian science and society. Involving cooperation with Prof. John Useem of Michigan State University, in a cross-national survey of scientific communities in Indonesia and the Philippines as well as India, the study will also enable us to begin to make comparative statements about India's experience in relation to other countries.

17. A major investigation of the process of technology transfer and other aspects of the scientific instruments industry in India is now in progress by the Programme Analysis Group at the Department of Atomic

most scientific activity in India is governmentally supported.[18]

We should also be looking at the process of how power is acquired and used within the organizational system of Indian science. This is what Steven Dedjier has called "research politics", and it exists in every national scientific community of any consequence. The composition of key committees, the process of decision-making within scientific organizations, the cross-links and alliances among major scientific organizations domestically and internationally, all enter into the picture and require careful analysis.[19]

Sooner or later investigation of these kinds of problems will bring us to the perplexing issue of how to measure quantita-

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Energy, working in collaboration with the Science Policy Research Unit at the University of Sussex. A recent survey by the Operations Research Group of Sarabhai Enterprises on industrial research and development activity and a workshop on industrial research management organized jointly by the National Institute of Science of India and the U.S. National Academy of Sciences (Baroda, 2-8 March, 1970) have begun to open up this potentially significant aspect of scientific activity in India about which remarkably little is known. And I hope also that case studies of the National Research Development Corporation and pilot plant activity in industrial research laboratories in which I am now engaged will shed further light on problems in the utilisation of industrial research so crucial to the development of economic linkages for scientific organisations.

18. Several of the studies previously mentioned, such as Jitendra Singh's investigation of the atomic energy programme, will enlarge our understanding of political decision-making affecting science. My own monograph on government and Science in India now being revised for publication and tentatively titled *Sarkar aur Vigyan: Problems of Government and Science in India*, will also include some data and analysis on political linkages and decision-making in Indian science affairs. A joint survey of views of members of the Indian Parliament on social and economic development, including the role of science and technology, has been undertaken by Surinder Suri, Steven Dedji, R. Chandidas, and myself; the survey should, when completed, give some illumination to the perceptions which different segments of the political elite have of the role of science and technology in social and economic change. The contrasting "Political cultures" mentioned in this essay are from Myron Weiner, "India: Two Political Cultures", in Lucien W. Rye and Sidney Verba, eds., *Political Culture and Political Development*, Princeton: Princeton University Press, p. 199.

19. A study of patterns of committee membership and decision-making in scientific organizations in India is being undertaken by A. Rehman and myself.

tively scientific activity. No one has yet resolved this proposition and probably no one ever will because vital aspects of scientific work are qualitative rather than quantitative. Still the effort must be made to try to enlarge the range of scientific activity which can be measured with some reliability in quantitative terms. Only if we do so, will we be able to produce "objective" measures of the performance of individuals and organizations so crucial to determining the impact of internal variables and external linkages on their work.[20] Eventually, if we achieve some success in quantifying different aspects of scientific activity, we should be able to engage in multi-variate analysis of a statistically significant and rigorous character. But it must be confessed that at the present time we appear to be a long way from that halcyon state.

While these kinds of investigations are of great potential interest to students of modern society interested in learning more about the institution-building process and the role of science and scientific technology in socio-economic growth and political development, studies along these lines have far more than just academic significance. Indian society is investing substantially in support of scientific research and technological development. A complex organizational system for this activity has been created in the last 20 years, and a sizeable pool of highly trained professional manpower has been brought into being. All of this has been done in the expectation that modern science and technology would, in the words of the late Prime Minister Nehru, provide a "way out" for the pressing problems of poverty, disease, and overpopulation confronting India in the second half of the twentieth century. Careful and systematic studies, if the social sciences have any basis at all in labelling themselves as "sciences", should lead to more effective policies and procedures to enhance greatly the contribution

20. The Science and Technology Programme of the Administrative Staff College is cooperating with several research organizations and laboratories in experimenting with different techniques for measuring the results of research. For a Tentative statement of the basic methodology, see Ward Morehouse and M. V. K. Sivamohan, "The Gordian Knot of Science Policy: An Exercise in Measuring the Results of Resaarch," Hyderabd Administrative Staff College, preliminary Draft, 1970.

21. A discussion of some of the underlying questions and their implications for public policy in this field is given in Ward Morehouse, "The

of science and scientific technology to solving the problems now before the Indian society.[21]

Science and Social Change

In thinking about the potential role of science and scientific technology in India's future, and mankind more generally, we need to remind ourselves, however, that they constitute only one set of variables among many in the complex, interacting system of society. The critical interaction of science and social change has been well expressed in these words by Kalman Silvert:

> . . . Science is merely another manifestation of that web, in which some of the threads are nationalism, democracy, secularism, and industrialization that we call the modern state. The good brought with these aspects of modernization is also what has made them possible; the partial liberation of the human mind and temper. The bad that has accompanied them is the ever-present danger of their use to stifle freedom. We are saying, then, that freedom and modernist change are intellectual alchemy—their mingling dissolves the contradiction between ends and means. The pursuit of freedom demands its use; the practice of freedom is its purpose. Scientific change thus is related to social change as both are related to the practice of freedom as instrumentality and as goal.[22]

Role of Science and Technology in Development: A Terra Incognita of Public Policy" (Paper presented before the ninth All India Sociological Conference, Indian Institute of Technology, Delhi, November 22-25, 1969, to be published in the *International Development Review*). My colleague, Jitendra Singh, has also produced a provocative unpublished note on science and technology policy studies and their relationship to public policy formation.

22. Kelman Silvert, "Concluding Essay", in Silvert, editor, *The Social Reality of Scientific Myth: Science and Social Change*, New York: American Universities Field Staff, 1969, p. 234.

II

The Organizational System For Research and Development in India

THE RELEVANCE and utility of the institution-building process and the conceptual approach to organizational types and functions set forth in the preceding essay as a framework for analysis and understanding scientific activity in India can only be determined through the detailed application of this framework to individual scientific organizations. In the section which follows, a synoptic view of the organizational landscape of Indian science is presented. In addition to a brief historical account of the origin of the organizational system for research and development as it has grown up since independence, major aspects of each principal sector of scientific activity and some of the factual data required for a more detailed analysis are presented. With this material as general background, deeper interpretive studies based on further empirical research of different segments of the organizational system of Indian science can be undertaken to determine the degree to which the process of "institutionalization" has occurred and for what reasons. A series of such studies would provide a solid foundation for framing public policies designed to maximize the contributions of modern science and technology to India's development.

Pre-Independence Foundations for the Organization of Indian Science

Before turning to an examination of the major scientific organizations in India, let us look briefly at the immediate antecedents of post-independence growth of science in the

country. Two important developments occurred during the period beginning with the Second World War which laid the groundwork for post-independence patterns of organization of Indian science. The first of these was a visit to India in late 1943 and early 1944 by Professor A. V. Hill. He was deputed by the Royal Society, where he held a research professorship, in words of the letter from the Secretary of State for India to the President of the Royal Society requesting his release for this purpose, to "see as much as possible of India's scientific, technical, and research work" and discuss "the organization of scientific and industrial research as part of the Indian post-war reconstruction plan".[1] Professor Hill, although a physiologist by scientific discipline, ranged widely over virtually all the aspects of the Indian scientific scene—including medical, agricultural, and industrial research, the government survey departments, the position of science in Indian universities, and a number of other topics.

Professor Hill, in his report, identified a variety of problems confronting research in India—problems, it would appear, of an unusually persistent character since most of them are re-emphasized in subsequent reports of reviewing committees of the major research councils, journalistic analyses of the Indian scientific scene, and other accounts by individuals within and outside the scientific community in India down to the present day. He noted the sense of intellectual isolation of scientists in India (doubtless intensified by the difficulties of personal mobility during the war years), the lack of interest in research on the part of industry in India, and the widespread neglect of research in the science departments of Indian universities. In the biological sciences, for example, he observed that "the university departments are nearly always small, ill-equipped, and under-staffed".[2] He likewise found the pay and status of scientific workers under the government much too inadequate, notwithstanding the limited resources of a country like India.

Perhaps most significant in Professor Hill's report is his recommendation for what he called a "central organization for scientific research", which turns out to be not quite as central

1. A. V. Hill, *Scientific Research in India*, London: Royal Society, 1945, p. 6.
2. Ibid., p. 52.

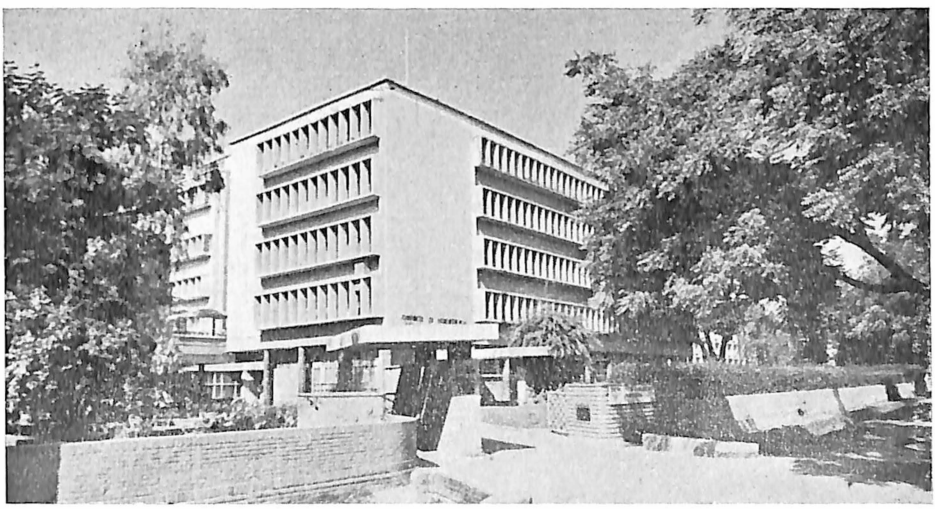
as its name would imply. What he rather suggested is a series of research boards in such fields as medicine, agriculture, industrial research, and other fields—a total of six, each of which would have its own executive officer who would be styled the director of medical research, or whatever subject was of concern to the research board in question. He proposed that the activities of these various boards be co-ordinated by a Scientific Consultative Committee which would advise the Member for Planning and Development of the Viceroy's Executive Council.

Professor Hill also proposed more autonomy for research institutions by urging that they be separated from the "user department" of government and in a sense from the whole process of utilization of the results of research of what is usually subsumed under the label of "development". This function would remain the responsibility of the particular government department or agency concerned. But he recognized the need for some co-ordination between research and its utilization and therefore suggested that each "user" department establish a development or improvement council (for example, the Agricultural Improvement Council under the Ministry of Agriculture) and the Member of the Viceroy's Executive Council for National Planning and Development should have, as a counterpart to the Scientific Consultative Committee, a Development Consultative Council which would include representatives from the various departments interested and officers of the development or improvement councils attached to the different departments.

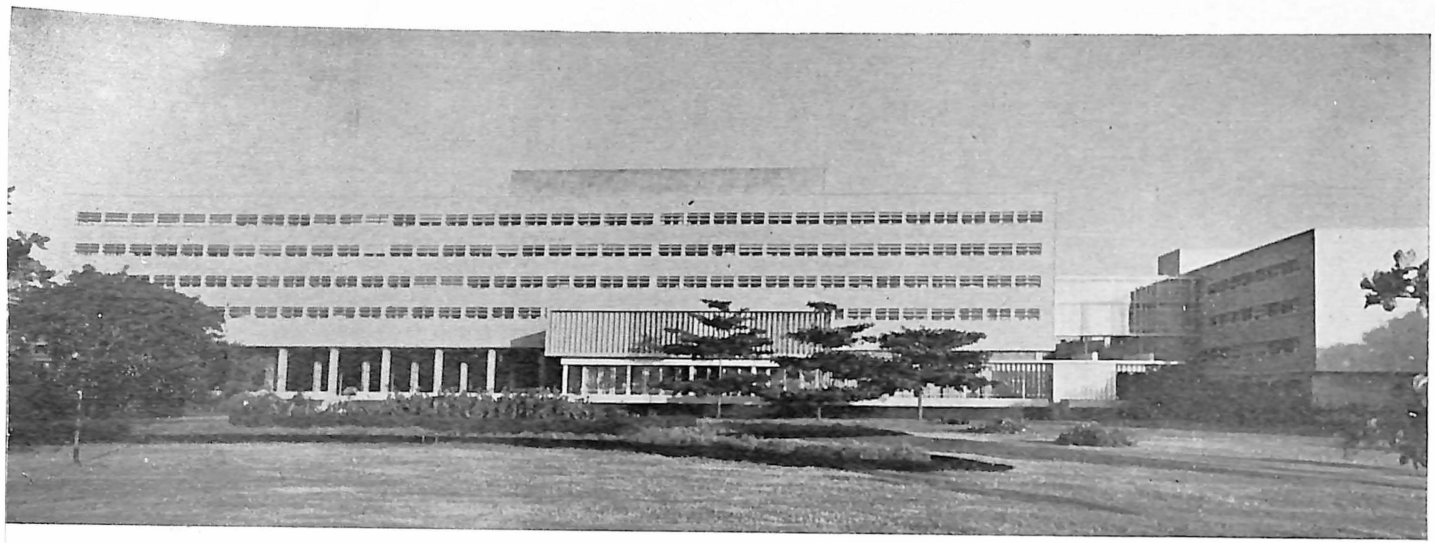
It is quite natural that Professor Hill should draw upon the British experience in organizing scientific research in his proposals for the post-war development of science in India. While he was not unmindful of the important differences between India and Great Britain, what he finally proposed for a central pattern of organization of research—and many of his other recommendations as well—were drawn directly from the British experience. The applicability of British (or any other foreign) patterns of scientific organization to Indian conditions is, needless to say, a moot point.

More or less simultaneously with the mission of Professor Hill to India was the appointment of an industrial research planning committee by the governing body of the recently

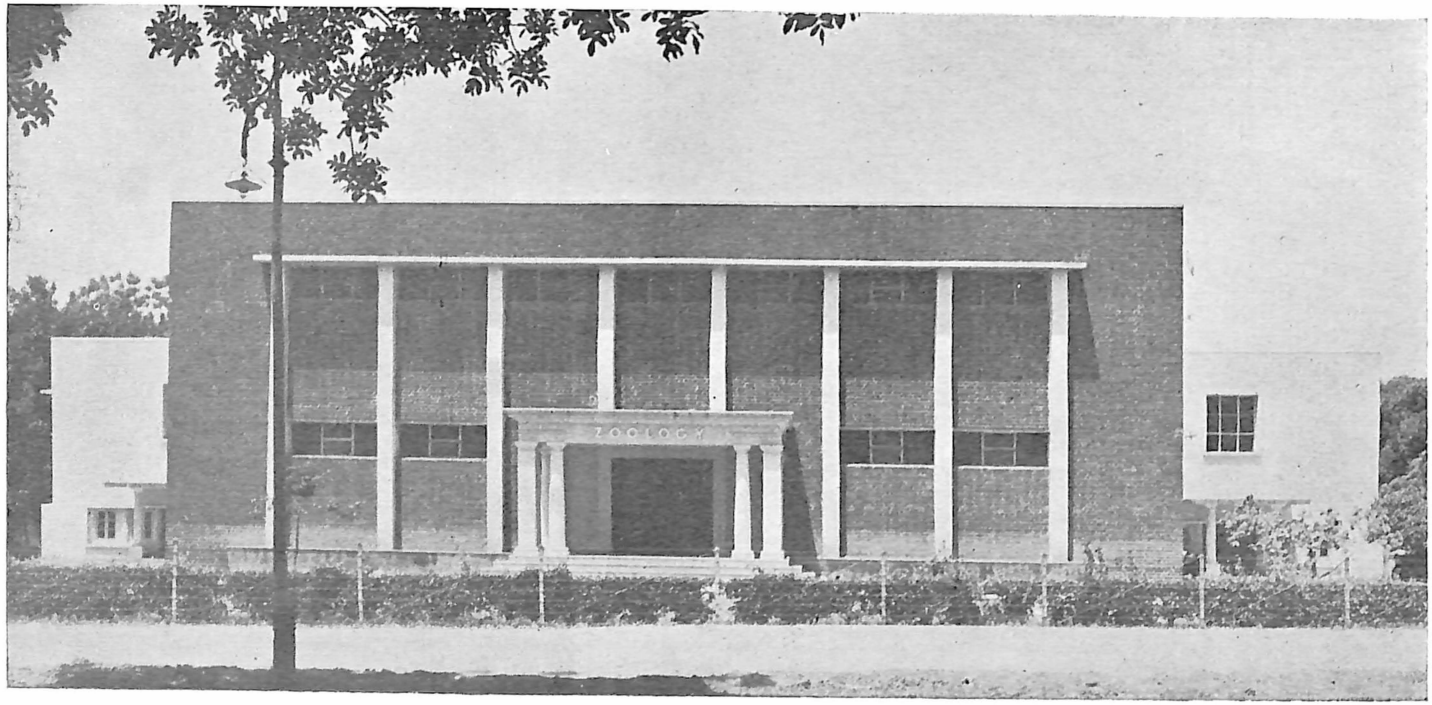
Central Food Technological Research Institute, Mysore



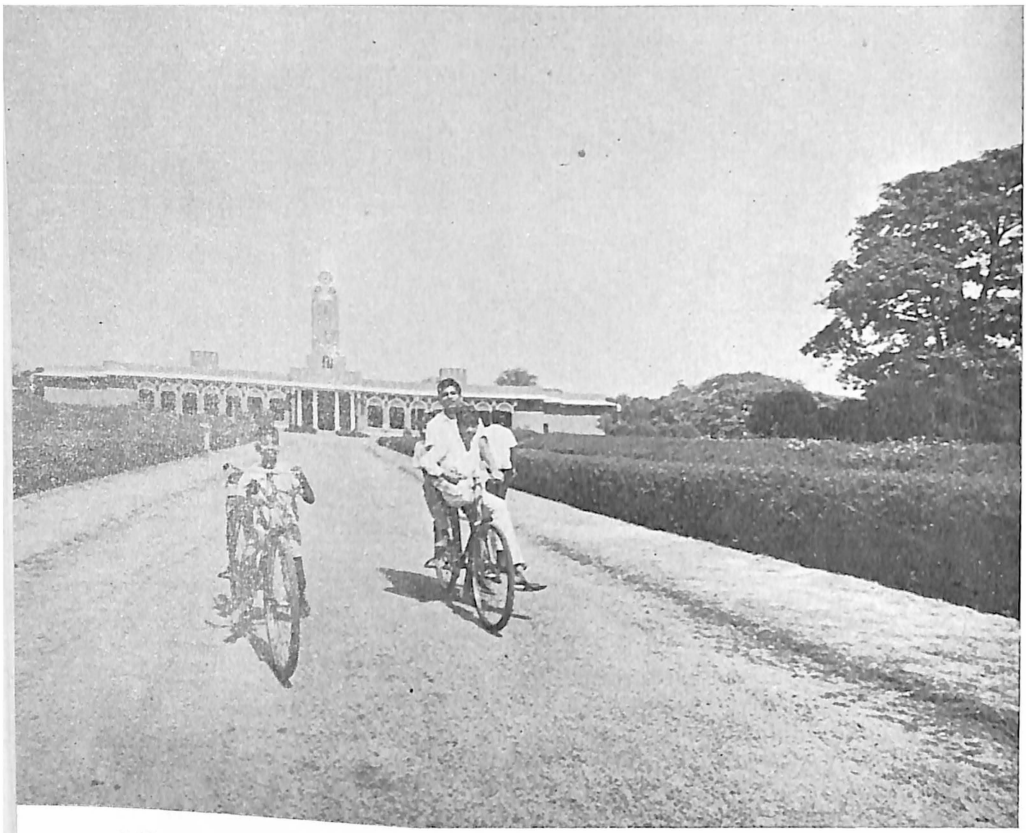
Headquarters of the Council of Scientific and Industrial Research, New Delhi



Tata Institute of Fundamental Research, Bombay

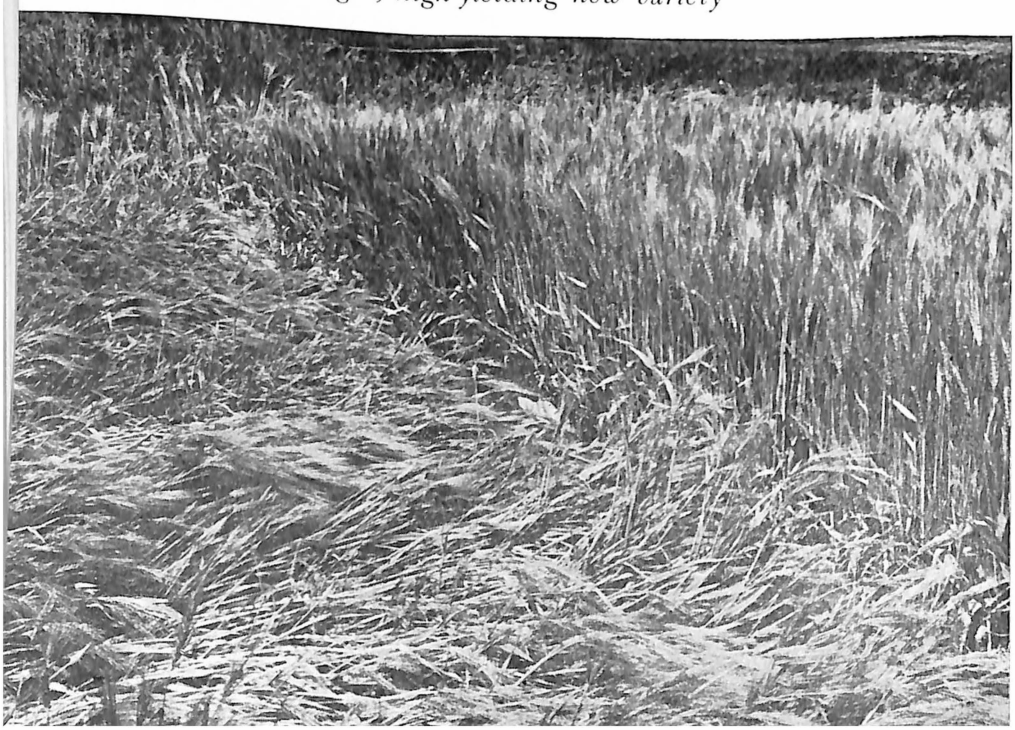


Department of Zoology, Delhi University, Delhi



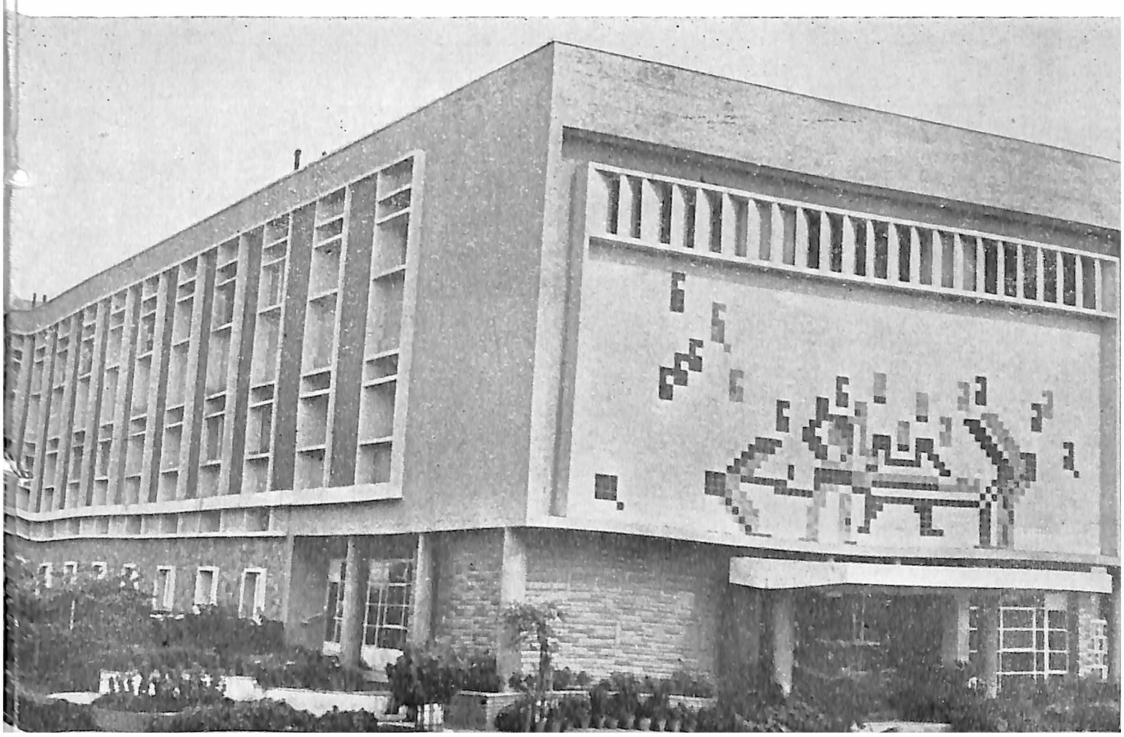
Library Building of the Indian Agricultural Research Institute, New Delhi

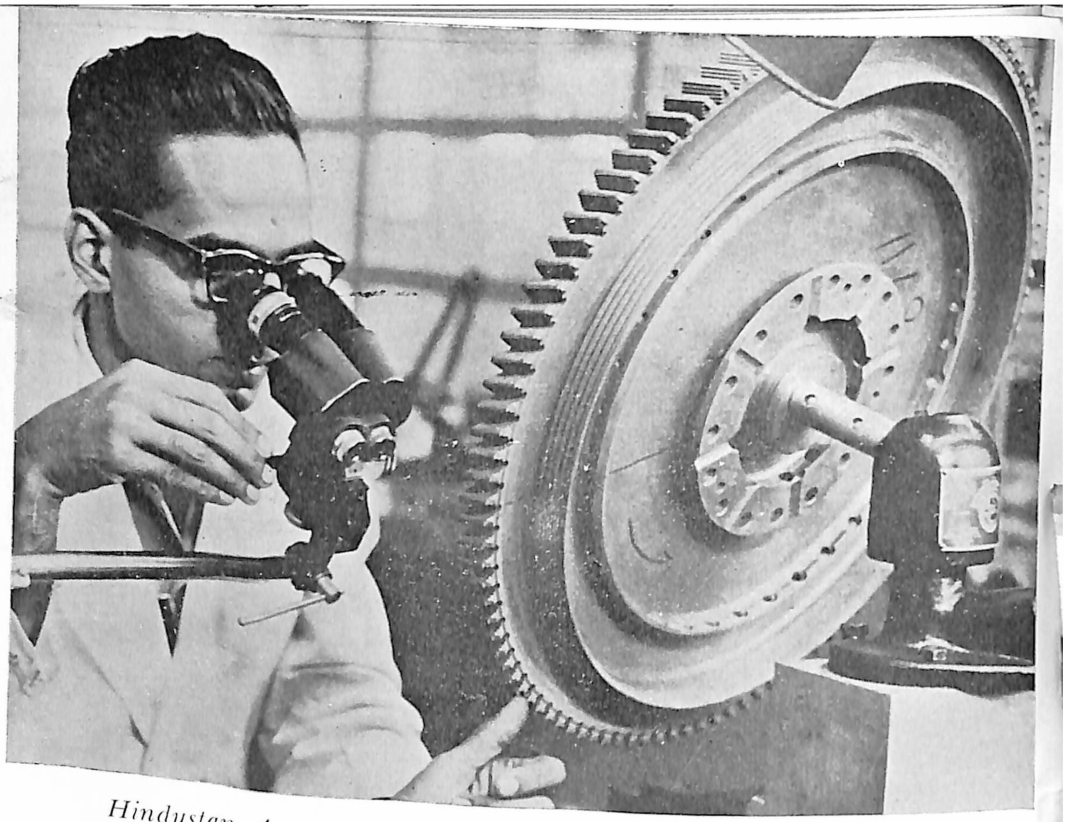
On the left, indigenous variety of wheat which has lodged; on the right, high-yielding new variety



Laboratory of the National Institute of Nutrition

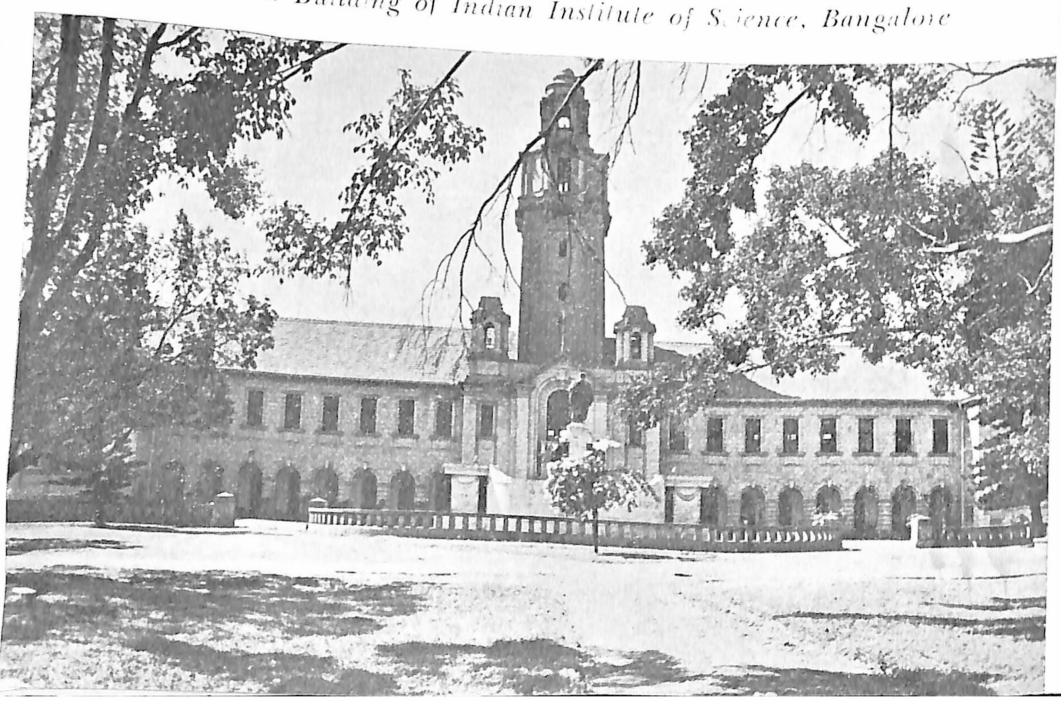
Headquarters of the Indian Council of Medical Research, New Delhi

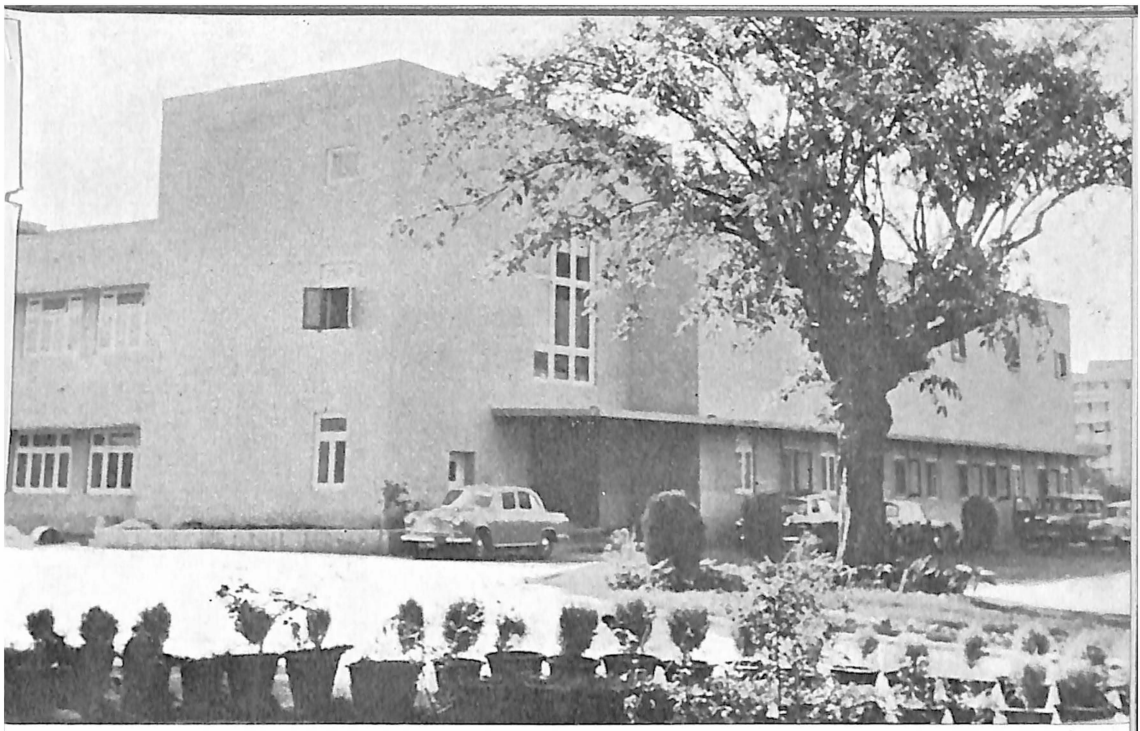




Hindustan Aeronautics Ltd., Bangalore, which is now manufacturing Indian designed fighter bombers
(COURTESY: *Ministry of Defence, Government of India*)

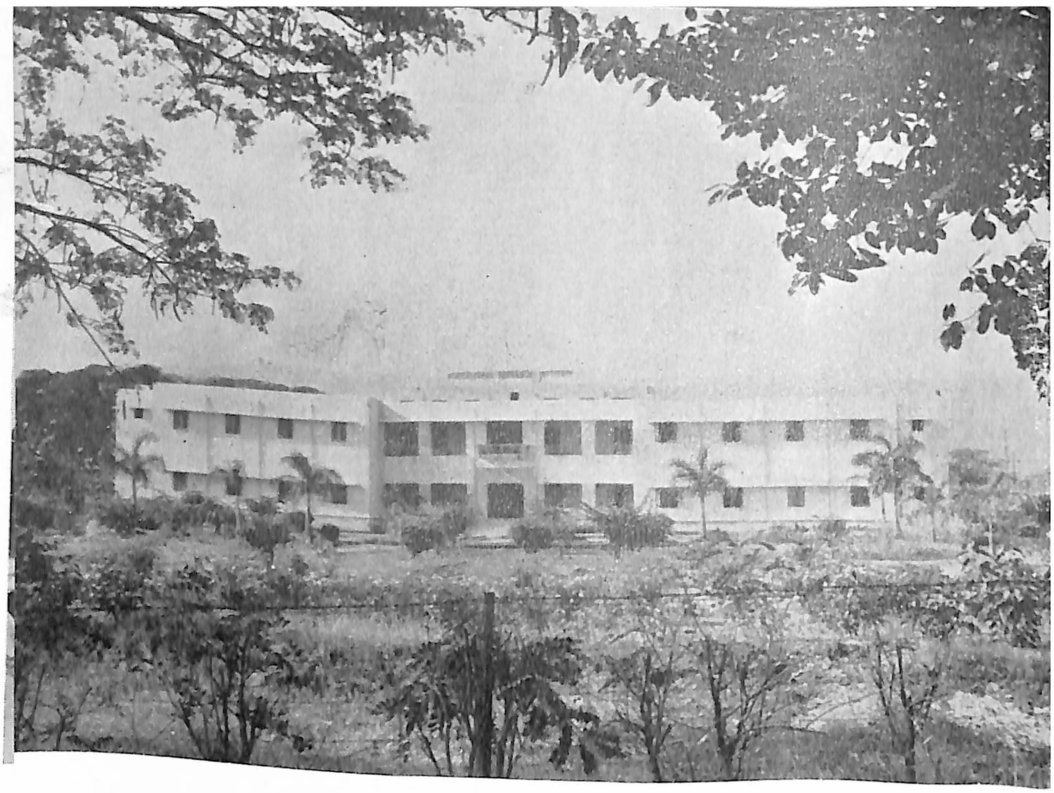
Main Building of Indian Institute of Science, Bangalore





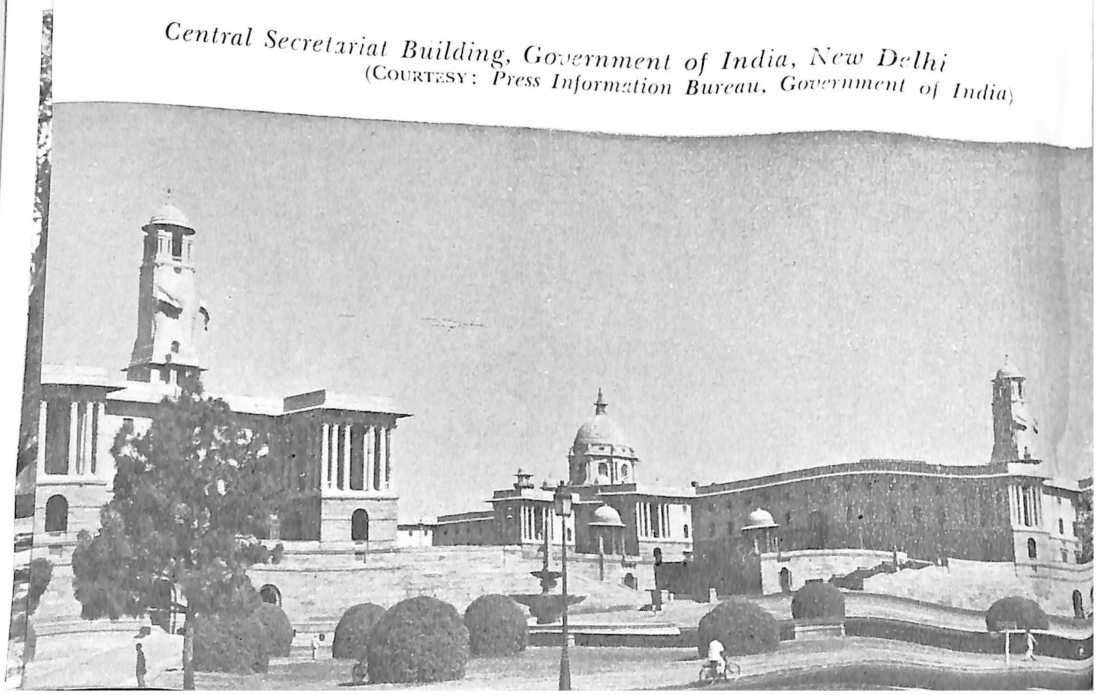
Headquarters of Indian National Science Academy, New Delhi

Hindustan Lever Research Centre, Bombay



Agricultural Research Institute, Andhra Pradesh

Central Secretariat Building, Government of India, New Delhi
(COURTESY: *Press Information Bureau, Government of India*)



established Council of Scientific and Industrial Research. This committee, often known as the Shanmukham Chetty Committee after its Chairman, R. K. Shanmukham Chetty, included several leading Indian industrialists and scientists. Among the leading members of the scientific community were J. C. Ghosh, then Director of the Indian Institute of Science at Bangalore, and S. S. Bhatnagar, the first Director of the Council of Scientific and Industrial Research (CSIR). The terms of reference of the committee included surveying existing scientific and industrial research in India in the universities, research institutions and laboratories attached to industrial and other concerns and developing a scheme of co-ordinated expansion of research activity by private firms, research institutions in the states, and other research establishments.[3]

The Shanmukham Chetty Committee thus had a somewhat narrower scope for its concerns than Professor Hill, although it likewise identified many of the same persisting problems confronting the scientific community in India—intellectual isolation, lack of interest in research in industry, inadequate emphasis on research in universities, unsatisfactory emoluments and other conditions of service for scientists in India, and so on. Being particularly concerned with industrial research, the committee deliberated at some length the underlying proposition of whether research should follow or precede the development of specific industries, professing to take a middle course.

The committee's recommendations included the establishment of two national laboratories (the National Chemical Laboratory and the National Physical Laboratory), as well as nine "specialized" institutes in such fields as food technology, metallurgy, fuel, leather, and glass research. (Of these nine, seven have in fact since been established.) In addition, the committee proposed a major effort at strengthening research in the universities through a programme of grants-in-aid and a series of scholarships for training research personnel both in India and abroad. And like Professor Hill, whose report was available to members of the committee before their report was released, the Shanmukham Chetty Committee gave considerable atten-

3. Council of Scientific and Industrial Research, *Report of the Industrial Research Planning Committee*, (Chairman, Sir R. K. Shanmukham Chetty). New Delhi: The Council, February, 1945, pp i-ii.

tion to the overall pattern of organization of research activities within the Government of India.[4]

The committee proposed, instead of a series of research boards in different fields as contemplated by Professor Hill, a National Research Council, functioning under the same Member for Planning and Development of the Viceroy's Executive Council who would be responsible for the research boards under the Hill proposal. The idea of a National Research Council did not originate with the committee but was first discussed at a symposium organized by the National Institute of Sciences of India in Calcutta in September, 1943, and further discussed at a second symposium held in Delhi at the end of December, 1943. The National Research Council would have a substantial membership of 60 individuals drawn from universities, industry, and trade unions and include nominees of the government. Because of its unwieldy size, it would have an executive arm of three full-time members, entitled the Research Board.

While the committee was not entirely explicit about the boundaries of concern to the National Research Council, its primary concern, among the several fields of applied research, apparently would have been in industrial research, along with basic research in various fields in the universities. There was no suggestion that it should encompass other applied fields like medicine and agriculture, which already had research councils or organizations in existence, and indeed it was suggested that for the most part existing research institutes such as the cotton and jute technological laboratories and the institutes of sugar technology and lac should not be brought under the administrative control of the National Research Council. The committee took a somewhat ambiguous position with respect to research activities of government departments and ministries, suggesting at least in the case of the railways that research problems might well be referred by the railways to proposed research institutes to be set up under the National Research Council like the Central Fuel Research Institute or the National Metallurgical Laboratory. In short, the National Research Council as proposed by the committee was to have been concerned with a series of laboratories and research insti-

4 *Ibid.*, pp. 29, 71-80.

tutes established directly under its auspices, as well as to provide special support to the universities for scientific research and for the training of research personnel—not too dissimilar from the range of functions now being performed by the Council of Scientific and Industrial Research.

The committee was less than unanimous in certain of its findings, and the reservations by individual members were in some cases spirited. One of the most searching dissents is that of Lt. Col. S. S. Sokhey of the Indian Medical Service, then director of the Haffkine Institute in Bombay, one of the oldest research institutes in India established in 1896 by the Government of India to combat the plague. While Dr. Sokhey suggested that since "India is a very large country, almost a continent, and because of large distances involved, single centralized laboratories may not suit the needs of the country" and urged that "the tendency to slavishly imitate the English practice in these matters . . . be curbed", his most telling complaint concerned the failure of the committee to establish priorities. He insisted that the "men required to man the laboratories must be found first, and they should have the greatest possible say in the matter of planning buildings and selecting equipment" and that any action in establishing research institutes must be "guided by the inescapable fact that we haven't got a sufficient number of able scientists".[5]

The differences between these two reports are not as great as their similarities and, coupled with the demonstrated interest of at least a segment of the political leadership in the nationalist movement in promoting modern science and technology, they helped to set the stage, with the end of the Second World War and the advent of the Indian independence, for active cultivation of the country's scientific capabilities.

Growth of Modern Science and Technology Since Independence

While the basic patterns of much of the organizational system of Indian science were established prior to independence, it was not until achievement of independence that the truly exponential growth of modern science and technology began.

5. *Ibid.*, pp. 80-84.

Statistical data, particularly on the first years immediately after independence, are not readily available or entirely comparable with later figures. It is, none the less, clear that the growth has been very substantial in two decades since independence, as the accompanying tables on expenditure for research and development and scientific personnel reveal.

Thus, expenditure by the central government on research and development has increased about 25 times between 1948-49 and 1968-69 (Table No. 2). In the past decade, the "research ratio" (percentage of gross national product used for research and development—Table No. 3) has doubled, while R and D personnel have more than tripled (Table No. 4). The total stock of scientific and technical personnel has also virtually tripled and now numbers approximately one million university graduates in the natural sciences, engineering, medicine, and agricultural sciences (Table No. 5), and the out-turn of scientific and technical personnel from the universities has likewise grown dramatically (Table No. 6).

Everything is relative, of course, and it may be useful to compare India's position in relation to other countries in the world, even though all such comparisons are risky because of lack of uniformity in the definitions used for different categories of research and development expenditure and personnel. In Table No. 7 are given figures for the mid-1960's. These figures indicate that while India's expenditure on research and development in relation to gross national product is small in comparison with more industrialized countries, the magnitude of personnel engaged in R and D activity is considerable, placing India on par with France and West Germany.[6]

TABLE No. 2

Estimated Expenditures on Scientific and Technical Research and Development in India

	1948-49	1952-53	1955-56	1958-59	1965-66	1968-69	1969-70
				Rs. in crores			
Central Government	3.70	8.38	16.61	26.05	74.89	105.74	118.99
State Governments[1]	N.A.	N.C.	N.C.	1.00	3.51	6.90	8.60
Private Sector[2]	N.A.	N.A.	N.A.	0.15	2.43	7.07	8.13
Total	3.70	12.19	20.48	27.20	80.83	119.71	135.72

Notes:

1. As far as the State Government sector is concerned, no reliable data on R & D expenditure is available. In the 103rd Report of the Estimates Committee on the Ministry of Education (1965-66), Rs. 1.73 crores, Rs. 1.93 crores and Rs. 2.25 crores have been indicated as R & D expenditure for 1961-62, 1962-63 and 1963-64 in this sector. Expansion during this period on an average is about 15 per cent. However, the expenditure for the years 1965-66, 1968-69 and 1969-70 has been projected at the rate of 25 per cent per year which can reasonably be the average maximum attainable. The corresponding figure for 1958-59 has been worked out at the rate of 15 per cent expansion.

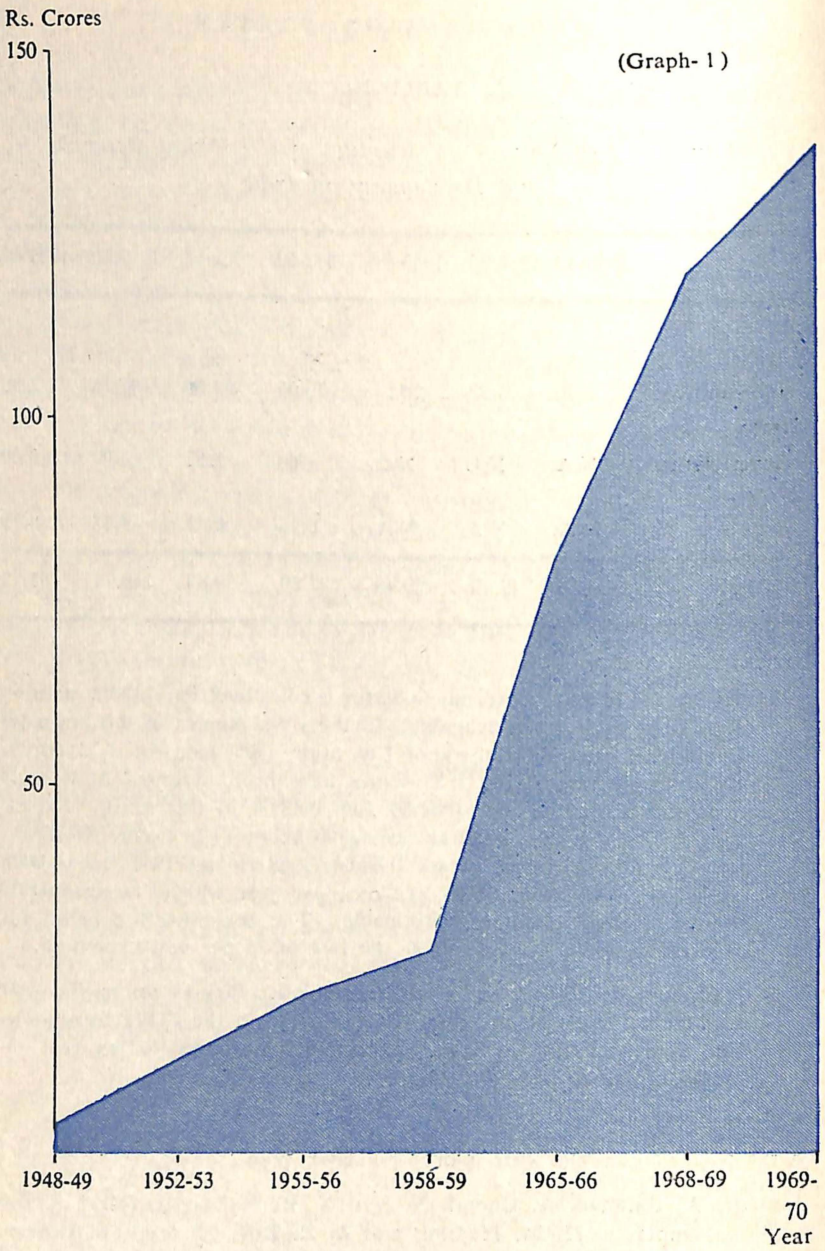
2. Data for the private sector are incomplete. Figures up to the year 1968-69 are based on the data so far received in the COST Secretariat. The figure for 1969-70 has been projected, assuming 15 per cent increase over that for 1968-69.

N.A. = Not available.

N.C. Not comparable with figures for later years.

Source: A. Rahman, A. Ghosal, N. Sen, N. R. Rajagopal, (Mrs.) S. Das Gupta, S. H. M. Husaini, and A. K. Roy, "A Study of Government Expenditure on Scientific Research", *Journal of Scientific and Industrial Research*, 1963 (Vol. 22, No. 12) for 1948-49 to 1955-56 figures; Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology, 1969*, New Delhi: Government of India Press, 1969, for 1958-59 to 1969-70 figures.

(Graph- 1)

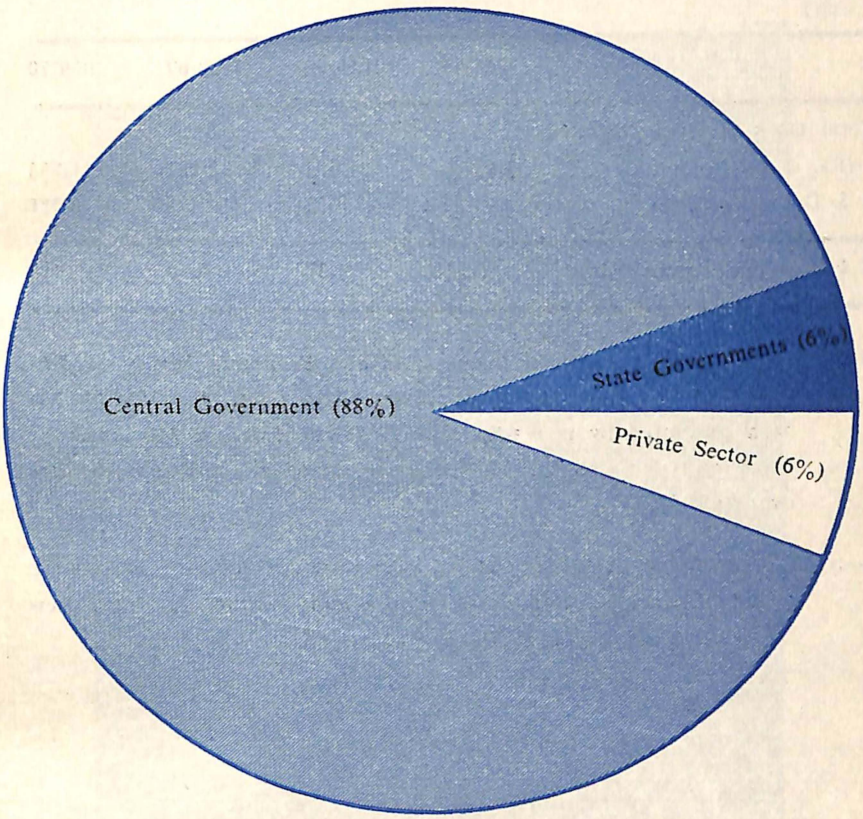


Growth of Expenditures on

Research and Development in India

(Based on Table No. 2)

(Graph- 2)



Central, State and Private Sector
Expenditures on Research
and Development in India
1969-70
(Based on Table No. 2)

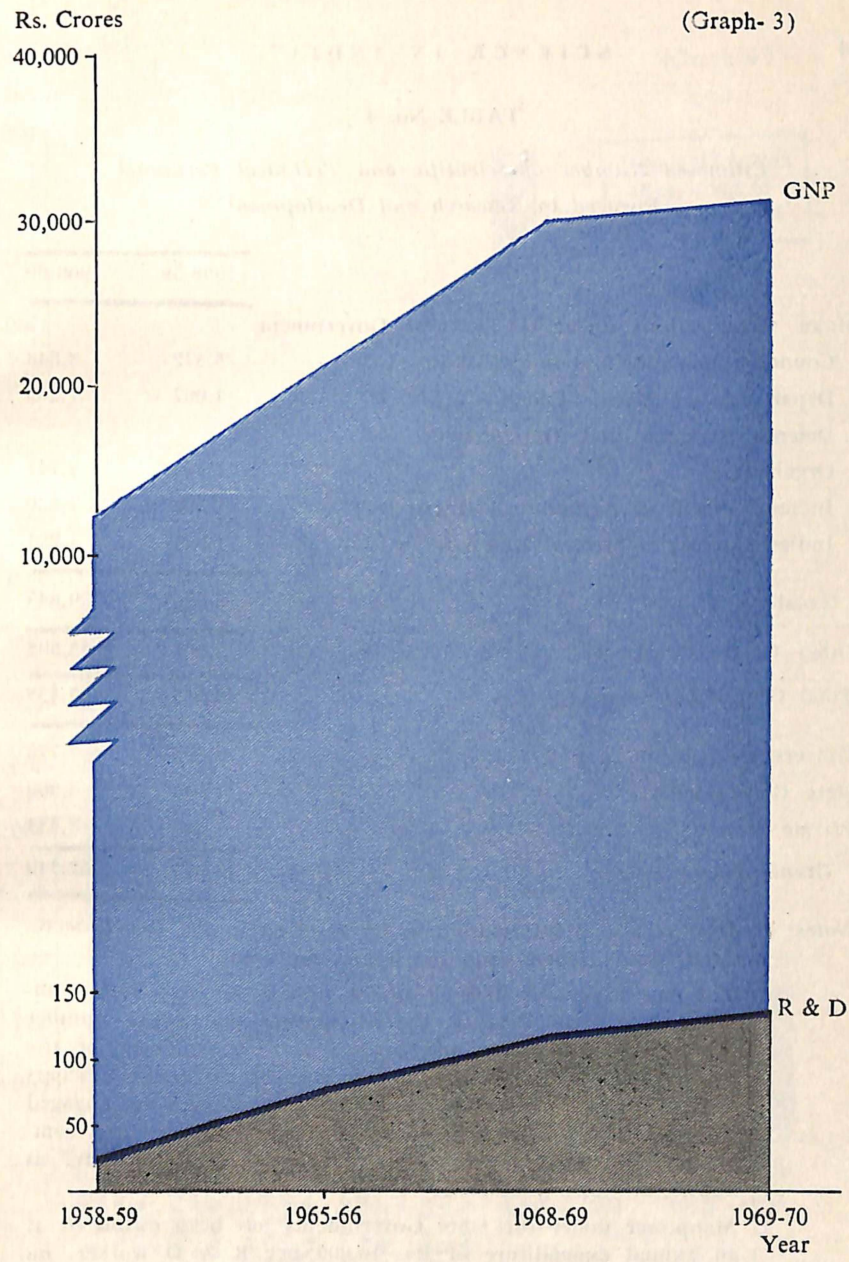
TABLE No. 3

Estimated Research and Development Expenditures in Relation to Gross National Product

	1958-59	1965-66	1968-69	1969-70
Total GNP at current prices (Rs. crores)	12,600	21,771	30,222	31,733
R & D expenditure (Rs. crores)	27	81	120	136
R & D expenditure as % of GNP	0.21	0.37	0.40	0.43

Note: GNP figures have been taken from the *Economic Survey 1968-69* issued by the Government of India. The figure for 1968-69 has been computed by increasing 1967-68 GNP of Rs. 29,342 crores by 3 per cent and that for 1969-70 by assuming a 5 per cent increase over 1968-69.

Source: Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology, 1969*, New Delhi: Government of India Press, 1969.



Research and Development Expenditures

in Relation to Gross National Product in India

(Based on Table No.3)

TABLE No. 4

Estimated Number of Scientific and Technical Personnel Engaged in Research and Development

	1958-59	1968-69
Major Organizations under the Central Government		
Council of Scientific and Industrial Research	3,512	8,848
Department of Atomic Energy	1,067	7,209
Defence Research and Development Organization	1,500	4,747
Indian Council of Agricultural Research	1,500	7,820
Indian Council of Medical Research	1,001	1,221
Total	8,580	29,845
Other Central Ministries	5,663	15,593
Total Central Government	14,243	45,438
Universities	2,600	7,778
State Governments	1,000	6,900
Private Sector	200	2,333
Grand Total	18,043	62,349

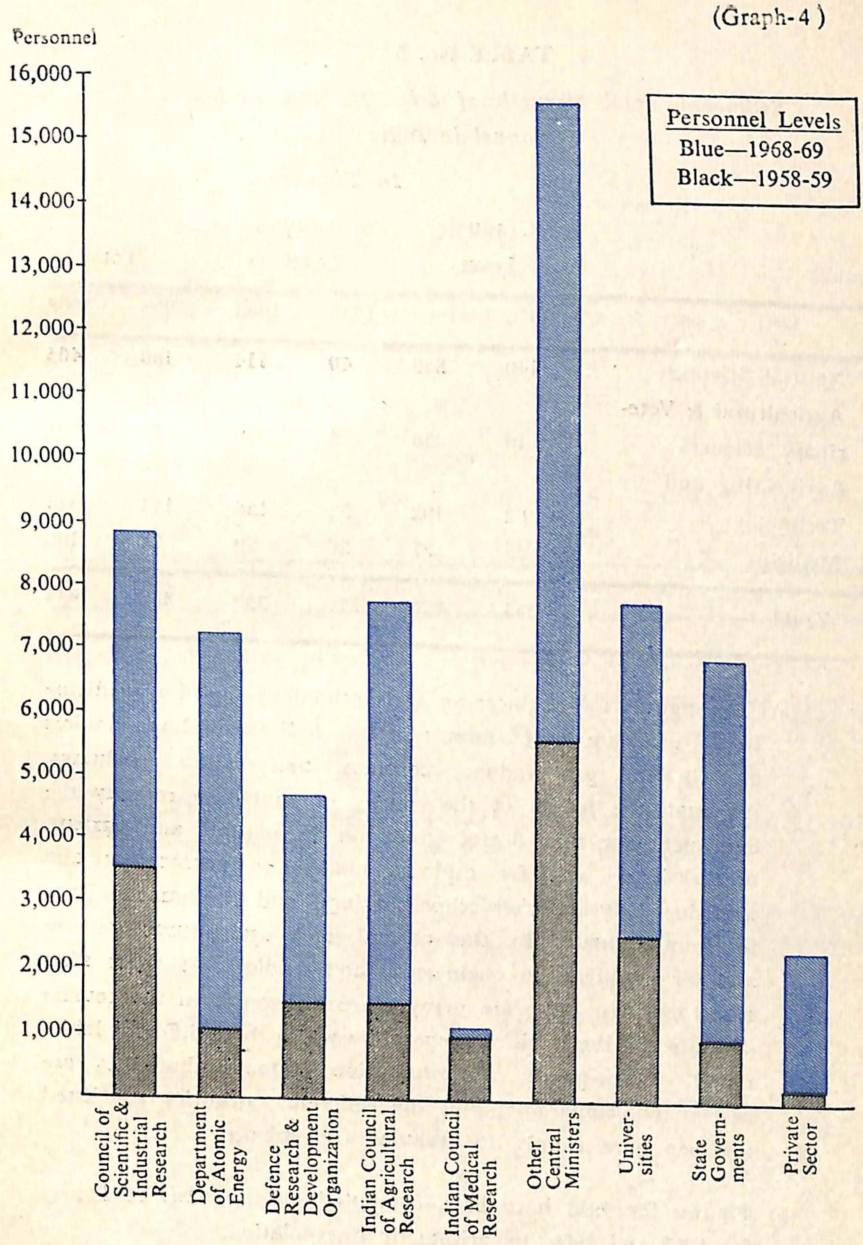
Notes: 1. Data relates to information so far received in the COST Secretariat, and in some cases the figures are complete.

2. The manpower for 1968-69 under universities has been computed from UGC data on the assumption that entire number of university professors and readers and 50 per cent of the lecturers in universities and 10 per cent of the senior teachers and 5 per cent of lecturers in the affiliated colleges are engaged in the R & D work. The manpower for 1958-59 has been computed, assuming the same rate of growth approximately, as under the Central Sector.

3. Manpower under the State Governments has been estimated at an annual expenditure of Rs. 10,000 per R & D worker, on *ad hoc* basis.

Source: Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology, 1969*, New Delhi: Government of India Press, 1969.

(Graph-4)



Scientific and Technical Personnel Engaged in Research and Development in India

(Based on Table No. 4)

TABLE No. 5

Estimated Total Strength of Scientific and Technical Personnel in India

In Thousands

	Graduate Level		Post-Graduate Level		Total	
	1958	1968	1958	1968	1958	1968
(a) Natural Sciences	140	349	40	114	180	463
(b) Agricultural & Veterinary Sciences	16	58	3	10	19	68
(c) Engineering and Technology	62	192	52	156	114	348
(d) Medicine	35	27	36	79	71	106
Total	253	626	131	359	384	985

Notes: (a) The figures for engineering and technology and for medicine in the graduate level columns in fact indicate diploma holders and in the post-graduate columns, first degree graduates. Although the length of the courses of study are roughly the equivalent for first degree graduates in natural and agricultural sciences and for diploma holders in engineering and medicine (3 years after school-leaving), and the same is true for post-graduates in the natural and agricultural sciences and for graduates in engineering and medicine (5 years after school-leaving), there are many other differences in the courses of study and the levels of preparation which these different lables reflect. Consequently no assumption is made that they are necessarily comparable, and the different categories are listed together here simply for tabular convenience.

(b) Figures for 1958 have been computed on the basis of figures for 1955 and 1960, by arithmetic interpolation.

Source: Council of Scientific and Industrial Research, Division for Scientific and Technical Personnel, *Bulletin on Technical Manpower*, April, 1969.

TABLE No. 6

Out-Turn of Scientific and Technical Personnel at Graduate and Post-Graduate Levels

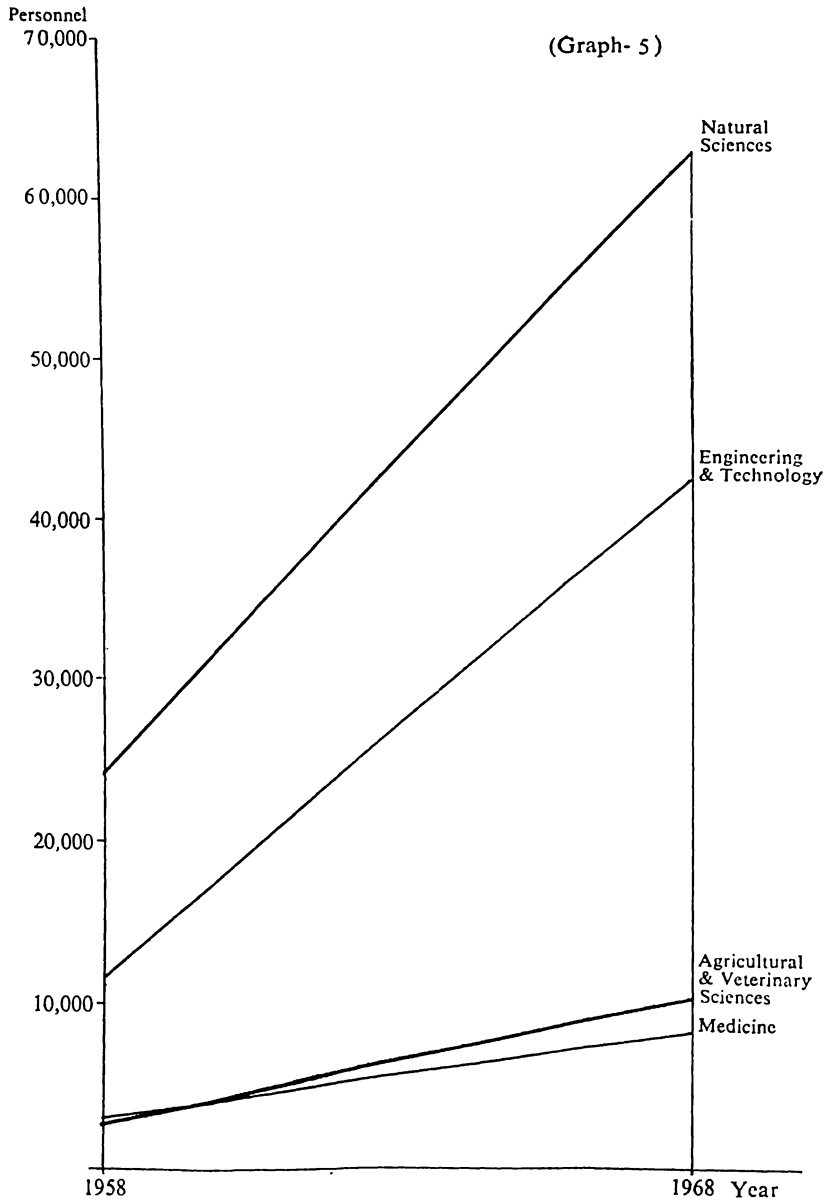
In thousands

	Graduate Level		Post-Graduate Level		Total	
	1958	1968	1958	1968	1958	1968
(a) Natural Sciences	20.0	50.0	4.5	12.5	24.5	62.5
(b) Agricultural & Veterinary Sciences	2.2	8.8	0.4	1.4	2.6	10.2
(c) Engineering and Technology	6.6	25.9	5.0	16.8	11.6	42.7
(d) Medicine	...	...	3.0	8.5	3.0	8.5
Total	28.8	84.7	12.9	39.2	41.7	123.9

Notes: (a) For this purpose, a degree in engineering, technology, and medicine has been taken as a post-graduate qualification, and a diploma in these subjects has been taken as a graduate level qualification.

(b) Figures for 1958 have been computed on the basis of figures for 1955 and 1960, by arithmetic interpolation.

Source: Council of Scientific and Industrial Research, Division for Scientific and Technical Personnel, *Bulletin on Technical Manpower*, April, 1969.



Out-Turn of Scientific and Technical Personnel in India

(Based on Table No. 6)

TABLE No. 7

Research Ratio and Research and Development Personnel in India and Selected Foreign Countries

Research Ratio in Selected Countries, 1967

(Percentage of the Gross National Product spent on Scientific Research and Development)

Country	*Percentage of G. N. P.*
U.S.A.	* 3.1
U.S.S.R.	(1) / (2) / 2.74
U.K.	(3) / 2.32
Netherlands	(4) / 2.26
France	2.17
Switzerland	1.92
Federal Republic of Germany	1.91
Canada	1.55
Japan	1.55
Sweden	(4) / 1.37
Belgium	0.93
Denmark	0.78
Italy	(4) / 0.67
Austria	(5) / 0.5
India	*(6) / 0.4*

* Estimated or provisional figure

(1) / For expenditure on "science", and based on a UNESCO estimate for G.N.P.

(2) / Including data for humanities

(3) / For 1966

(4) / Not including data for social sciences

(5) / Partially estimated

(6) / Estimate for 1968-69

TABLE No. 7
(continued)

Research and Development Manpower in Selected Countries, 1967

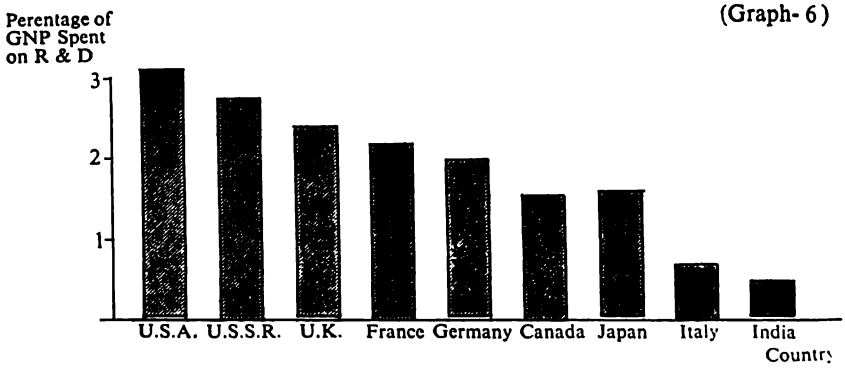
(Full-time equivalent Scientists and Engineers)

Austria	* 2,350
Denmark	* 4,080
Sweden	(1) / 6,566
Belgium	9.010
Switzerland	(2) / * 10,510
Netherlands	(1) / 15,700
Canada	(1) / 19,350
Italy	(1) / 19,670
France	50,744
India	(6) / *62,349*
Federal Republic of Germany	63,110
U.K.	* 65,000
Japan	(1) / (3) / 1,57,612
U.S.A.	(1) / * 5,25,000
U.S.S.R.	(4) / (5) / 7,70,013 *

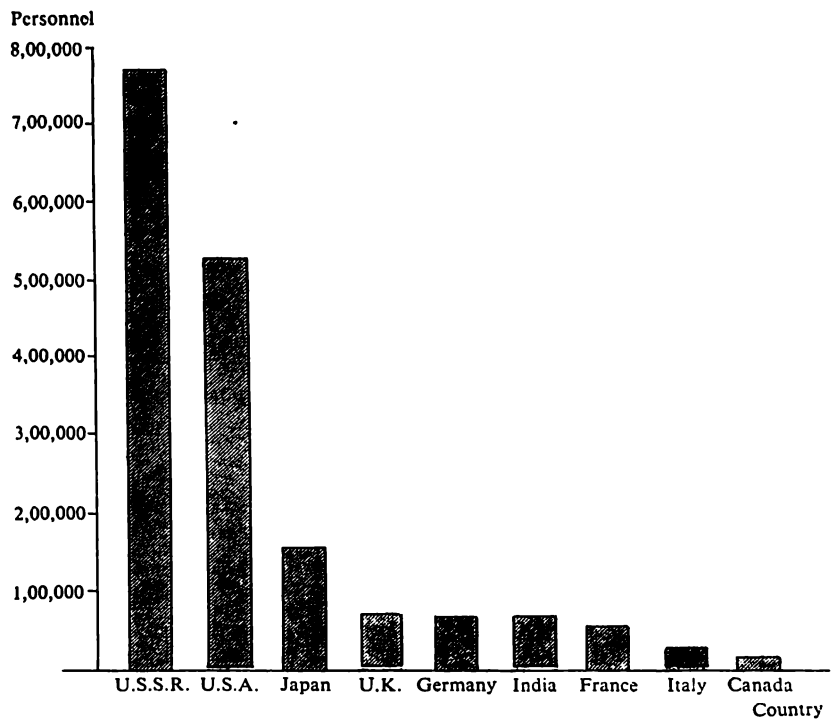
* Estimated or provisional figure
(1) / Not including data for social sciences
(2) / Full-time
(3) / Number of Physical persons
(4) / Including data for humanities
(5) / Scientific workers
(6) / Estimate for 1968-69. This may not be comparable with the other figures because it is not clear how "technical personnel" which are included in the Indian statistics have been defined.

Source: UNESCO Science Statistics Office for all figures except India, which are taken from Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology, 1969*, New Delhi: Government of India Press, 1969.

(Graph- 6)



Research Ratio in Selected Countries, 1967
(Based on Table No. 7)



Research and Development Manpower
in Selected Countries 1967
(Based on Table No. 7)

Department of Atomic Energy

In 1948, an Atomic Energy Act was passed by the Constituent Assembly, functioning as India's national parliamentary body until after the first general elections in 1952, and the Atomic Energy Commission was organized with Dr. Homi J. Bhabha as its Chairman. The Commission at first functioned within the Ministry of Natural Resources and Scientific Research. In 1954, India's atomic energy programme moved into a more active phase of development with the establishment of the Department of Atomic Energy (DAE) directly under the Prime Minister, where it has remained ever since. Dr. Bhabha then assumed the additional post of Secretary to the Government of India in the Department of Atomic Energy. He had previously been Director of the Tata Institute of Fundamental Research in Bombay, a position he continued to hold until his death in a plane crash in 1966. He was also, from 1954 onward, Director of the Atomic Energy Establishment, the major research and development facility of the Department of Atomic Energy at Trombay near Bombay (now called the Bhabha Atomic Research Centre or BARC).[7]

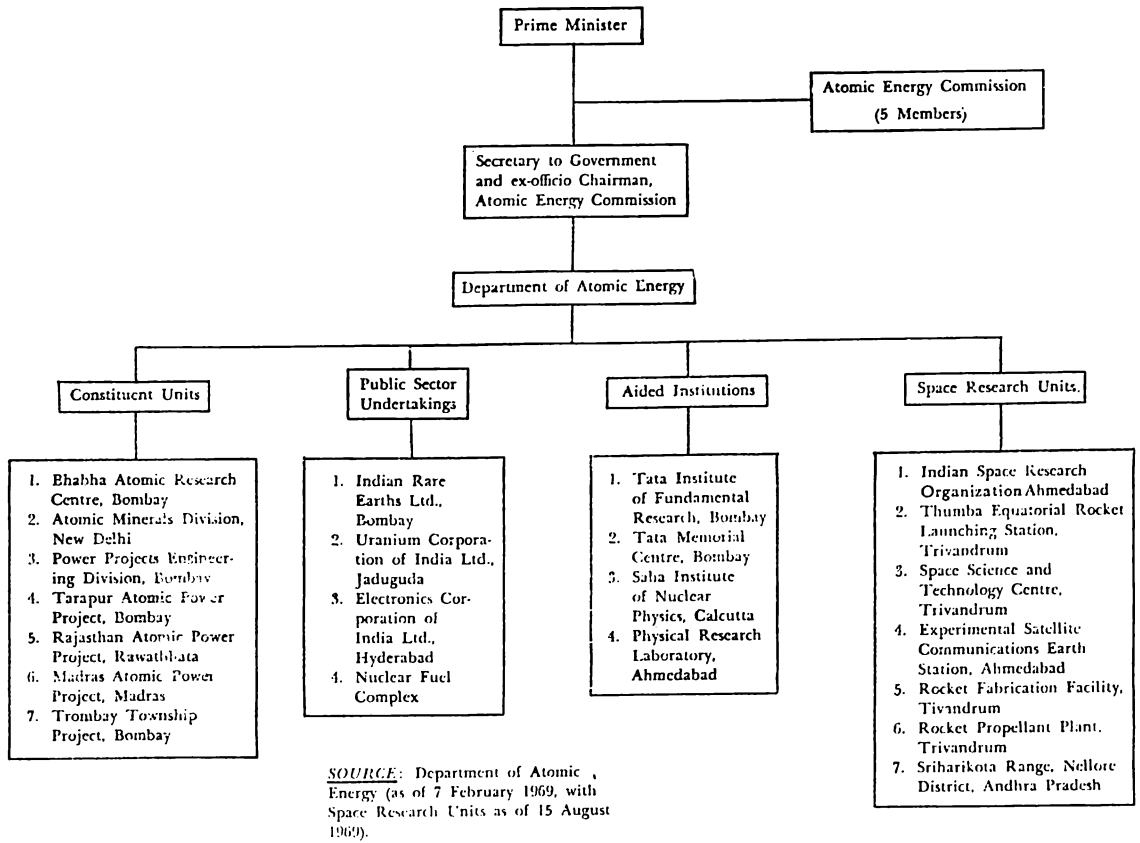
Now the largest single scientific organization in the country in terms of financial support by the government, the Department of Atomic Energy budget estimates for 1969-70 were approximately Rs. 28 crores (out of a total estimated central government budget for research and development of almost Rs. 120 crores—see Table No. 8). Its scientific and technical staff numbers over 7,000 and is of the same general order of magnitude as the other largest scientific organization in the country, the Council of Scientific and Industrial Research, which in 1968-69 had about 8,800 scientific and technical staff (see Table No. 4).[8]

While the DAE's objectives are broadly directed toward increasing knowledge and use of nuclear energy for construc-

7. Government of India, Department of Atomic Energy, *Ten Years of Atomic Energy in India*, Bombay: The Department, n.d.

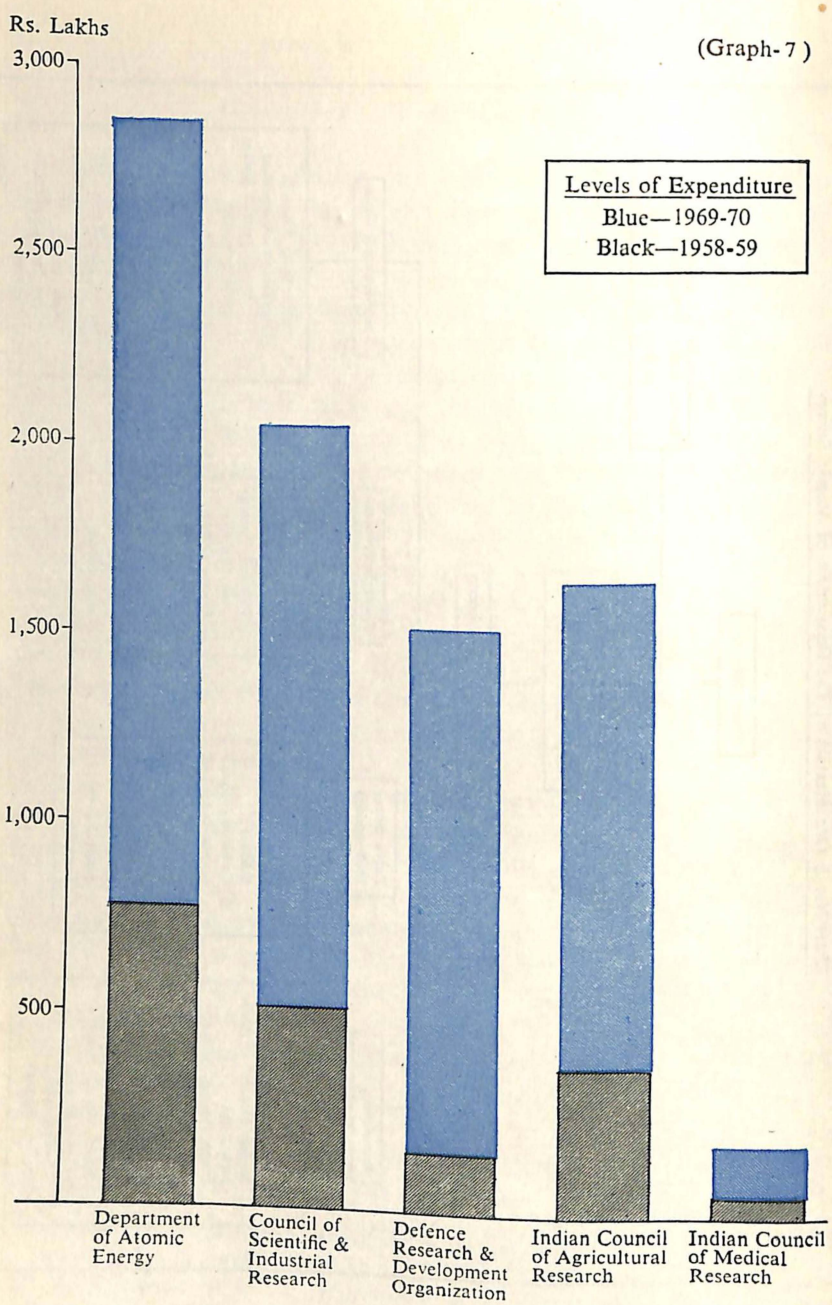
8. Government of India, Department of Atomic Energy, *Annual Report for 1967-68*, Bombay: The Department n.d. (?-1968), pp. 38; A. Rahman (in collaboration with B. V. Ranga Rao, K. D. Sharma, and M. A. Querashi), "Report on Financing of Scientific and Technological Research in respect of India" (unpublished manuscript), March, 1969.

Chart No. 2: Organization of The Department of Atomic Energy



SOURCE: Department of Atomic Energy (as of 7 February 1969, with Space Research Units as of 15 August 1969).

(Graph- 7)



Government of India Expenditures on Research and Development by Major Research Councils 1958-59 and 1969-70

(Based on Table No. 8)

TABLE No. 8

Expenditures and Allocations by the Government of India for Research and Development

Name of Organization/ Ministry/Department	1958-59		1965-66		1968-69		1969-70	
	Allocation (Rs. in lakhs)	% to total	Allocation (Rs. in lakhs)	% to total	Allocation (Rs. in lakhs)	% to total	Allocation (Rs. in lakhs)	% to total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Major Oaganizations								
Department of Atomic Energy (R & D)	775.88	29.8	2005.14	26.8	2536.61	24.0	2845.03	23.9
Council of Scientific & Industrial Research	509.94	19.6	1413.89	18.9	1997.00	18.9	2053.26	17.3
Defence Research and Development Organization	150.00*	5.8	973.00	13.0	1412.00	13.3	1516.00	12.8
Indian Council of Agricultural Research	372.29	14.3	640.98	8.5	1265.08	12.0	1659.66	13.9
Indian Council of Medical Research	50.50	1.9	105.00	1.4	164.10	1.5	170.00	1.4
Sub-total	1858.61	71.4	5138.01	68.6	7374.79	69.7	8243.95	69.3
Ministries								
Education and Youth Services**	145.60	5.6	409.01	5.5	483.51	4.6	523.49	4.4
Petroleum, Chemicals, Mines & Metals	88.84	3.4	735.88	9.8	1063.89	10.1	1063.89	8.9
Tourism and Civil Aviation	178.19	6.8	318.18	4.2	441.38	4.2	821.32	6.9
Health and Family Planning	53.28	2.1	193.87	2.6	350.80	3.3	350.80†	2.9
Food and Agriculture	52.52	2.0	96.94	1.3	98.32	0.9	98.32†	0.8
Information, Broadcasting and Communications	13.77	0.5	25.18	0.3	43.16	0.4	44.12	0.4
Railways	40.63	1.6	125.10	1.7	209.44	2.0	244.54	2.1
Irrigation & Power	41.91	1.6	193.99	2.6	176.99	1.7	176.99†	1.5
Department of Statistics	85.77	3.3	172.60	2.3	236.01	2.2	236.04†	2.0
Industrial Development, Internal Trade Company Affairs and Foreign Trade	45.54	1.7	80.68	1.1	95.66	0.9	93.66†	0.8
Sub-total	746.08	28.6	2351.43	31.4	3199.19	30.3	3655.17	30.7
GRAND TOTAL	2604.69	100.0	7489.44	100.0	10573.98	100.0	11899.12	100.0

Notes:

Figures for 1958-59 and 1965-66 are actual expenditures. Later figures are budget estimates or represent other kinds of estimates as indicated in the final note below.

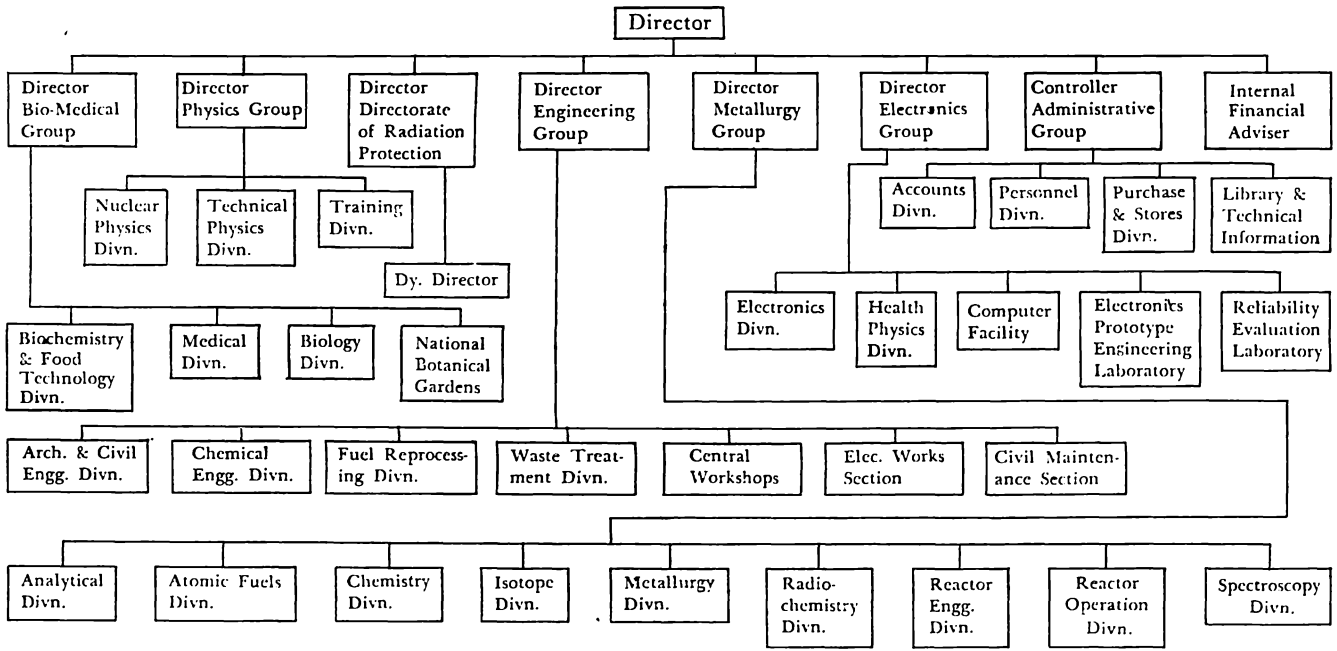
* Projected on the basis of data available from 1968-69 and earlier years.

** 50% of the total expenditure under UGC for higher education and research in science and 10% of the total expenditure under I.I.T's have been estimated as research expenditure in these calculations.

† As the data for 1969-70 is not available for these Ministries, the figures have been taken at the same level as in 1968-69 some of which also relate to the previous years where data for 1968-69 has not been received. Besides, in some cases, figures for total allocation are incomplete as data for all the institutions under the concerned Ministries has not been received.

Source: Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology*, New Delhi: Government of India Press, 1969.

Chart No. 3: Organization of Bhabha Atomic Research Centre



SOURCE: Department of Atomic Energy (as of 15 October, 1968).

tive purposes, the major concern of the Department thus far has been the development of the use of nuclear energy for generation of electric power. It also carries on a wide range of activities in fundamental and applied research, as well as related industrial operations (see Chart No. 2).

The largest single unit in the Department, and indeed the largest scientific centre in India with total staff of over 9,000 persons of whom 5,800 are scientific and technical personnel, is the Bhabha Atomic Research Centre, located in Trombay, near Bombay. BARC has research groups in physics, electronics, chemistry, metallurgy, engineering and biology (see Chart No. 3). It is also the site of experimental nuclear reactors and considerable activity in the scientific instrumentation field.

One of the major institutions associated with the work of DAE is the Tata Institute of Fundamental Research in Bombay. The Tata Institute was started as an independent institution with financial support from the Tata family, Bombay Government, and the Government of India. The Institute is now largely supported through the Department of Atomic Energy. The Institute functions as centre of advanced training and research in the nuclear sciences and mathematics.

Other research institutions supported by the Department of Atomic Energy include the Physical Research Laboratory at Ahmedabad, the Saha Institute of Nuclear Physics in Calcutta, and the Tata Memorial Centre for cancer research in Bombay. The Department has established the Thumba Equatorial Rocket Launching Station in Kerala and is developing a space science and technology centre nearby. Activity in the space field has expanded significantly in recent years. In August, 1969, the Indian Space Research Organization was established with headquarters at the Physical Research Laboratory in Ahmedabad, and the Department has entrusted administrative control of the Thumba Rocket Station and other space units to it.[9]

Another important dimension to the work of the Department of Atomic Energy includes the Atomic Minerals Division, industrial undertakings such as Indian Rare Earths, Ltd., which processes mineral sands important in nuclear operations, and

9. Annual Report of the Department of Atomic Energy, 1967-68, ibid., pp 49-66.

three major atomic power projects, of which one has recently begun operations (at Tarapur near Bombay), another well along to completion in the state of Rajasthan, and a third in the beginning stages of development near Madras.[10]

In recent years, the Department of Atomic Energy has been moving more actively into related fields of industrial activity, including the production of uranium fuel for nuclear reactors. The DAE has also had "spin off" impact on the electronics industry with the establishment of the Electronics Corporation of India, Ltd., in Hyderabad.[11]

The Department of Atomic Energy is concerned with agricultural uses of atomic energy and is experimenting with use of radiation in developing new varieties of crops in collaboration with the Indian Agricultural Research Institute in New Delhi. It is a substantial producer of radio isotopes for medical treatment in India and for export to other countries in Europe, Asia, Africa, and Australia. In 1965-66, as another indication of the level of development of work in atomic energy in India, ten tons of heavy water were provided to Belgium, marking "the first time that such a sophisticated product has been supplied to Western Europe from a country other than the United States of America".[12] Finally, the DAE sponsors research in universities, offers fellowships and gives grants-in-aid to mathematical societies and institutions for research in mathematics and related scientific fields.[13]

One of the significant organizational features of the Department of Atomic Energy is that, more than any other major scientific organization in the country, it contains within its own organizational fold a wider range of the inputs essential to its research mission and even controls in part the circumstances of utilization of its research through the development of its own atomic power stations and related industrial undertakings. In other words, it includes a larger number of steps in the "chain of innovation" from discovery to utilization than is true of any other major scientific organization in the country.

The Department of Atomic Energy is also distinctive by the

10. *Ibid.*, 1968-69, pp. 72-74. 79-81.
11. *Ibid*, 1968--69, pp. 74-79.
12. *Ibid.*, 1965-66, p. 4.
13. *Ibid.*, 1968-69, p. 82.

nature of its direct linkage to the highest levels of political leadership in the central government. As the organization chart for Indian science (see Chart No. 1) indicates, the Department's formal organizational linkage is directly with the Prime Minister. Among other scientific organizations in India, only the Council for Scientific and Industrial Research has a direct tie with the Prime Minister, who functions as the President of the Governing Body of the CSIR, but even there the ministerial link is indirect, namely, through the Minister of Education and Youth Services.

The development of the Department of Atomic Energy in the relatively short period of a decade and a half into the largest (in terms of financial support) single scientific organization in India, with work at what is generally acknowledged as a high international standard, is the consequence not only of the character of its formal linkages and of its organizational scope. Critically important also have been the character of leadership, organizing abilities and personal relationships which have existed within the context of the formal organization and linkages of the Department.

The role of Bhabha and his relationship with not only Nehru but also other key figures in the decision-making process were complex phenomena.[14] Suffice it to say that Nehru's awareness of the importance of stimulating scientific work in a country like India and his confidence in Bhabha were important factors in providing sustained support at a high level for the Department of Atomic Energy over an extended period of time. For other countries with limited resources trying to develop their scientific capabilities, this kind of long-term support of a relatively concentrated area of scientific activity may well be the object lesson to be drawn from India's experience with its atomic energy programme.

For the work of India's Department of Atomic Energy is widely acknowledged among scientists in other, "more advanced" countries as being of a high international standard. One such scientist, in a private communication to the author, commented that:

India is a country of great contrast and this is true in their

14. See above (p. 18) for a brief discussion of Bhabha's role in developing the Department of Atomic Energy.

scientific and technological work as well as in many other aspects of their national life.... I would say that their work in the field of atomic energy is of high quality and that it contrasts markedly with their work in some other areas, particularly medical and some industrial areas. The whole of the work of the Indian Atomic Energy Establishment was built up by Dr. Homi Bhabha who was not only a scientist of high standing but a shrewd and effective administrator. My impression of the work at Trombay is that it compares quite favourably with work in similar establishments in the United States, in Canada, in Britain and in European countries. It would be possible to pick broad areas where work in India was of a lower calibre than that in some overseas establishment and the reverse position could also be found, but on the whole I regard the Trombay establishment as one of the excellent atomic energy centres in the world, though of course, its scale is much less than that in some of the larger industrial countries....

Council of Scientific and Industrial Research

The Council of Scientific and Industrial Research (CSIR) is the major civil and industrial research organization in the country. The origins of the CSIR go back to its formal establishment as an "autonomous body" registered under the Registration of Societies Act in 1942, but its major development occurred after the Second World War and the achievement of independence. The earliest separate CSIR research laboratories, planned in the middle and late 1940's, began opening in 1950. The National Chemical Laboratory, National Physical Laboratory, Central Food Technological Research Institute, Central Fuel Research Institute, Central Glass and Ceramic Research Institute, and National Metallurgical Laboratory all were formally inaugurated in that year, and the growth was steady and substantial for the next decade and a half.

CSIR laboratories, institutes, and other organizations by 1970 number over 40 and are of five types. (See Chart Nos. 4 and 5 for the organization of CSIR and a typical individual laboratory and Table No. 9 for a list of CSIR institutes.)

Chart No. 4: Organization of Council of Scientific and Industrial Research

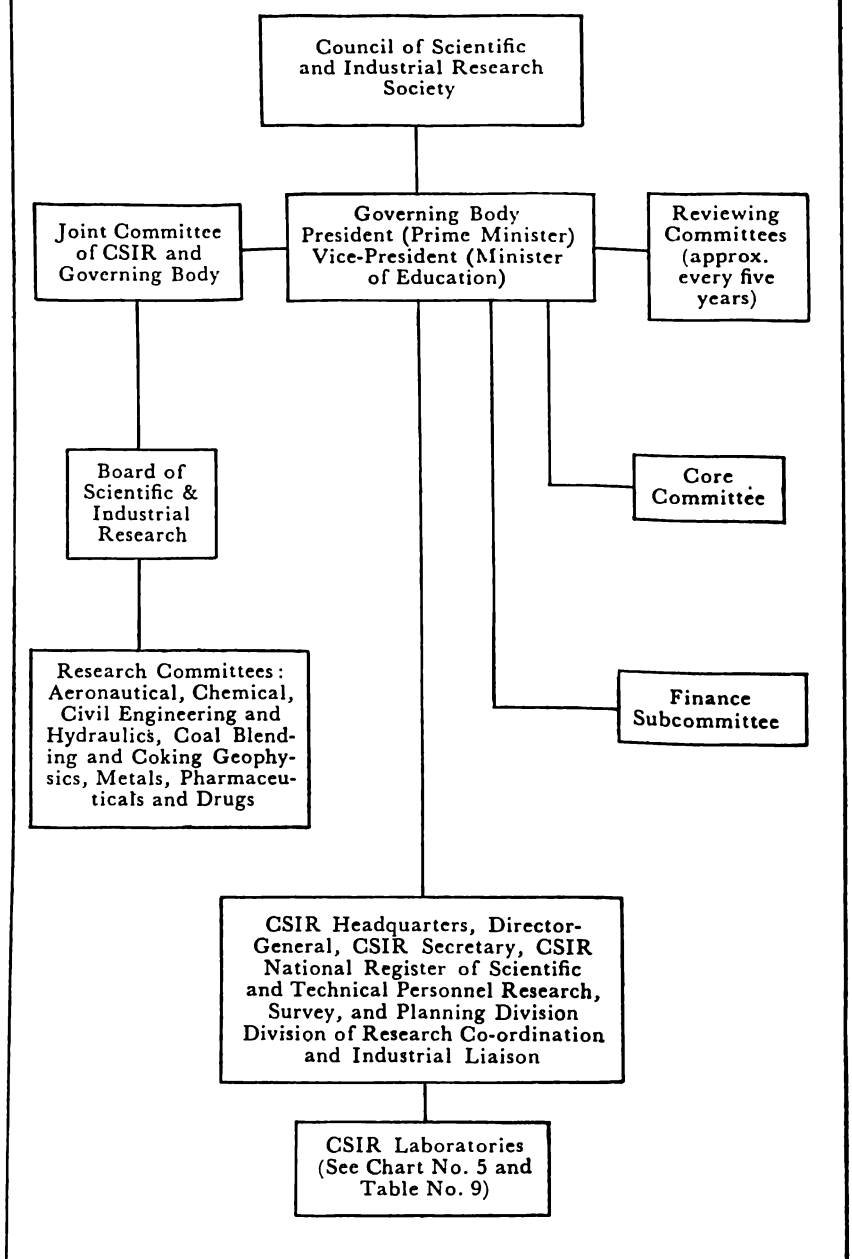
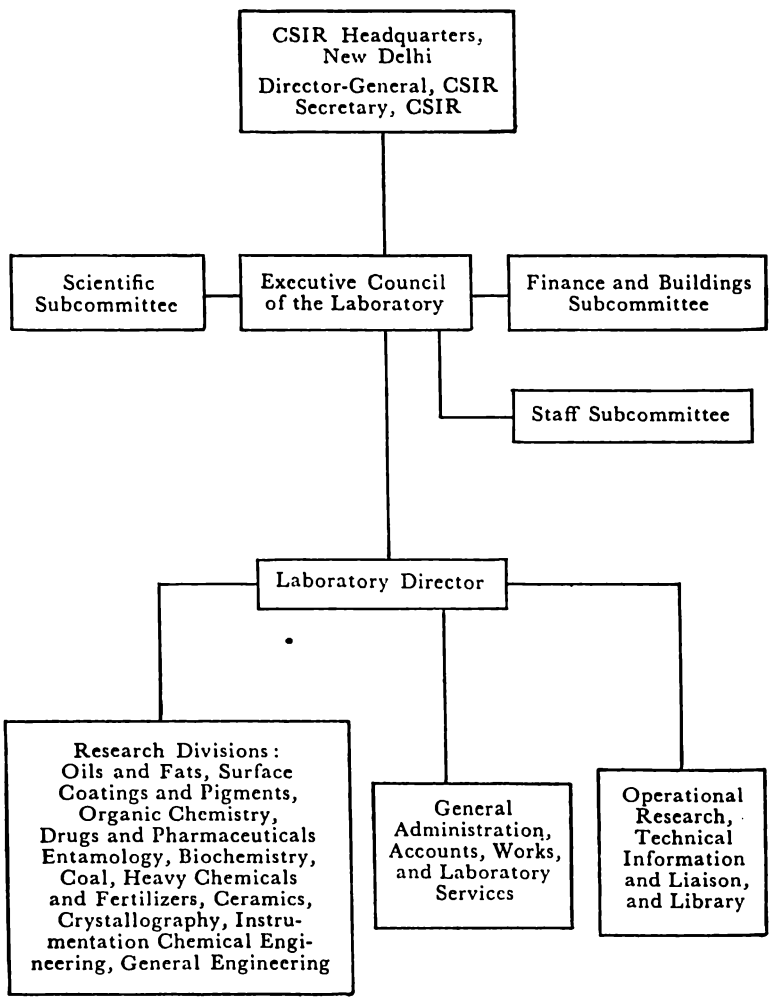


Chart No. 5: Organization of an Individual CSIR Laboratory*



*Based on the Regional Research Laboratory, Hyderabad.

1. Commodity or function-oriented laboratories such as Central Leather Research Institute in Madras, Central Food Technological Research Institute in Mysore, and Central Public Health Engineering Institute in Nagpur.
2. Scientific discipline laboratories like National Physical Laboratory in New Delhi and the National Chemical Laboratory in Poona.
3. Multi-purpose regional laboratories like the Regional Research Laboratories in Hyderabad, Jorhat, Jammu, and Bhubaneswar.
4. Museums, directorates, and other organizations serving different purposes such as the Birla Industrial and Technological Museum in Calcutta, Indian National Scientific Documentation Centre and the Publications and Information Directorate in Delhi, and the Industrial Toxicology Research Centre in Lucknow.
5. Cooperative research associations, which are jointly sponsored by CSIR and various industrial research associations, like the Ahmedabad Textile Industry Research Association or the Indian Plywood Industries Research Association in Bangalore.[15]

CSIR's budget estimate for 1969-70 was approximately Rs. 20 crores. The scientific and technical staff of CSIR, according to its 1968 annual report, was in excess of 8,750 persons (8,850 by 1969), and its total staff was about 11,000. (See Table Nos. 4 and 8.) CSIR has thus become, during the two decades of Indian independence a highly diversified scientific organization and a major element in organizational system of Indian science.[16]

In terms of formal linkages, as Chart No. 4 indicates, CSIR is tied to the Ministry of Education. But it also is linked to the Prime Minister who serves as the President of the Governing Body. (The Minister of Education and Youth Services is the Vice-President.) Formal relationships are, of course, only part of the story. The same is clearly true in looking at styles of leadership. Here CSIR differs from Atomic Energy in that it has had four (including the current one) Directors-General who serve as the principal executive officer of the organiza-

15. Council of Scientific and Industrial Research, *Annual Report 1968*, New Delhi: The Council, 1969, *passim*.

16. Ibid., pp. iv, 119-121.

tion. These, naturally, have had different working relationships with the Minister of Education (who has changed a number of times) and with the Prime Minister (who, since Nehru's death in May of 1964, has also changed twice). Since leadership is one of the important variables in institution building, it is not unnatural that these shifting circumstances of leadership in CSIR have introduced some discontinuities into programme implementation and policy formulation.

CSIR is a coordinating and resource allocating agency. The individual institutes, laboratories, and other organizations function at the operational level. Each of these institutes is governed by an executive council, appointed by the CSIR Governing Body, with a director or scientist-in-charge as the principal executive officer. (See Chart No. 5). It is difficult to generalize about the development of these operational units. They have varied widely in terms of the time period during which they have functioned, the quality of their leadership, their linkages within CSIR, with the industries or other fields of activities they are designed to serve, and with other elements in the economic and political systems of Indian society.

The Council of Scientific and Industrial Research has been subject to periodic scrutiny by reviewing committees, the third and most recent (1964) of which laid considerable emphasis on organizational decentralization and closer liaison with industry.[17] Another committee established at the instance of Parliament under the chairmanship of Justice Sarkar is now engaged in examining different aspects of the work of the organization.

Indian Council of Agricultural Research

While the Department of Atomic Energy and the Council of Scientific and Industrial Research remain the two largest scientific organizations in India, they no longer dominate the picture to the degree which they did five years ago. (In 1965-66 more than 45 per cent of all central government expenditure on research and development was allocated to these two orga-

17. Council of Scientific and Industrial Research, *Report of the Third Reviewing Committee*, New Delhi: The Council, 1964, pp. 86-87.

nizations, in 1969-70 the percentage was down to about 40 per cent.) As might be expected in a country where agriculture is the principal form of livelihood for the majority of the population and which, after experiencing a period of great difficulty in food production as a consequence of the extremely adverse weather conditions in the middle 1960s, is now in the first stages of a technological "revolution" in agriculture, allocations of resources for agricultural research have increased very substantially in the last four years from Rs. 6.4 crores to Rs. 16.6 crores (see Table No. 8).[18]

The principal instrumentality of the central government in agricultural research is the Indian Council of Agricultural Research (ICAR), although its position at the present time and its past history differ in a number of important respects from the Council of Scientific and Industrial Research.

As does agricultural research generally in India, the ICAR has a considerably longer history, going back to its establishment in 1929 as the Imperial Council of Agricultural Research. It too is registered as an "autonomous" body but is for all practical purposes a government agency. Its income is received from grants from the Government of India through the Ministry of Food and Agriculture and from an agricultural export cess of one and half of one per cent of the value of agricultural exports which in 1964-65 accounted for somewhat less than 50 per cent of its total revenue.

ICAR has also been subjected to periodic scrutiny by reviewing teams, the first of which completed its report in April 1954, the second of which submitted its report in 1960, and the third, in 1964.[19] With increasing emphasis, each of the reviewing teams has pointed out some of the difficulties confronting agricultural research in India and the limited role which the ICAR

18. Rahman, *Report on Financing of Scientific and Technological Research*, op. cit., p. 25; A. Rahman, N. Sen, and N. R. Rajagopal, *State Support to Scientific Research in India; An Analysis of Trends* (Survey Report No. 8) New Delhi; Research Survey and Planning Organization, Council of Scientific and Industrial Research, 1966, Table 2.

19. Indian Council of Agricultural Research, *Report of the First Joint Indo-American Team on Agricultural Education Research and Extension*, New Delhi: The Council, 1955; *Ibid., Report of the Second Joint Indo-American Team on Agricultural Education Research, and Extension* (Chairman, M. S. Randhawa), The Council, July, 1960; Government of

has been able to play because of unclear lines of responsibility and authority.

One of the problems affecting agricultural research is the circumstance that agriculture (including "agricultural education and research", which are mentioned by name in Article 14 of the list of state powers in the Seventh Schedule of the Indian Constitution) is a state, not a central subject (although paradoxically the "production, supply and distribution of... food stuffs" is a concurrent subject under Article 33 of the concurrent list of state and centre powers in the Constitution). This means a substantially larger state role in agricultural research than in other fields of scientific activity (with the possible exception of medical research). Until recently, furthermore, even those agricultural research institutes supported primarily through the central government were related directly to the Ministry of Food and Agriculture or functioned under more or less autonomous commodity committees so that the ICAR, which did provide project support for research schemes, still had relatively little leverage on these institutions.

This situation led the Third Agricultural Research Review Team under the chairmanship of the late Marion W. Parker of the U.S. Department of Agriculture to propose formal transformation of the ICAR into a new kind of council for agricultural and food research. There were two central objectives to the third reviewing team's recommendations—first, to establish clearer relationships between the ICAR and research institutes in the field of agriculture, including better coordination with research at the state level, and second, to give research scientists a more dominant role in the work of the ICAR and, therefore, the administration of agricultural research in the country.

Some progress has been made on the formal reorganization proposed by the committee (See Chart No. 6 for the present status and Chart No. 7 for the situation prior to reorganization.) The former director of the country's premier agricultural research and training institute, the Indian Agricultural Research Institute (commonly known as the Pusa Institute)

India, Ministry of Food and Agriculture, *Report of the Agricultural Research Review Team*, (Chairman, M. W. Parker), New Delhi: The Ministry (mimeo.), March, 1964.

Chart No. 6: Organization of Indian Council of Agricultural Research

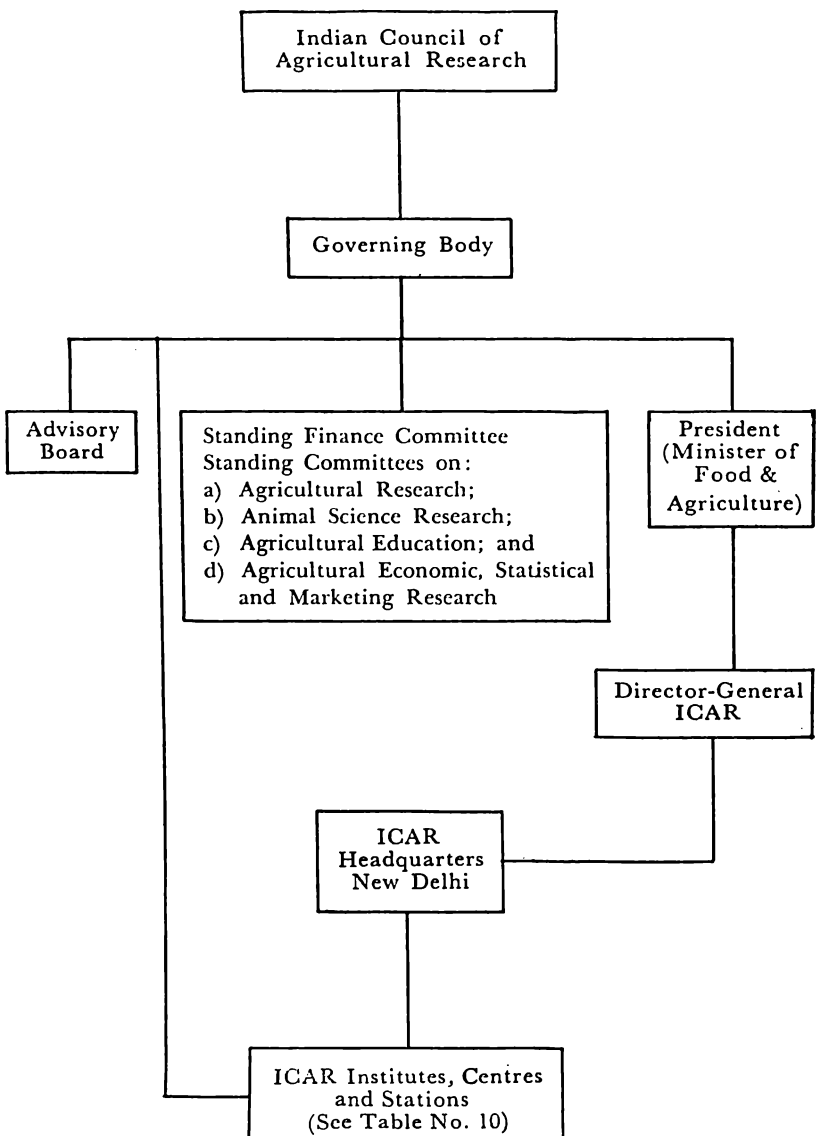
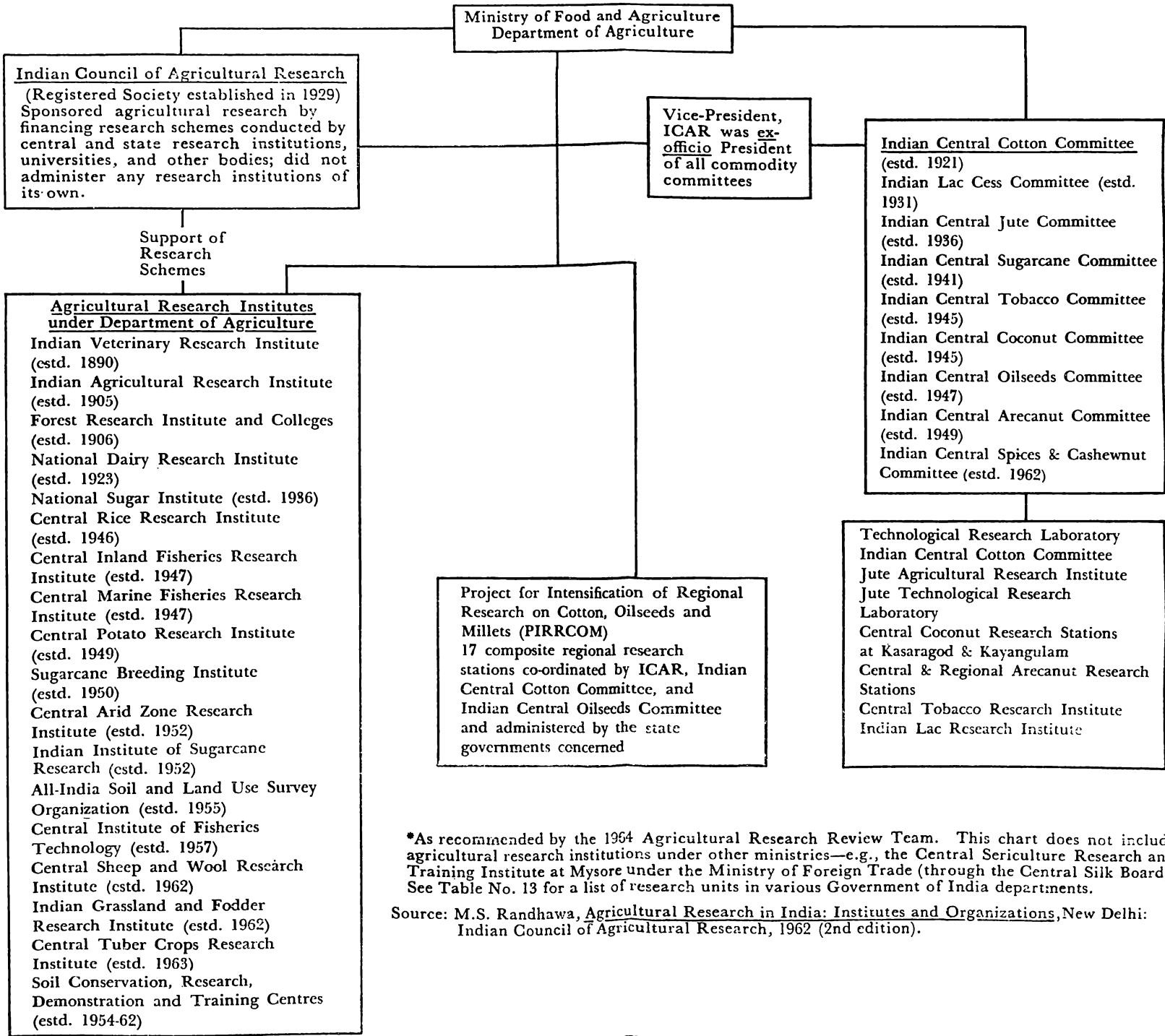


Chart No. 7: Organization of Agricultural Research under Government of India prior to recent reorganization*



*As recommended by the 1964 Agricultural Research Review Team. This chart does not include agricultural research institutions under other ministries—e.g., the Central Sericulture Research and Training Institute at Mysore under the Ministry of Foreign Trade (through the Central Silk Board). See Table No. 13 for a list of research units in various Government of India departments.

Source: M.S. Randhawa, Agricultural Research in India: Institutes and Organizations, New Delhi: Indian Council of Agricultural Research, 1962 (2nd edition).

in New Delhi, B. P. Pal, has been made Director-General of the ICAR. The various research institutes functioning under the central commodity committees—such as jute, cotton, tobacco, and sugarcane—have been brought under the ICAR. Other central research institutes like the Central Rice Research Institute at Cuttack and the Central Potato Research Institute in Simla have likewise been brought under ICAR as have three research institutes with somewhat special status—the Indian Agricultural Research Institute of New Delhi, The National Dairy Research Institute in Karnal, Haryana, and the Indian Veterinary Research Institute in Izatnagar, U.P.[20] (Table No. 10 lists ICAR units.)

While some progress has been made in implementing the formal aspects of the Parker team report, there are exceptions. For example, the Central Food Technological Research Institute remains with CSIR and the Botany and Zoological Surveys remain with the Ministry of Education in spite of reviewing committee recommendations that they be associated with ICAR. The report also proposes, in the interest of greater coordination, more centralization of agricultural research, in contrast to the prevailing character of most recent recommendations for more decentralization of scientific research in India by giving more autonomy to individual research institutes, and ultimately, to individual scientists. And concern has also been expressed that while the reorganization of the ICAR was inevitable and in and of itself desirable, until there develops a tradition within the central government which accepts greater autonomy for agricultural research institutes, many of the same administrative inhibitions found in the previous attachment of research institutes directly to the Ministry of Food and Agriculture will continue. The matter is further compounded by the fact that centre-state relationships in India are highly fluid and changing, and agriculture, because it involves food, is a sensitive area of Government activity in the Indian federal structure.[21]

20. *Report of the Agricultural Research Review Team*, 1964, *ibid.*, pp. 28-58.

21. Interviews by the author with an agricultural economist, director of a CSIR laboratory, and three directors of ICAR institutes, India, 1966-67. See also M. S. Swaminathan, "Government Policy and Agricultural Research", *Indian Journal of Public Administration*, (Special Number on Science and Government), July-September, 1969, pp. 559-564.

One major objective in the reorganization of ICAR was to achieve better coordination of research efforts at the central and state levels. Because the organizational linkages were more varied in the past, such coordination was difficult to bring about. An important step forward in this connection has been the organization of a series of all-India coordinated research projects which now cover virtually all major food grain crops and other agricultural commodities.

The coordinated crop improvement projects have been described as "a unique instrument for achieving inter-institutional and inter-disciplinary integration in research work, without causing any 'administrative disturbances'."[22] The projects are drawn up by groups of scientists actively engaged in research on the crops concerned. They envisage the establishment of a number of regional research stations in different states. These research stations are under the administrative control of the states concerned but subject to overall technical coordination through the All-India Coordination Project. The day-to-day coordination work is undertaken by full-time project coordinators who are again active research scientists. The organizational formalities of a coordinated project are covered by a "memorandum of understanding" to which the ICAR and the states concerned are parties.[23]

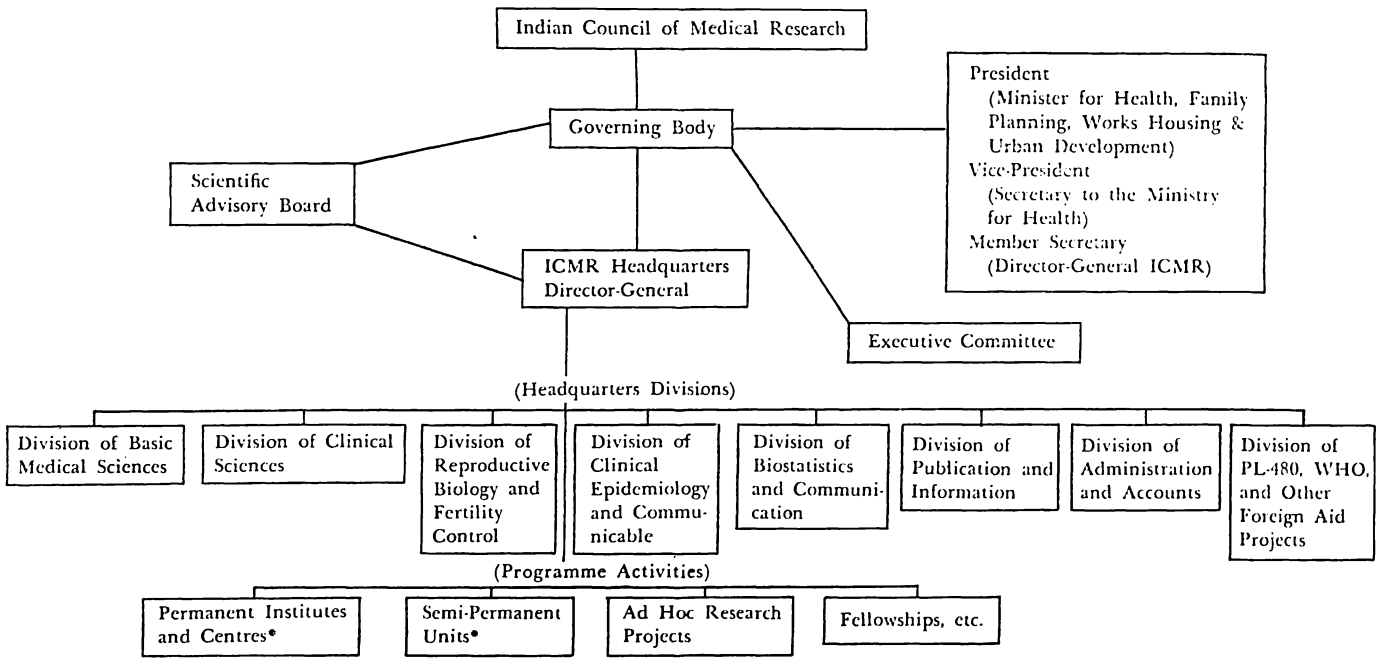
Indian Council of Medical Research

Excluding the survey departments of the government (the Geological Survey began in 1851), medical research represents one of the earliest areas of applied scientific activity in India—slightly ahead of, but more or less simultaneous with, the beginning of agricultural research. The Haffkine Institute was established in Bombay in 1896 to work on the plague, and what is now known as the Central Research Institute in Kasauli near Simla began work in 1906, a year after the founding of the Indian Agricultural Research Institute at Pusa in Bihar (since moved to Delhi). A variety of other institutions for

22. M. S. Swaminathan, *ibid.*, p. 563, interviews by author with three directors or scientists in-charge of former Central Commodity Committee Research Institutes, 1966-1967 and 1969.

23. Swaminathan, *ibid.*

Chart No. 8: Organization of Indian Council of Medical Research



Source : Indian Council of Medical Research

* See Table No. 11

training and research in different aspects of medicine were established in succeeding decades—for example, the Malaria Institute of India (now the National Institute of Communicable Diseases) in Delhi in 1927 and the All-India Institute of Hygiene and Public Health in Calcutta in 1932.[24]

Here again as in other fields of scientific research, major organizational patterns were well established by the time of independence but it was only with the advent of independence that significant strides were made in expanding the organizational base and scope of activity in both medical education and research. Thus, medical colleges in India, which numbered 20 at the time of independence, have multiplied fourfold since then. Post-graduate centres of training and research have also been established or greatly expanded, such as the All-India Institute of Medical Sciences in New Delhi, the premier institution in the country for advanced medical training and research (somewhat similar in character to the Indian Agricultural Research Institute), which was established in 1956.[25]

The principal instrumentality of central government support of medical research is the Indian Council of Medical Research (ICMR), the origins of which go back to 1911 when its predecessor body, the Indian Research Fund Association, was established. The Association was supported by an annual government grant and assisted research, particularly in the field of communicable diseases such as malaria, plague, smallpox, and cholera. With independence, the Indian Research Fund Association was rechristened as the Indian Council of Medical Research, and its activities since then have been substantially expanded. (See Chart No. 8.) Medical research still represents, however, a modest part of the total research effort in India. The ICMR budget is only one and half per cent of central government allocations for R and D (see Table No. 8), and ICMR staff is less than one-seventh the size of CSIR staff (see Table No. 4). The Indian Council of Medical Research is, fur-

24. B. L. Taneja and S. Sriramachari, *Bio-medical Research in India: Problems and Policies*, New Delhi: Indian Council of Medical Research 1963, pp. 1-2; Government of India, Ministry of Education, Bureau of Education, *Scientific Institutions and Societies in India* (Publication No. 69), Delhi: Manager of Publications, 1949, pp. 4-8, 24-26, 53-67, 70-77.

25. Taneja, and Sriramachari, *ibid.*, p. 18.

thermore, by no means the sole source of initiative and support for research; one estimate, for example, suggests that the ICMR is responsible for approximately half of the total amount spent on medical research in India.[26] (Thus the list of ICMR institutes in Table No. 11 excludes some major medical institutions which are noted below.)

Although structurally the ICMR is similar to the other major research councils like CSIR and ICAR, its pattern of operation is somewhat different, in the sense that a considerably larger proportion of its total budgets goes to the support of *ad hoc* research proposals submitted by individual research workers. Some 36 per cent of its budget goes into its own administration and the support of seven institutions directly and entirely under its auspices. The balance of its funds, which in 1967-68 totalled about Rs. 1.4 crores are allocated to the support of some seven "semi-permanent" research units located in medican research and training institutions and in support to fellowships and *ad hoc* research proposals submitted by individual research workers. More than half of these proposals (over 600 in 1967-68) came from research institutes and post-graduate teaching centres, with the balance from the medical colleges. About two-thirds of the proposals submitted are actually supported at the present time.[27]

While the ICMR is the principal agency for support and encouragement of medical research in India, it is responsible, as has been indicated, for only about half of what is spent on health research. Research and training institutes supported by the central government, like the Central Research Institute in Kasauli or the National Institute of Communicable Diseases in Delhi, are directly under the Ministry of Health and Family Planning and conduct some research with funds of their own, in addition to receiving support from the ICMR. The same may be said of an autonomous body like the All-India Institute of Medical Sciences, which receives a direct government grant for its basic support but may also have individual research projects supported by ICMR. In medical research as in agri-

26. Taneja, and Sriramachari, *ibid.*, p. 26; Rahman, *et al.*, *State Support to Research in India: An Analysis of Trends*, op. cit., Table 2.

27. Indian Council of Medical Research, *Report of the ICMR Reviewing Committee*, New Delhi: The Council, 1968, *passim*.

culture, the states play a more substantial role and some research activity, although it is difficult to know how much, is carried on in teaching colleges and research institutes directly under state auspices. And other major elements in the organizational system of Indian science which we have already discussed deal with some aspects of bio-medical research. Among these are the CSIR through certain of its laboratories like the Central Public Health and Engineering Research Institute at Nagpur, Central Drug Research Institute at Lucknow, and Indian Institute of Biochemistry and Experimental Medicine in Calcutta, or the Department of Atomic Energy through the Bio-medical Group at the Bhabha Atomic Research Centre at Trombay and the Tata Memorial Centre (for cancer research) in Bombay.[28]

There has recently been some consideration of the possibility of reorganizing the ICMR along the lines of the Indian Council of Agricultural Research—both being inspired by the experience of CSIR. This would presumably bring certain research institutes now linked directly to the Ministry of Health under the aegis of the ICMR, which at the present time has only seven research institutes under its direct control, or result in the creation of large, new research institutes directly under the Council. The recent ICMR Reviewing Committee, however, is "not in favour of the ICMR setting-up large multidisciplinary research institutes, like a Central Institute of Medical Research of its own...". The Reviewing Committee instead favours greater autonomy for the Council in relation to its parent ministry and greater autonomy for the Council's permanent research institutes along the lines of the CSIR pattern, with establishment of executive councils and enlargement of the powers of the directors of these institutes.[29]

One of the major problems confronting medical research in India, as indeed other fields of research activity such as those included within CSIR, is its relative isolation from teaching. Prof. Hill, over two decades ago, commented on the almost total lack of serious research activity in medical colleges in India. This problem has persisted to the present. Career patterns for research scientists in the field of medicine are not

28. Taneja and Sriramachari, *ibid.*, pp. 3-4, 26.
29. *Report of the ICMR Reviewing Committee*, op. cit., pp. 166-168.

well developed and the result is that even in relatively well equipped and financed post-graduate centres of training and research like the All-India Institute of Medical Sciences, it is difficult to maintain a high level of performance. "Although India has contributed substantially to knowledge of some fields, particularly in diseases like plague, malaria, kala-azar, cholera, etc.", the recently retired director of the Indian Council of Medical Research has observed, "we have to go a long way to reach the standard of bio-medical research in advanced countries of the world, more particularly in fundamental research. Traditionally, the people of the country and its leaders as also the medical profession have been interested in the development of medical relief and to some extent medical education. But it is only lately that there has been a felt need in the development of medicine as a science".[30]

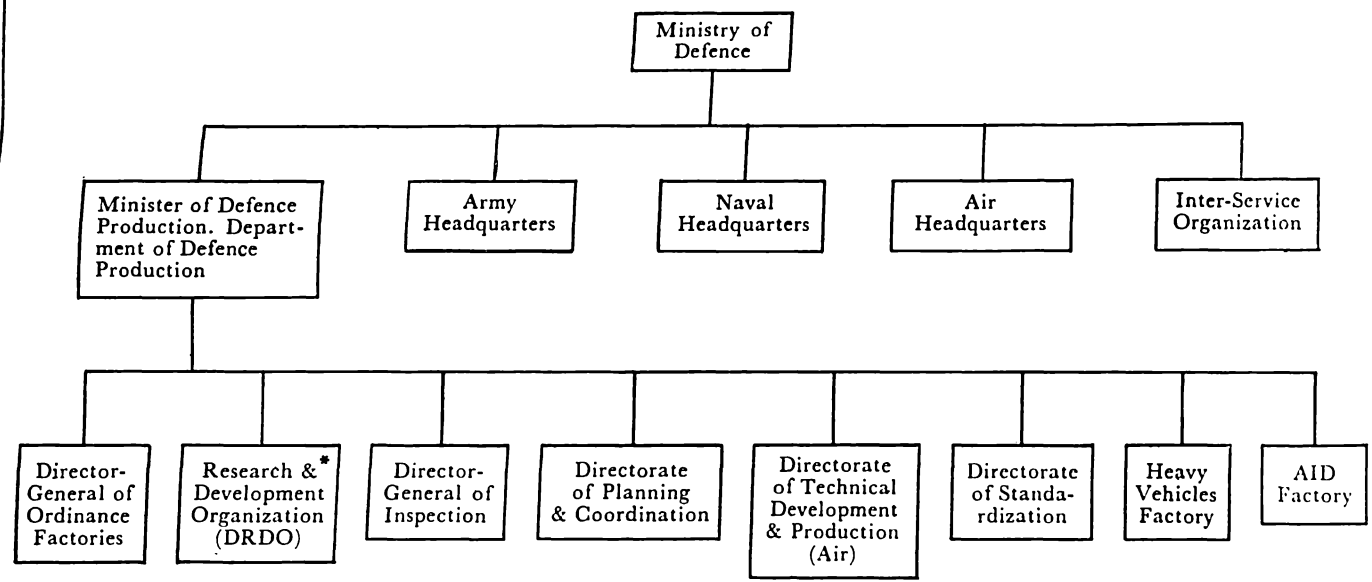
Defence Research and Development Organization

In 1948, a Defence Science Organization was established to deal with basic problems of defence science and operational research. The present Defence Research and Development Organization was formed in 1958 by amalgamating some of the existing technical development staff establishments with the Defence Science Organization. The DRDO has grown rapidly during the last decade so that today it has some 30 research and development establishments and laboratories situated throughout the country and working in such fields as armaments, electronics, aeronautics, engineering, high altitude research, and food research (Chart No. 9 and Table No. 12). Expenditure on defence research has also grown rapidly from about Rs. 1.5 crores in 1958-59 to an estimated Rs. 16 crores in 1969-70 (see Table No. 8), with a further increase planned to Rs. 30 crores by 1973-74.[31]

30. Taneja and Sriramachari, op. cit., p. 32. Related points of view were expressed in interviews by the author with an American medical scientist and an Indian research scientist who had been a student at the All-India Institute of Medical Sciences, New Delhi, November, 1966, and February, 1967. See also Taneja and Sriramachari, pp. 17-21, and Hill, op. cit., pp. 13-16, 20-21.

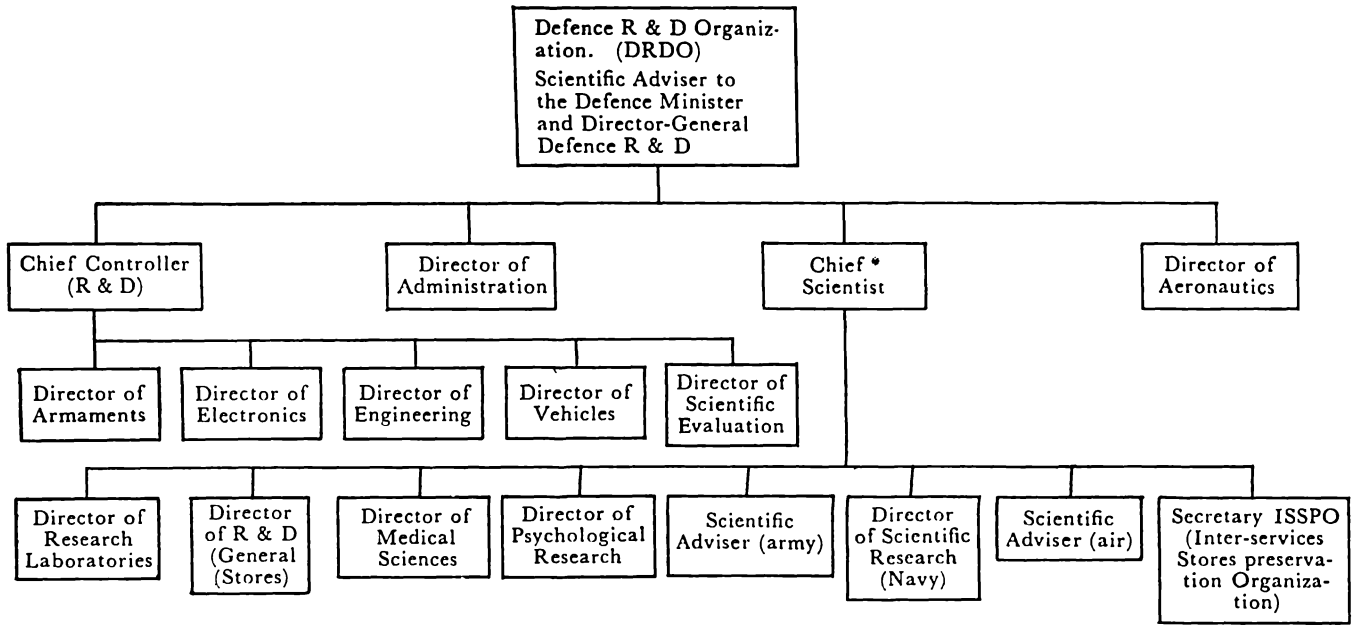
31. Government of India, Ministry of Defence, *Report 1968-69*, New Delhi; Government of India Press, 1969, pp. 45-51; Ministry of Defence,

Chart No. 9: Organization of Ministry of Defence and Defence Research Development Organization



*See next table

Chart No. 9: Organization of Ministry of Defence & DRDO (continued)



*At present the post is vacant and the work is being looked after by the Chief Controller (R & D) in addition to his own duties.

Sources: Government of India, Ministry of Defence, Report 1968-69, New Delhi: Government of India Press, 1969.

Similar increases are recorded in scientific and technical staff (from 1509 in 1958-59 to over 4700 a decade later—see Table No. 4.)

The DRDO is headed by the Director-General of Defence Research and Development, who is administratively linked to the Minister for Defence Production, although he also serves as the Scientific Adviser to the Defence Minister. This post, currently vacant, has been held by Prof. D. S. Kothari, who is now Chairman of the University Grants Commission, and by Dr. S. Bhagavantham, who recently retired but continues to serve as Chairman of the Committee on Organization of Scientific Research to the Cabinet.[32]

Notwithstanding the increased emphasis which has been given to defence research and development by the country, particularly since the military encounter with the Chinese in 1962, it is interesting to note that in terms of organizational linkages, the defence research and development effort in India is given a lower place in the organizational hierarchy than in a country like France. Over roughly the same period of time, France also has given major new emphasis to its defence-related research and development activities as part of General De Gaulle's efforts to strengthen French military capacity. An agency known as the Ministerial Delegation for Armaments was established a decade ago. Headed by a Minister Delegate for Armaments, the agency was given an organizational status similar to the three military services, in contrast to the Indian situation where the Defence Research and Development Organization has a considerably less exalted status.[33]

Research and Development and Organization, "Background Note" (cyclostyled, n.d.); Rahman, Sen, Rajagopal, op. cit., Table No. 2.

32. Government of India, Lok Sabha, Estimates Committee, *Defence Metallurgical Research Laboratory, Hyderabad* (Ninety-fourth Report, Third Lok Sabha), New Delhi: Lok Sabha Secretariat, March, 1966, pp. 2-4, 43-44; Government of India, Ministry of Defence, *Defence R and D Establishments and Laboratories*, New Delhi: Headquarters R and D Organization, The Ministry, November 1964; Ministry of Defence, *Report, 1968-69 ibid.*, pp. 199-200.

33. Robert Gilpin, *France in the Age of Scientific State*, Princeton: Princeton University Press, 1968, pp. 262-263; Ministry of Defence, *ibid.*, p. 200.

The organizational linkages of the Indian defence research and development effort are reflected in the organization of its governing council and officers. DRDO is directed by a Defence Research Development Council. The Minister for Defence is the Chairman of this Council and the Minister for Defence Production is the Vice-Chairman.[34]

In terms of internal organizational structure, while considerably less is known about the operating procedures of the DRDO because of the classified character of much of its work, it appears that there is a movement toward organizational decentralization. The 1968-69 report of the Ministry of Defence indicates, for example, the formation of nine governing councils for planning and directing the nine major fields of activity in DRDO, each of which has its own director (Director of Armaments, Director of Electronics, etc.), as indicated in Chart No. 9.[35]

Survey Organizations and Research Units in Government Departments

In addition to the Department of Atomic Energy and the major government-supported research councils which have already been discussed, other government research activities are varied, and no single effort is very large in relation to the total scientific endeavour in India (see Table No. 13). There are, for example, the old-line survey departments such as the Geological Survey, Zoological Survey, and Botanical Survey. The Ministry of Railways maintains a Research, Design, and Standards Organization in Lucknow, while a Telecommunications Research Centre is maintained by the Posts and Telegraphs Directorate. Another important area of research within the central government is that of the Ministry of Irrigation and Power; a number of state governments also carry on research related to irrigation problems. "The fact that most of these units are minor responsibilities of large ministries is important from the organizational point of view", observed the

34. Rahman, *Report on Financing of Scientific and Technological Research*, op. cit., p. 11.

35. Ministry of Defence, *Report, 1968-69*, op. cit., p. 46.

Indian Delegation to the British Commonwealth Scientific Committee in 1962. "There is, at present, no safeguard to ensure that the value and needs of such units are fully comprehended and adequately provided for by the executive wings of the Ministries. From this point of view, it would seem that they function under less favourable conditions for scientific work than autonomous scientific organizations."[36]

The converse point of view is also to be found, particularly among those research units which are threatened with or have recently been transferred from being a direct part of a government department to an "autonomous" scientific body such as a coordinating research council (or at the state level an agricultural university with its own research wing). The essential complaint of the directors of such research institutions is that as long as they remain organizationally a part of a government department they can press their claim for more resources or for solutions to administrative problems directly. If they become a part of a "autonomous" body, they can only argue their case at that level, but the case must still be carried to the departmental level within government for final solution.[37]

Research in the Universities

The plight of science in the Indian universities is widely recognized. If teaching in the natural sciences is in a bad way, research, it is argued, is in an even worse state. And yet it is generally conceded that a vital and growing tradition of research in the universities is a crucial stimulus to the teaching process and is one of the most important and most neglected elements in India's effort to strengthen its scientific capabilities.

From some 20 universities with a student enrolment in the science faculties of the universities in the neighbourhood of

36. British Commonwealth Scientific Committee, *Report of Discussions of Second Meeting Held in New Delhi*, India, November 19-30, 1962, p. 15.

37. Interviews by the author with the directors of a central government research institute which continues to have regular departmental status and has not been incorporated into an "autonomous" research organization and with the director of a state agricultural research station, which has recently been shifted from the state department of agriculture to the agricultural university in that state, December 1969.

1 lakh at the time of independence, the number of universities had grown by 1962-63 to 65 and the science enrolment to almost 14 lakhs. By 1967, including institutions "deemed to be universities", the total had risen to 85. Despite this growth in number of institutions and in student enrolment and notwithstanding the generally accepted importance of strong work in the sciences in the universities to all other aspects of a country's scientific endeavour, the investment of funds and allocation of manpower to teaching *and* research, let alone research alone, in the universities is not great in relation to India's total scientific effort.[38] (See Table Nos. 4, 6, 8).

While exact figures for science faculties in the universities are not readily available, a rough calculation would suggest that there were around 5,000-6,000 members of science departments in the better established Indian universities in 1962-63 carrying on research which has been published (out of a much larger number of college and university teachers of science who do not publish and who may or may not do research—perhaps 20,000 in all). The Cabinet Committee on Science and Technology (COST) estimates for 1969-70 suggest an increase to about 7,800 (see Table No. 4). In terms of financial support, the University Grants Commission (UGC), which is the major central government instrument for support of universities allocated Rs. 2.5 crores for all aspects, but primarily the teaching programmes, of science departments in Indian universities and another Rs. 1.9 crores for technological education in 1965-66. In 1969-70, COST estimates a *research* expenditure in the sciences in the universities and Indian Institutes of Technology of Rs. 5.2 crores (Table No. 8). This is still a rather modest investment when compared with Rs. 28.5 crores allocated to the Department of Atomic Energy during the same year.[39]

Still, the picture is not entirely that dark. First of all the various research councils, particularly CSIR and the Depart-

38. N. Sen, A. Rahman, S. P. Gupta, A. K. Roy, S. Malik, S. H. M. Husaini, S. Das Gupta, and Y. K. Agarwal, *Scientific Research in Indian Universities*, (Survey Report No. 6), New Delhi: Survey and Planning of Scientific Research Unit, Council of Scientific and Industrial Research, 1965, pp. 1-2; University Grants Commission, *Report for the Year 1965-66*, New Delhi: The Commission, 1966, pp. 58-59.

39. University Grants Commission, *ibid.*, pp. 62-63, 66; Sen *et. al.*, *ibid.*, Tables 1.3-12.3; K. Ray, *Scientific and Technical Personnel* (Census

ment of Atomic Energy, do provide some support to research activities in the universities and research fellowships for post-graduate students. The Department of Atomic Energy, for example, in 1967-68, granted somewhat more than Rs. 12 lakhs to finance research projects at various universities and other institutions. It also provided a number of junior and senior research fellowships (40 junior and 20 senior in 1964-65). And CSIR, in recent years, has made a major effort to expand its fellowship programme which has increased from about 450 fellowships in 1962 to over 1,500 by 1964 and more than 2,000 in 1968.[40]

One of the most important stimuli for research in the universities has come from a scheme of the University Grants Commission itself—namely the designation of especially strong departments in certain universities as "Centres of Advanced Study" (see Table No. 15 for a list of these centres in the natural sciences and mathematics). Initiated in the early 1960's, this scheme had been extended by 1968 to 30 departments in all fields of knowledge, 17 of them in scientific disciplines. Designation as a centre for advanced study means that additional funds are provided by the UGC for the appointment of additional academic staff, as well as for research fellowships, laboratory equipment, and the like. Important as this has been to teaching and research in those departments designated as centres for advanced study, only 17 departments in more than 80 university-level institutions in a country of 500 million persons is not much. The funds devoted to this enterprise are equally modest; Rs. 73 lakhs were paid out in grants to the centres during the 1967-68 fiscal year.[41]

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of India, 1961, Monograph Series No. 1), New Delhi: Office of the Registrar General, Ministry of Home Affairs, n.d. (1966-?) pp. 1, 12, 67-70.

40. *Annual Report of the Department of Atomic Energy, 1965-66,* op. cit., p. 60; *ibid., Annual Report, 1967-68,* p. 78; S. Husain Zaheer, "Department of Scientific Research in India and the Role of the Council of Scientific and Industrial Research", in Ward Morehouse, ed., *Science and the Human Condition in India and Pakistan,* New York: Rockefeller University Press, 1968, p. 62; Council of Scientific and Industrial Research, *Annual Report,* 1968, op. cit., p. iv.

41. University Grants Commission, *Report for the Year 1967-68,* New Delhi: The Commission, 1969, pp. 12-13, 54-55.

Research work in the Indian Institutes of Technology is also developing rapidly and may offer another bright spot in the university picture. The IIT's are all relatively new institutions and have had, understandably, to give primary attention to the organization of their teaching programmes in their formative years. But as their teaching programmes mature, more emphasis is expected to be given to research. And as the IIT's are generally better supported financially than the universities, the prospects for this particular category of institutions of higher education making a substantial contribution to India's total research effort is correspondingly greater. As one index of the development of the research dimension of the IIT's is the fact that some 750 research students were turned out from these institutions in 1968-69.[42]

For all the lack of support for research in the universities, they still appear to be one of the largest sectors of research activity within the scientific community in India. We have yet to develop really meaningful tools for measuring research productivity, but by one of the conventional means of doing so, viz., number of publications. A recent study (see Table No. 11) reveals that the universities were responsible for considerably more than one-third of the total number of scientific publications and slightly less than half of the research papers. This figure may be inflated because of the involvement of so many research students, but there is still a substantial amount of research activity going on in the universities (see Table No. 16).[43]

Research and Development in Industry

Research by industry, whether in the public or the private sector (and most of it appears to be in the private sector) is still in the very early stages of development (see Table No. 17 for a list of some industrial R & D units). According to one

42. Government of India, Ministry of Education and Youth Services, *Report, 1968-69,* New Delhi: The Ministry, 1969, p. 41.

43. B. V. Ranga Rao, *Scientific Research in India: An Analysis of Publications* (Survey Report No. 10), New Delhi: Research Survey, and Planning Organization, Council for Scientific and Industrial Research, 1967, Table 1 and pp. 19-20.

TABLE No. 16

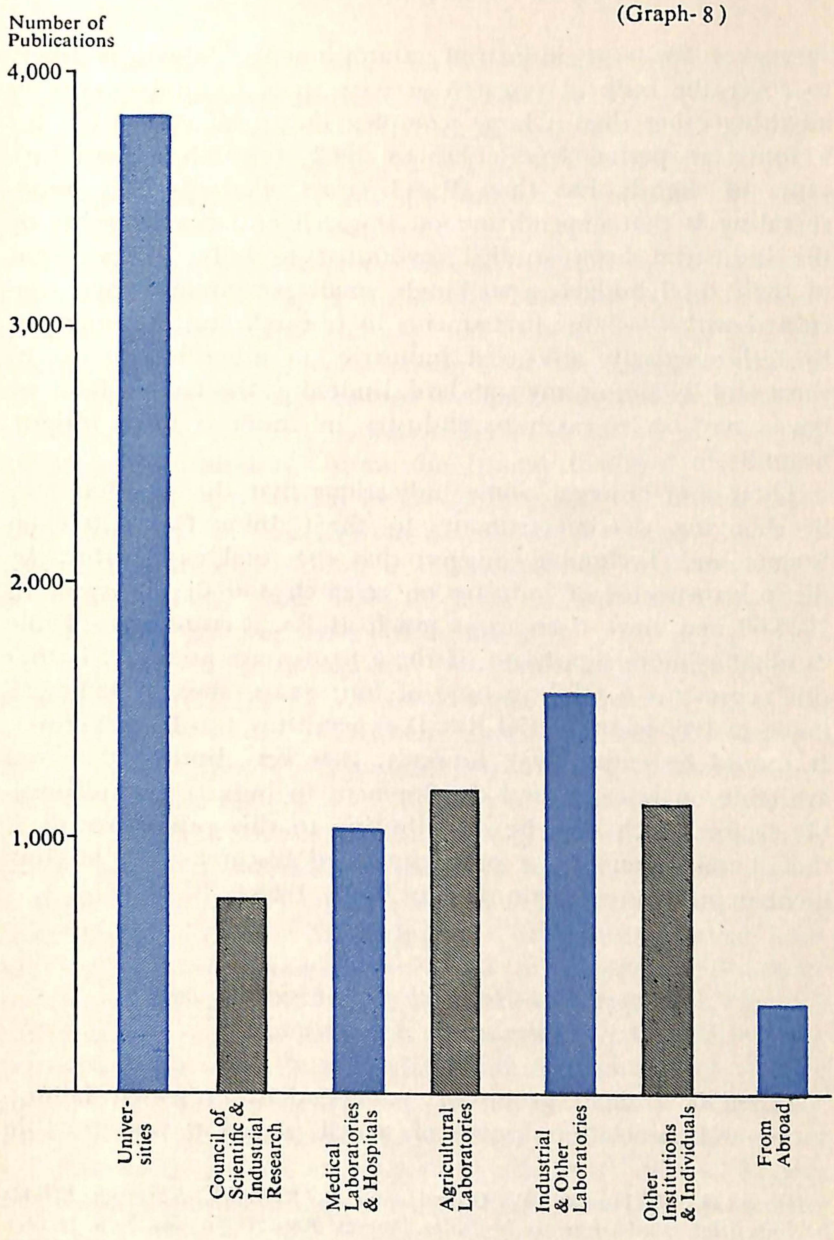
Distribution of Scientific Research publications by Institution of Origin: 1964-65

Institutions	Total Number of Publications	Research Papers	Letter to the Editors and Short Communications	Technical Reports	Symposia & Conference Papers	Review & Informative Articles	Case Reports	Others
Universities[1]	3816	2492	613	6	43	353	287	25
Council of Scientific and Industrial Research[2]	766	537	115	22	23	69	—	—
Medical Laboratories and Hospitals	1023	543	108	—	—	203	157	12
Agricultural Laboratories	1187	764	291	4	1	123	4	—
Industrial and Other Laboratories[3]	1545	957	277	43	88	177	3	—
Other Institutions and Individuals	1122	485	99	5	7	460	60	6
From Abroad	345	170	20	6	34	102	13	—
Total	9804	5948	1523	86	193	1487	524	43

1. Including medical, engineering, and agricultural colleges.
2. Including research association laboratories supported by CSIR.
3. Including research organizations of all ministries not covered by the above groups, privately maintained laboratories, etc.

Source: B. V. Rangarao, *Scientific Research in India: An Analysis of Publications* (Survey Report No. 10). New Delhi: Research, Survey, and Planning Organization, Council of Scientific and Industrial Research, 1967.

(Graph- 8)



Distribution of Scientific Publications in India

1964-65

(Based on Table No. 16)

survey of 25 large industrial establishments (which is likely to cover the bulk of research activity since it rarely exists in anything other than a large, complex industrial enterprise) for a four-year period from 1958 to 1962, research expenditure came to slightly less than Rs. 1 crore. Perhaps even more revealing is that expenditure on research and development by the industrial firms studied amounted to only .37 per cent of their total budget, a strikingly small percentage when contrasted with the large investments in research and development by technologically advanced industries in other countries. In short and by almost any standard, limited as the factual data we have, may be, research by industry in India is most insignificant.[44]

There are, however, some indications that the position may be changing. Recent estimates by the Cabinet Committee on Science and Technology suggest that the total expenditure by the private sector of industry on research and development in 1968-69 may have risen to as much as Rs. 8 crores (see Table 2).What is more significant, if these figures are accurate, is that this represents a tripling time of four years, since COST estimates in 1965-66 industrial R & D expenditure was Rs. 2.4 crores. It should be emphasised, however, that very limited data are available on research and development in industry. One possible factor which may be contributing to this rapid growth is the liberalization of tax policies toward research and development expenditures, beginning in April, 1968.[45]

Independent Research Organizations and Professional Associations

There is a small group of "independent" research laboratories and associations, some of which played a very notable

44. S. H. M. Husaini, A. Ghosal, and A. Rahman, *Research Efforts in Industrial Establishments in India* (Survey Report No. 5), New Delhi: Survey and Planning of Scientific Research Unit, Council of Scientific and Industrial Research, 1965, Tables 1 and 10 and pp. 1-13.

45. Government of India, Incentives for Scientific Research (Extract from the Income-tax Act, 1961, as Amended by the Finance (No. 2) Act, 1967, Taking Effect from 1st April, 1968) Section 35.

role in the history of modern science in India. (For a listing of some of these organizations, see Table No. 18). This is particularly true in Calcutta, where there exist the Bose Institute (founded in 1917 by one of India's most illustrious scientists, Jagadish Chandra Bose) and the Indian Association for the Cultivation of Science (established 1876), where C. V. Raman did his work in the earlier decades of this century on Raman's Effect, which won him India's only Nobel prize in science. Other such institutions are scattered around the country—for example, the Indian Statistical Institute in Calcutta, Birbal Sahni Institute of Palaeobotany in Lucknow, Indian Institute of Science and Raman's Research Institute (which Raman set up after his retirement from the Indian Institute of Science and where he now works) in Bangalore, and the Maharashtra Association for the Cultivation of Science in Poona. Most of these institutions are more or less committed to fundamental or basic research, while some, such as the Indian Institute of Science, also provide advanced training.

While these organizations are "independent" in formal status, as indeed are the major research councils which are organized as autonomous bodies or registered societies, they also depend in varying degrees upon public patronage, particularly from the central government. The Ministry of Education is the main channel for such support in the form of grants, either directly or through the National Institute of Sciences of India. For example, the Bose Institute received Rs. 13 lakhs in 1964-65 from the Ministry of Education, not to mention other sums in the form of research fellowships from other government bodies, including CSIR and the Department of Atomic Energy.[46]

Finally, there are scientific and professional societies, the organizational apparatus of the scientific community. These societies are numerous, probably somewhere in the neighbourhood of 200 in the country as a whole. They range widely in size from general organizations like the Indian Science Congress Association with close to 6,000 members to societies

46. Government of India, Ministry of Education, *Report, 1965-66*, New Delhi: The Ministry, 1966, p. 79; Council of Scientific and Industrial Research, Research Survey and Planning Organization, *Science in India*, New Delhi: RSPO, Council of Scientific and Industrial Research, 1966 (2nd ed.); Bose Institute, *Report for 1964-65*, Calcutta: The Institute, 1965.

in various disciplines or scientific specialities with much more modest memberships, such as the Zoological Society (1962 membership, 288), Indian Physical Society (membership in 1962 of 544), and the Mycological Society (with a membership in 1962 of 32) individuals active in that field of research interest.[47]

At the apex of this organizational network are the "elite societies" of a general scientific character. While there are three in India (the National Academy of Sciences in Allahabad, the Indian Academy of Sciences in Bangalore, and, Indian National Science Academy which was formerly the National Institute of Sciences of India, in Delhi) which aspire to national status and prestige corresponding to the National Academy of Sciences in the United States and the Royal Society in Britain, it is probably fair to state that only one—the Indian National Science Academy—has begun to achieve that goal. The other major "apex" body at the all-India level is the Institution of Engineers.

One of the more interesting aspects of the organizational scene in Indian science is the Association of Scientific Workers of India (ASWI), a body established in 1947 and registered under the Indian Trade Union Act. "A new India is emerging and a democratic-socialist Indian society in a peaceful world is the cherished goal of every Indian", states the Association. "There is so much that remains to be done to exterminate hunger, poverty, and disease. Scientists have to play a vital role in shouldering the different tasks that face India today."[48]

The Association, in addition to publishing a monthly journal dealing for the most part with organizational developments in Indian science and relationships between the scientific community and the government, *Vijnan Karmee*, sponsors occasional symposia, such as the 1964 symposium on "Science and the Nation in the Third Five-Year Plan" and an international conference in 1966 on "Collaboration between the Countries

47. A. Rahman, N. Sen, and N. R. Rajagopal, *Scientific Societies in India* (Survey Report No. 3), New Delhi: Survey and Planning of Scientific Research Unit, Council of Scientific and Industrial Research, 1965; *Science in India*, ibid.

48. Association of Scientific Workers in India, Brochure on the Association, New Delhi: The Association, n.d.

of Asia and Africa for the Promotion and Utilization of Science and Technology". ASWI also has a number of local branches, many of them associated with CSIR laboratories, and carries on various other efforts to advance the welfare and conditions of service of its members.[49]

State Governments and Scientific Research

By constitutional prescription, the central government plays the dominant role in supporting research and development in India. (More than 85 per cent of all government expenditure on research and development is made by the central government.) The states, nonetheless, have an important role in three fields—medicine and public health, agriculture, and higher education.

Aside from those institutions directly controlled by the central government or supported largely by it, such as the Indian Institutes of Technology and those universities of "national importance", like Banaras Hindu University and Aligarh Muslim University, state governments carry primary responsibility for maintenance of universities in India, notwithstanding the assistance provided through another central government agency, the University Grants Commission. There are also a number of research institutes and laboratories directly under the control of state governments such as agricultural research stations (which in some states have been shifted from a direct linkage with the state department of agriculture to the agricultural university). A number of these research institutes and training institutions also receive support through central government science agencies. Thus, the Indian Council of Medical Research, the Indian Council of Agricultural Research, and the Council of Scientific and Industrial Research all support research schemes in medical colleges, university science

49. Association of Scientific Workers of India, *Symposium on Collaboration Between the Countries of Africa and Asia for the Promotion of Science and Technology* (May, 1966, issue of *Vijnan Karmee*), New Delhi: The Association; "Symposium on Science and the Nation during the Third Five Year Plan, New Delhi, July, 1964", *Vijnan Karnee,* August, 1964, pp. 5-8.

departments, and agricultural research stations maintained by the states.[50]

Table No. 2 indicates levels of expenditure by the states collectively for scientific research in comparison with the central government expenditures, while Table No. 4 gives a general indication of state level R and D personnel.

Using only relative levels of expenditure by the states and the centre on R and D as a measure, however, understates the role of the states. In fact, state governments occupy a crucial place in a whole range of activities that bear upon utilization of the results of scientific and technological research. For, as Paul Appleby, the American expert in public administration who surveyed India's administrative services in the early 1950's, pointed out, there is "almost complete dependence of the Centre on the states for the administration of social-action programmes, including almost everything in the crucial, national Welfare State dedication".[51] Thus, the states represent critical vehicles for acceptance and utilization of the results of the research in fields like agriculture and health.

We know very little about the role of states in India in relation to scientific and technical research and development. Given the growing importance of the states in the Indian federal structure (R and D expenditures by the states increased by more than eight times in the last 11 years—see Table No. 2), this aspect of the organizational system of research and development and the related process of utilization of R and D in

50. The Indian Constitution places the locus for scientific matters in the Indian federal system with considerable precision. In the Seventh Schedule (which lists responsibilities allocated to the central government, to the states, or to both), the central government list includes atomic energy, patents and inventions, standardization, development of mineral resources, "the promotion of special studies or research," "coordination and determination of standards in institutions for higher education or research and scientific and technical institutes," and the major survey departments of the Government of India (Survey of India, Geological, Botanical, Zoological and Anthropological Surveys of India and the Meteorological Department). The state list includes education, agriculture, including agricultural education and research, and health. One of the interesting anomalies in the Constitution is that while agriculture is a state subject, food is concurrent subject.

51. Paul H. Appelby, *Public Administration in India: Report of a Survey*, Delhi: Manager of Publications, Government of India, 1953, p. 3.

India should be examined more carefully and systematically than it has been thus far.[52]

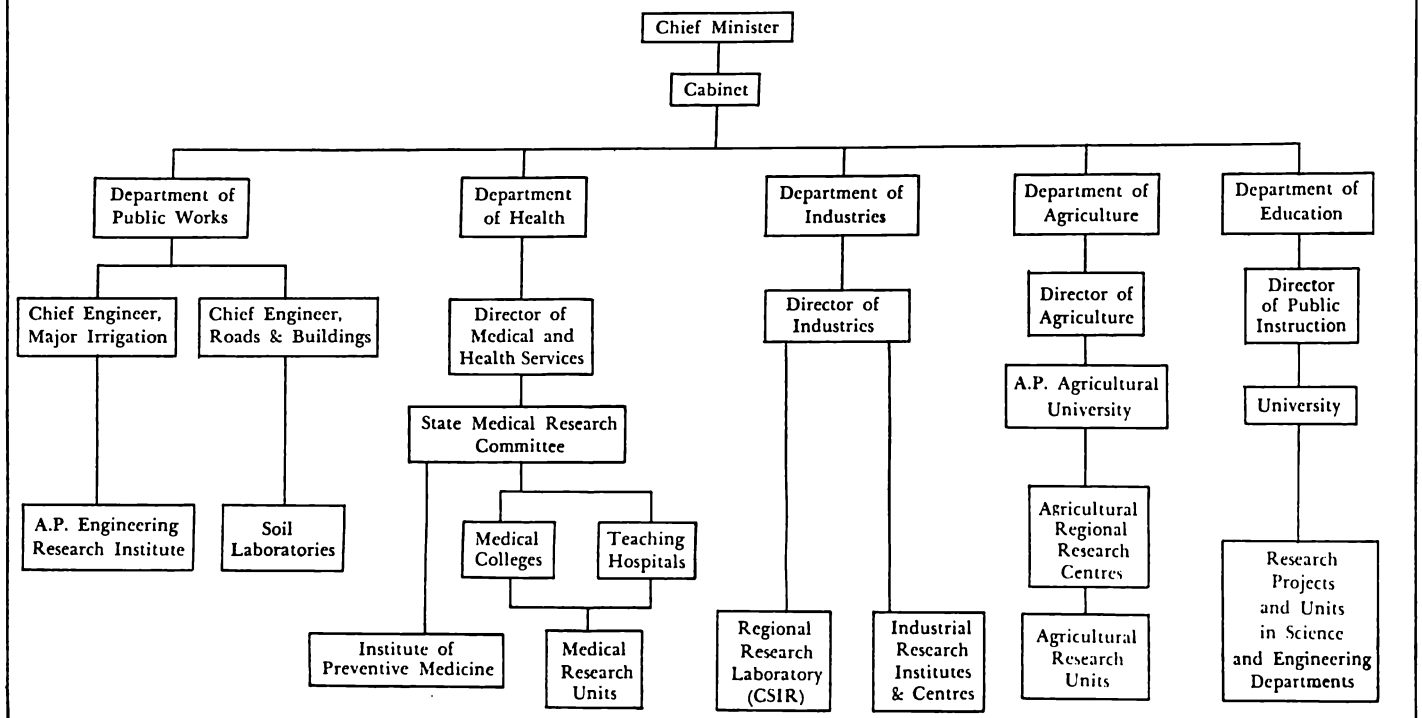
To give a general idea of the scope and character of research activity at the state level, however, Chart No. 10 and Table No. 19 present a profile of major aspects of the organizational arrangements for scientific and technical research in one state, namely, Andhra Pradesh. The paragraphs following describe briefly the principal sectors of research activity, although neither these paragraphs nor the chart and table mentioned above attempt to cover in detail all aspects of scientific and technical research in the state.

In Andhra Pradesh agricultural research is the largest single area of research activity and is conducted under the Andhra Pradesh Agricultural University at Hyderabad. In 1966, agricultural research was handed over to the Agricultural University from the State Department of Agriculture. There are six regional research stations located in Hyderabad, Rudrur (Nizamabad district), Tirupathi (Chittoor district), Bapatla (Guntur district), Srikakulam (Visakhapatnam district) and Anantapur (Anantapur district). The regional stations in turn supervise the research activity of all the 43 research centres and units under their jurisdiction and coordinate their programmes by functioning as links to the Agricultural University.

Medicine and public health appears to be the second largest sector of research activity in Andhra Pradesh. The State Medical Research Committee functions under the Director of Medical and Health Services. This Committee scrutinizes proposals for schemes and grants in medical research to be undertaken in various research centres in medical colleges and teaching hospitals situated throughout the state. The Institute of Preventive Medicine in Hyderabad consists of a manufacturing wing for bacterial vaccines, the diagnostic group, the analytical group, and the Central Blood Bank. The Institute is responsible for coordination of state research schemes, with the Director of the Institute as the Secretary of the State Medical Research Committee.

52. The author and M. V. K. Sivamohan, Research Associate in the Administrative Staff College Science and Technology Programme, are engaged in a case study of research and development activities of the Andhra Pradesh state government.

Chart No. 10 Organization Chart for Scientific and Technical Research in the Government of Andhra Pradesh



Other areas of research activity include irrigation, public works, and industries. The Andhra Pradesh Engineering Research Laboratory at Himayat Sagar works under the Chief Engineer, Major Irrigation, of the Public Works Department, and conducts research in soils, construction materials, and hydraulics. Research in this laboratory is also supported by the Central Board of Irrigation.

There are two small soil laboratories functioning under the Roads and Buildings Wing of the Public Works Department, although these laboratories mainly engaged in routine testing and analysis rather than research. The Oil Technological Institute located in Anantapur is a state-supported institution, which conducts research on the processing of vegetable oils and is related administratively to the Department of Industries. Through the Department of Industries, the State Government also provides an annual grant of Rs. 2 lakhs to the Regional Research Laboratory, Hyderabad, which is now a central government-sponsored institution but which was established and operated by the State Government until its transfer to CSIR in 1956.

The State Government is also indirectly related to the research activities carried on in various science departments of the three universities of the state through the general support which it provides to these institutions. Most specific research schemes and projects, however, draw their support from various central government sources. The three post-graduate centres at Warangal (affiliated to Osmania University), Guntur (affiliated to Andhra University), and Anantapur (affiliated to Sri Venkateshwar University) were started recently and in course of time are expected to undertake research activity also.

Science Planning and Coordination

There is no centralised coordinating agency for scientific research activities in India. The Planning Commission, which includes one member with special responsibilities for science, is concerned with the process of allocation of resources but in spite of efforts made in the past, the Commission has yet to achieve the role of overall coordination of scientific work

through the establishment of prorities and allocation of financial resources. The Member for Science is assisted by a very small secretariat, which includes the Secretary to the Cabinet Committee on Science and Technology.

The Committee on Science and Technology (COST) was established in August, 1968 and in effect replaces the Scientific Advisory Committee to the Cabinet as the highest level policy advisory body in the Government of India. The terms of reference and membership of COST are given in Table No. 20. It has 15 members, including the administrative heads of the major central government scientific organizations (CSIR, ICMR, ICAR, the Department of Atomic Energy, the Defence Research and Development Organization and University Grants Commission), as well as several other scientists. The Chairman is the Member for Science of the Planning Commission, and the Secretary is the principal staff officer to the Planning Commission Member for Science.

COST is too new to be able to make any determination about its effectiveness. It has issued only one report for general circulation—*Report on Science and Technology, 1969* —although it has submitted to the Cabinet a second report on the implementation of the Scientific Policy Resolution of 1958 (see Appendix No. 2 for the text) and has constituted a number of panels and standing committees to study in greater depth long-term national needs in such fields as non-ferrous metals and minerals, water resources, dry farming, silicones and fine chemicals.[53]

The only other organized effort at coordination, planning and review of scientific work at the supra-ministerial level in the Government of India is the Committee on Organization of Scientific Research, which was established at the suggestion of former Scientific Advisory Committee to the Cabinet (the predecessor body to COST). This Committee, which is headed by the former Scientific Advisor to the Ministry of Defence, is presently engaged in examining the scientific work done by isolated scientific departments of the Government of India. It has studied thus far the Indian Meteorological Department,

53. Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report of Science and Technology, 1969*, Delhi: Government of India Press, October, 1969, pp. 43-44.

the Radio Construction and Development Unit, and the Research and Development Directorate of the Civil Aviation Department, all in the Ministry of Tourism and Civil Aviation.[51] The membership and terms of reference are given in Table No. 21.

51. Ibid., p. 45.

TABLE No. 9

List of Council of Scientific and Industrial Research Laboratories and Institutes

COMMODITY OR FUNCTION ORIENTED LABORATORIES

1 CENTRAL BUILDING RESEARCH INSTITUTE
Roorkee, U.P.: Established: 1953
DIRECTOR: PROF. DINESH MOHAN
Research Staff: Scientific: 132, Technical: 123,
Budget: *Rs. 29,86,800.*

2 CENTRAL DRUG RESEARCH INSTITUTE
Lucknow, U.P.: Established: 1951
DIRECTOR: M. L. DHAR
Research Staff: Scientific: 137, Technical: 153,
Budget: *Rs. 45,01,900.*

3 CENTRAL ELECTRO-CHEMICAL RESEARCH INSTITUTE
Karaikudi, Tamil Nadu: Established: 1953
DIRECTOR: DR. H. V. K. UDUPA
Research Staff: Scientific: 111, Technical: 182,
Budget: *Rs. 38,91,500.*

4 CENTRAL ELECTRONICS ENGINEERING RESEARCH INSTITUTE
Pilani, Rajasthan: Established: 1953
DIRECTOR : DR. AMARJIT SINGH
Research Staff: Scientific 63, Technical 132,
Budget: *Rs. 52,69,900.*

5 CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE
Mysore: Established: 1950
DIRECTOR: DR. H. A. B. PARPIA
Research Staff: Scientific: 307, Technical: 188,
Budget: *Rs. 41,89,000.*

6 CENTRAL FUEL RESEARCH INSTITUTE
Dhanbad, Bihar: Established: 1950
DIRECTOR: DR. A. LAHIRI
Research Staff: Scientific: 324, Technical: 407
Budget: *Rs. 67,73,900.*

7 CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE
Calcutta: Established: 1950
DIRECTOR: DR. K. D. SHARMA
Research Staff: Scientific: 100, Technical: 168.
Budget: *Rs. 48,48,100.*

8 CENTRAL INDIAN MEDICAL PLANTS ORGANIZATION
Lucknow, U.P.: Established: 1959
DIRECTOR: DR. K. GANAPATHI
Research Staff: 22
Budget: *Rs. 5,90,300.*

9 CENTRAL LEATHER RESEARCH INSTITUTE
Madras: Established: 1953
DIRECTOR: DR. Y. NAYUDAMMA
Research Staff: Scientific: 112, Technical: 118.
Budget: *Rs. 27,59,300.*

10 CENTRAL MECHANICAL ENGINEERING RESEARCH INSTITUTE
Durgapur, West Bengal: Established: 1958
DIRECTOR: DR. A. K. DAY
Research Staff: Scientific: 227, Technical: 276.
Budget: *Rs. 42,22,500.*

11 CENTRAL MINING RESEARCH STATION
Dhanbad, Bihar: Established: 1955
DIRECTOR: DR. K. N. SINHA
Research Staff: Scientific: 161, Technical: 107.
Budget: *Rs. 28,35,900.*

12 CENTRAL PUBLIC HEALTH ENGINEERING RESEARCH INSTITUTE
Nagpur, Maharashtra: Established: 1958
DIRECTOR: PROF. S. J. ARCEIVALA
Research Staff: Scientific: 93, Technical: 120.
Budget: *Rs. 27,00,000.*

13 CENTRAL ROAD RESEARCH INSTITUTE
New Delhi: Established: 1950
DIRECTOR: DR. B. H. SUBBA RAJU
Research Staff: Scientific: 119, Technical: 90.
Budget: *Rs. 31,00,000.*

14 CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE
Bhavnagar, Gujarat: Established: 1954
DIRECTOR: DR. D. S. DATAR
Research Staff: Scientific: 70, Technical: 71.
Budget: *Rs. 24,24,600.*

15 CENTRAL SCIENTIFIC INSTRUMENTS ORGANISATION
Chandigarh, Punjab: Established: 1959
DIRECTOR: DR. P. S. GILL
Research Staff: Scientific: 51, Technical: 124,
Budget: *Rs. 23,30,000.*

16 INDIAN INSTITUTE OF EXPERIMENTAL MEDICINE
Calcutta: Established: 1935
DIRECTOR: PROF. R. N. CHAKRAVARTI
Research Staff: Scientific: 58, Technical: 44,
Budget: *Rs. 18,71,000.*

17 INDIAN INSTITUTE OF PETROLEUM
Dehra Dun, U.P.: Established: 1960
DIRECTOR: DR. M. G. KRISHNA
Research Staff: Scientific: 129, Technical: 185,
Budget: *Rs. 47,77,900.*

18 NATIONAL AERONAUTICAL LABORATORY
Bangalore, Mysore: Established: 1959
DIRECTOR: DR. S. R. VALLURI
Research Staff: Scientific: 103, Technical: 222,
Budget: *Rs. 89,03,000.*

19 NATIONAL METALLURGICAL LABORATORY
Jamshedpur Bihar: Established: 1950
DIRECTOR: V. A. ALTEKAR
Research Staff: Scientific: 184, Technical: 362,
Budget: *Rs. 1,04,51,200.*

20 STRUCTURAL ENGINEERING RESEARCH CENTRE
Roorkee, U.P.: Established: 1965
DIRECTOR: PROF. G. S. RAMASWAMY
Research Staff: Scientific: 41, Technical: 23,
Budget: *Rs. 9,36,300.*

DISCIPLINE LABORATORIES

1 NATIONAL CHEMICAL LABORATORY
Poona: Established: 1950
DIRECTOR: DR. B. D. TILAK
Research Staff: Scientific: 273, Technical: 213,
Budget: *Rs. 64,26,100.*

2 NATIONAL GEOPHYSICAL RESEARCH INSTITUTE
Hyderabad, A.P.: Established: 1961
DIRECTOR: DR. HARI NARAIN
Research Staff: Scientific: 80, Technical: 60,
Budget: *Rs. 16,59,700.*

3 NATIONAL INSTITUTE OF OCEONOGRAPHY
New Delhi: Established: 1966
DIRECTOR: DR. N. K. PANIKKAR
Research Staff: Scientific: 59, Technical: 9,
Budget: *Rs. 20,65,000.*

4 NATIONAL PHYSICAL LABORATORY
New Delhi: Established: 1950
DIRECTOR: DR. A. R. VERMA
Research Staff: Scientific: 140, Technical: 401.
Budget: *Rs. 75,12,800.*

REGIONAL RESEARCH LABORATORIES

1 REGIONAL RESEARCH LABORATORY
Hyderabad, A.P.: Established: 1959
DIRECTOR: DR. G. S. SIDHU
Research Staff: Scientific: 200, Technical: 236,
Budget: *Rs. 64,60,000.*

2 REGIONAL RESEARCH LABORATORY
Jammu: Established: 1941
DIRECTOR: DR. K. GANAPATHI
Research Staff: Scientific: 83, Technical: 153,
Budget: *Rs. 37,80,400.*

3 REGIONAL RESEARCH LABORATORY
Jorhat, Assam: Established: 1944
DIRECTOR: DR. M. S. IYENGAR
Research Staff: Scientific: 53, Technical: 60,
Budget: *Rs. 26,08,600.*

4 REGIONAL RESEARCH LABORATORY
Bhubaneshwar, Orissa: Established: 1964
DIRECTOR: G. S. CHOWDHURY
Research Staff: Scientific: 27, Technical: 28,
Budget: *15,00,000.*

DIRECTORATES, MUSEUMS AND OTHER CENTRES

1 INDIAN NATIONAL SCIENTIFIC DOCUMENTATION CENTRE
New Delhi: Established: 1952
SCIENTIST-IN-CHARGE: S. PARTHASARATHY
Research Staff: Scientific: 98, Technical: 134,
Budget: *Rs. 26,67,100.*

2 INDIAN TOXICOLOGY RESEARCH CENTRE
Lucknow, U.P.: Established: 1965
DIRECTOR: DR. S. H. ZAIDI
Research Staff: Scientific: 27, Technical: 9,
Budget: *Rs. 5,20,600.*

3 NATIONAL BOTANIC GARDENS
Lucknow, U.P.: Established: 1953
DIRECTOR: DR. L. B. SINGH
Research Staff: Scientific: 110, Technical: 126,
Budget: *Rs. 26,67,100.*

4 PUBLICATIONS AND INFORMATION DIRECTORATE, CSIR
New Delhi: Established: 1951
CHIEF EDITOR: A. KRISHNAMURTHI
Research Staff: Scientific: 32, Technical: 41,
Budget: *Rs. 15,76,600.*

5 BIRLA INDUSTRIAL & TECHNOLOGICAL MUSEUM
Calcutta: Established: 1956
CHIEF CURATOR: A. BOSE
Research Staff: Scientific: 26, Technical: 82,
Budget: *Rs. 12,14,800.*

6 VISVESVARAYA INDUSTRIAL & TECHNOLOGICAL MUSEUM
Bangalore: Established: 1962 (taken over by CSIR)
CHIEF CURATOR: A. BOSE
Research Staff: Scientific & Technical: 37,
Budget: *Rs. 6,69,500.*

CO-OPERATIVE RESEARCH INSTITUTES

1 AHMEDABAD TEXTILE INDUSTRY'S RESEARCH ASSOCIATION
Ahmedabad, Gujarat: Established: 1947
DIRECTOR: DR. P. C. MEHTA
Research Staff: 143,
Budget: *Rs. 22,03,000.*

2 BOMBAY TEXTILE RESEARCH ASSOCIATION
Bombay: Established: 1954
DIRECTOR: DR. C. NANJUNDAYYA
Research Staff: 80,
Budget: *Rs. 19,90,000.*

3 CEMENT RESEARCH INSTITUTE OF INDIA
New Delhi: Established: 1966
DIRECTOR: DR. H. C. VISVESVARAYA
Research Staff: 11.

4 INDIAN JUTE INDUSTRIES' RESEARCH ASSOCIATION
Calcutta: Established: 1966
DIRECTOR: DR. T. S. SUBRAMANIAN
Research Staff: 172,
Budget: *Rs. 31,01,000.*

5 INDIAN PLYWOOD INDUSTRIES RESEARCH ASSOCIATION
Bangalore: Established: 1961
DIRECTOR: DR. JOSEPH GEORGE
Research Staff: 34,
Budget: *Rs. 16,39,017.*

6 SILK AND ART SILK MILLS' RESEARCH ASSOCIATION
Bombay: Established: 1950
EXECUTIVE DIRECTOR: J. G. PARIKH
Research Staff: 30,
Budget: *8,48,500.*

7 SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
Coimbatore, Tamil Nadu: Established: 1951
DIRECTOR: K. SREENIVASAN
Research Staff: 50,
Budget: *Rs. 8,21,000.*

8 TEA RESEARCH ASSOCIATION
Jorhat, Assam: Established: 1911
DIRECTOR: D. H. LAYCOCK
Research Staff: 97,
Budget: *Rs. 51,57,613.*

9 WOOL RESEARCH ASSOCIATION
Bombay: Established: 1963
DEPUTY DIRECTOR-IN-CHARGE: DR. N. P. BADVE
Research Staff: 10,
Budget: *Rs. 1,97,152.*

Source: T. S. Rajagopalan and R. Satyanarayana, *The Director of Scientific Research Institutions in India, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 10

List of Indian Council of Agricultural Research Institutes, Centres and Stations

1 CENTRAL ARID ZONE RESEARCH INSTITUTE
Jodhpur, Rajasthan: Established: 1959
DIRECTOR: DR. T. R. MEHTA
Research Staff: 121,
Budget: *Rs. 18,11,200.*

2 CENTRAL COCONUT RESEARCH STATION
Kasargod, Kerala: Established: 1916
DIRECTOR: M. C. NAMBIAR
Research Staff: 41,
Budget: *Rs. 5,28,500.*

3 CENTRAL COCONUT RESEARCH STATION
Kayangulam, Kerala: Established: 1948
DIRECTOR: DR. S. B. LAL
Research Staff: 30,
Budget: *Rs. 7,50,250.*

4 CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
Barrackpore, West Bengal: Established: 1947
DIRECTOR: DR. V. G. JHINGRAN
Research Staff: 170,
Budget: *Rs. 32,56,000.*

5 CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
Chittoor Road, Ernakulam, Cochin, Kerala: Established: 1957
DIRECTOR: DR. A. N. BOSE
Research Staff: 130,
Budget: *Rs. 15,96,000.*

6 CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Mandapam Camp, Tamil Nadu: Established: 1947
DIRECTOR: DR. S. JONES
Research Staff: 131
Budget: *Rs. 21,18,000.*

7 CENTRAL POTATO RESEARCH INSTITUTE
Simla, Himachal Pradesh: Established: 1949
DIRECTOR: DR. MUKHTAR SINGH
Research Staff: 346,
Budget: *Rs. 17,28,300.*

8 CENTRAL INSTITUTE OF PLANTATION CROPS
Vittal, Mysore State: Established: 1956
ARECANUT SPECIALIST: K. V. AHAMED BAVAPPA
Research Staff: 88,
Budget: *Rs. 8,42,000.*

9 CENTRAL RICE RESEARCH INSTITUTE
Cuttack, Orissa: Established: 1946
DIRECTOR: DR. S. Y. PADMANABHAN
Research Staff: 121,
Research: *Rs. 21,75,000.*

10 CENTRAL SHEEP AND WOOL RESEARCH INSTITUTE
Avikanagar, Jaipur, Rajasthan: Established: 1962
DIRECTOR: DR. A. ROY
Research Staff: 31,
Budget: *Rs. 13,00,000.*

11 CENTRAL SOIL SALINITY RESEARCH INSTITUTE
Karnal, Haryana: Established: 1969
DIRECTOR: DR. D. R. BHUMBLA
Research Staff: 16,
Budget: *Rs. 10,00,000.*

12 CENTRAL TOBACCO RESEARCH INSTITUTE
Rajahmundry, Andhra Pradesh: Established: 1947
DIRECTOR: DR. D. M. GOPINATH
Research Staff: 79,
Budget: *Rs. 13,90,000.*

13 CENTRAL TUBER CROPS RESEARCH INSTITUTE
Vazhuthacaud, Trivandrum, Kerala State: Established: 1963
DIRECTOR: DR. M. L. MAGOON
Research Staff: 27,
Budget: *Rs. 3,98,400.*

14 COTTON TECHNOLOGICAL RESEARCH LABORATORY
Matunga, Bombay: Established: 1924
DIRECTOR: DR. V. SUNDARAM
Research Staff: 91,
Budget: *Rs. 16,00,000.(approximately).*

15 INDIAN AGRICULTURAL RESEARCH INSTITUTE
Pusa, New Delhi: Established: 1905
DIRECTOR: DR. M. S. SWAMINATHAN
Research Staff: 798,
Budget: *Rs. 2,45,13,800.*

16 INDIAN GRASSLAND AND FODDER RESEARCH INSTITUTE
Jhansi, Uttar Pradesh: Established: 1962
ACTING DIRECTOR: P. M. DABADGHAO
Research Staff: 53,
Budget: *Rs. 21,69,490.*

17 INDIAN INSTITUTE OF SUGARCANE RESEARCH
Dilkusha, Lucknow, Uttar Pradesh: Established: 1952
DIRECTOR: R. R. PANJE
Budget: *Rs. 6,97,500.*

18 INDIAN LAC RESEARCH INSTITUTE
Namkum, Ranchi, Bihar: Established: 1925
DIRECTOR: DR. G. S. MISRA
Research Staff: 53,
Budget: *Rs. 13,10,000.*

19 INDIAN VETERINARY RESEARCH INSTITUTE
Izatnagar and Mukteswar, Uttar Pradesh: Established: 1889
DIRECTOR: DR. C. M. SINGH
Research Staff: 276,
Budget: *Rs. 98,56,900.*

20 INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS
New Delhi: Established: 1930
STATISTICAL ADVISER: DR. G. R. SETH
Research Staff: 350 (approximately),
Budget: *Rs. 14,67,000.*

21 INSTITUTE OF HORTICULTURAL RESEARCH
Upper Palace Orchards, Bangalore, Mysore State: Established: 1967
DIRECTOR: DR. G. S. RANDHAWA
Research Staff: 16,
Budget: *Rs. 1,00,000.*

22 JUTE AGRICULTURAL RESEARCH INSTITUTE
Nilgang, Barrackpore, West Bengal: Established: 1939
DIRECTOR: DR. T. GHOSH
Research Staff: 85,
Budget: *Rs. 12,88,400.*

23 JUTE TECHNOLOGICAL RESEARCH LABORATORIES
Regent Park, Calcutta, West Bengal: Established: 1938
DIRECTOR: DR. S. B. BANDYOPADHYAY
Research Staff: 15,
Budget: *Rs. 5,33,000.*

24 NATIONAL DAIRY RESEARCH INSTITUTE
Karnal, Haryana: Established: 1955
DIRECTOR: DR. NOSHIR N. DASTUR
Research Staff: 203,
Budget: *Rs. 78,75,000.*

25 SUGARCANE BREEDING INSTITUTE
Coimbatore, Tamil Nadu: Established: 1912
DIRECTOR: DR. J. THULJARAM RAO
Research Staff: 37,
Budget: *Rs. 5,62,400.*

26 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Agra Uttar Pradesh: Established: 1955
OFFICER-IN-CHARGE: S. C. GUPTE
Research Staff: 8,
Budget: *Rs. 1,28,400.*

27 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Bellary, Mysore State: Established: 1954
OFFICER-IN-CHARGE: A. R. BHASKARAN
Research Staff: 15,
Budget: *Rs. 1,83,000.*

28 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Chandigarh: Established: 1956
OFFICER-IN-CHARGE: I. I. ERASMUS
Research Staff: 10,
Budget: *Rs. 1,53,000.*

29 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Dehra Dun, Uttar Pradesh: Established: 1954
OFFICER-IN-CHARGE: DR. K. G. TEJWANI
Research Staff: 17,
Budget: *Rs. 3,35,800.*

30 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Ibrahimpatan, Andhra Pradesh: Established: 1962
OFFICE-IN-CHARGE: S. CHINNAMANI
Research Staff: 7,
Budget: *Rs. 1,36,000.*

31 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Kota, Rajasthan: Established: 1954
OFFICER-IN-CHARGE: RAJBANS DAYAL
Research Staff: 9,
Budget: *Rs. 1,35,700.*

32 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Ootacamund, Tamil Nadu: Established: 1955
OFFICER-IN-CHARGE: P. K. THOMAS
Research Staff: 17,
Budget: *Rs. 2,20,100.*

33 SOIL CONSERVATION RESEARCH, DEMONSTRATION AND TRAINING CENTRE
Vasad, Gujarat: Established: 1955-56
OFFICER-IN-CHARGE: BALVIR VARMA
Research Staff: 15,
Budget: *Rs. 1,87,300.*

Source: T. S. Rajagopalan, and R. Satyanarayana, *The Directory of Research Institutions in India, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 11

List of Indian Council of Medcal Research Institutes, Laboratories and Units

1 NATIONAL INSTITUTE OF NUTRITION
Jamia Osmania, Hyderabad 7, Andhra Pradesh: Established: 1918
DIRECTOR: DR. C. GOPALAN
Research Staff: 48,
Budget: *Rs. 17,69,000.*

2 VIRUS RESEARCH CENTRE
20-A, Wellesley Road, Poona 1, Maharashtra: Established: 1952
DIRECTOR: T. RAMACHANDRA RAO
Research Staff: 28,
Budget: *Rs. 16,83,000.*

3 TUBERCULOSIS CHEMOTHERAPY CENTRE
Chetpur, Madras 31: Established: 1956
DIRECTOR: S. P. TRIPATHY
Research Staff: 19,
Budget: *Rs. 11,20,000.*

4 CHOLERA RESEARCH CENTRE
3, Kyd Street, Calcutta 16: Established: 1962
DIRECTOR: DR. S. MUKERJEE
Research Staff: 13,
Budget: *Rs. 5,44,000.*

5 INDIAN REGISTRY OF PATHOLOGY
C/o Department of Pathology, Safdarjung Hospital, New Delhi 16
Established: 1965
DIRECTOR: DR. S. SRIRAMACHARI
Research Staff: 14,
Budget: *Rs. 4,94,000.*

6 OCCUPATIONAL HEALTH RESEARCH INSTITUTE
B. J. Medical College, Ahmedabad 16, Gujarat: Established: 1967
DIRECTOR: DR. M. N. GUPTA
Research Staff: 13,
Budget: *4,04,000.*

7 INSTITUTE FOR RESEARCH IN REPRODUCTION
Jahangir Merwanji Street, Parel, Bombay 12: Established: 1970
OFFICER-IN-CHARGE: DR. (MRS.) SHANTA S. RAO
Research Staff: 25
Budget: *Rs. 7,06,000.*

8 ENTERO-VIRUS RESEARCH UNIT
Haffkine Institute, Bombay 12: Established: 1949-50
OFFICER-IN-CHARGE: DR. K. H. DAVE
Research Staff: 4,
Budget: *Rs. 1,90,000.*

9 NEUROPHYSIOLOGY RESEARCH UNIT
Department of Physiology, All-India Institute of Medical Sciences, New Delhi 16: Established: 1956-57
OFFICER-IN-CHARGE: DR. B. K. ANAND
Research Staff: 3,
Budget: *Rs. 68,000.*

10 HAEMATOLOGICAL UNIT
School of Tropical Medicine, Calcutta 12: Established: 1943-44
OFFICER-IN-CHARGE: DR. J. B. CHATTERJEE
Research Staff: 2,
Budget: *Rs. 51,000.*

11 MEDICAL TOXICOLOGY UNIT
Department of Pharmacology, All-India Institute of Medical Sciences, New Delhi 16: Established: 1968
OFFICER-IN-CHARGE: DR. S. K. KASHYAP
Research Staff: 2,
Budget: *Rs. 46,000.*

12 LABORATORY ANIMALS INFORMATION SERVICE
Tata Memorial Centre, Parel, Bombay 12: Established: 1959
OFFICER-IN-CHARGE: DR. (MRS.) B. K. BATRA
Budget: *Rs. 23,000.*

13 BLOOD GROUP REFERENCE CENTRE
Seth G. S. Medical College, Bombay 12: Established: 1956-57
OFFICER-IN-CHARGE: DR. H. M. BHATIA
Research Staff: 5,
Budget: *Rs. 1,19,000.*

14 I. C. M. R. RESEARCH UNIT
Pasteur Institute, Coonoor, Tamil Nadu: Established: 1969-70
DIRECTOR: DR. N. VEERARAGHAWAN
Research Staff: 7,
Budget: *Rs. 5,81,000.*

Source: T. S. Rajagopalan and R. Satyanarayana, *The Directory of Scientific Research Institutions in Industry, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969 (as supplemented and updated by ICMR Headquarters).

TABLE No. 12

List of Defence Research and Development Organization Laboratories and Establishments

AERONAUTICS

1 AERONAUTICAL DEVELOPMENT ESTABLISHMENT
Bangalore, Mysore State
DIRECTOR: O. P. MEHRA.

2 GAS TURBINE RESEARCH ESTABLISHMENT
Bangalore, Mysore State
DIRECTOR: GP. CAPT. S. N. ROY CHAUDHURY

ARMAMENTS

1 ARMAMENTS RESEARCH AND DEVELOPMENT ESTABLISHMENT
Poona, Maharashtra.

2 DEFENCE METALLURGICAL RESEARCH LABORATORY
Hyderabad, Andhra Pradesh
DIRECTOR: R. U. TAMBANKAR

3 DEFENCE RESEARCH AND DEVELOPMENT LABORATORY
Hyderabad, Andhra Pradesh

4 EXPLOSIVES RESEARCH AND DEVELOPMENT LABORATORY
Poona, Maharashtra
DIRECTOR: DR. W. D. PATWARDHAN.

5 INSTRUMENTS RESEARCH AND DEVELOPMENT ESTABLISHMENT
Dehra Dun, Uttar Pradesh
DIRECTOR: A. N. BHATTACHARYA.

6 PROOF AND EXPERIMENTAL ESTABLISHMENT
Balasore, Orissa
SUPERINTENDENT: COL. PRAKASH SINGH

7 TERMINAL BALLISTIC RESEARCH LABORATORY
Chandigarh
DIRECTOR: DR. SAMPURAN SINGH

ELECTRONICS

1 DEFENCE ELECTRONICS RESEARCH LABORATORY
Hyderabad, Andhra Pradesh
DIRECTOR: V. N. RAO

2 ELECTRONICS AND RADAR DEVELOPMENT ESTABLISHMENT
Bangalore, Mysore State
DIRECTOR: BRIG. S. K. MALHOTRA

3 SOLID STATE PHYSICS LABORATORY
Delhi
DIRECTOR: DR. N. B. BHATT

ENGINEERING EQUIPMENT

1 RESEARCH AND DEVELOPMENT ESTABLISHMENT (ENGINEERS)
Poona, Maharashtra
DIRECTOR: BRIG. A. C. AGA.

FIRE REESEARCH

1 FIRE SERVICE, RESEARCH, DEVELOPMENT AND TRAINING ESTABLISHMENT
New Delhi.

GENERAL RESEARCH LABORATORIES

1 DEFENCE FOOD RESEARCH LABORATORY
Mysore
DIRECTOR: DR. P. K. VIJAYARAGHAVAN.

2 DEFENCE INSTITUTE OF PHYSIOLOGY AND ALLIED SCIENCES
New Delhi
DIRECTOR: SURG. CAPT. M. S. MALHOTRA.

3 DEFENCE LABORATORY
Jodhpur, Rajasthan
DIRECTOR: DR. B. N. SINGH.

4 DEFENCE RESEARCH LABORATORY (MATERIALS)
Kanpur, Uttar Pradesh
DIRECTOR: DR. J. N. NANDA.

5 DEFENCE SCIENCE LABORATORY
Delhi
DIRECTOR: DR. KARTAR SINGH.

6 INDIAN NAVAL PHYSICAL LABORATORY,
Cochin, Kerala
DIRECTOR: DR. D. SRINIVASAN.

7 INSTITUTE OF ARMAMENT TECHNOLOGY
Poona, Maharashtra
DEAN: BRIG. PRITAMPAL SINGH.

8 INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES
Delhi
DIRECTOR: COL. S. K. MAJUMDAR.

9 INSTITUTE OF WORK STUDY
Mussorie, Uttar Pradesh
DIRECTOR: BRIG. V. DHRUVA.

10 NAVAL CHEMICAL AND METALLURGICAL LABORATORY
Bombay
DIRECTOR: DR. C. P. DE.

GENERAL STORES

1 AERIAL DELIVERY DETACHMENT
Agra, Uttar Pradesh
OFFICER-IN-CHARGE: COL. RAGHUBIR SINGH.

2 DEFENCE RESEARCH LABORATORY (TEXTILE, AERIAL AND GENERAL STORES)
Kanpur, Utter Pradesh
DIRECTOR: DR. C. N. K. MURTHY.

OTHER UNITS

1 DIRECTORATE OF PSYCHOLOGICAL RESEARCH
New Delhi
DIRECTOR: DR. A. K. P. SINHA.

2 DIRECTORATE OF SCIENTIFIC EVALUATION
New Delhi
DIRECTOR: DR. S. S. SRIVASTAVA.

3 INTERSERVICE STORES PRESERVATION ORGANIZATION
New Delhi
SECRETARY: SHUMSHER SINGH.

4 VEHICLES RESEARCH AND DEVELOPMENT ESTABLISHMENT
Ahmednagar, Maharashtra
DIRECTOR: D. P. MUKHERJEE.

Source: T. S. Rajagopalan and R. Satyanarayana, *The Directory of Scientific Research Institutions in India, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 13

List of Some Survey Organizations and Research Units in Government of India Departments

MINISTRY OF FOOD AND AGRICULTURE

1 CENTRAL FOOD LABORATORY
3, Kyd Street, Calcutta 16: Established: 1955
DIRECTOR: DR. S. N. MITRA
Research Staff: 27,
Budget: *Rs. 3,18,000.*

2 DEEP SEA FISHING ORGANIZATION
Botawala Chambers, Sir P. M. Road, Bombay 1: Established: 1946
SUPERINTENDING ENGINEER: S. MISKEITH
Budget: *Rs. 23,48,000.*

3 FOREST RESEARCH INSTITUTE AND COLLEGES
New Forest P. O., Dehra Dun, Uttar Pradesh: Established: 1906
PRESIDENT: R. C. KAUSHIK
Research Staff: 606,
Budget: *Rs. 67,96,450.*

4 GRAIN STORAGE RESEARCH AND TRAINING CENTRE
Meerut Road, P. O. Box 10, Hapur, Uttar Pradesh: Established: 1958
DIRECTOR: DR. K. KRISHNA MURTHY
Research Staff: 11,
Budget: *Rs. 1,30,000.*

5 NATIONAL SUGAR INSTITUTE
Kalianpur, Kanpur, Uttar Pradesh: Established: 1936
DIRECTOR: SURESH CHANDRA GUPTA
Research Staff: 89,
Budget: *Rs. 24,89,000.*

MINISTRY OF TOURISM AND CIVIL AVIATION

1 INDIA METEOROLOGICAL DEPARTMENT
Meteorological Office, Lodi Road, New Delhi 3: Established: 1875
DIRECTOR-GENERAL OF OBSERVATORIES: DR. P. KOTESVARAM
Research Staff: 370 (approximately),
Budget: *Rs. 3,75,00,000.*

2 RESEARCH AND DEVELOPMENT DIRECTORATE
Technical Centre, Civil Aviation
Department, Safdarjung, New Delhi 3: Established: 1950
Dy. Director-General: S. Ramamritham
Dy. Director: K. B. Ganesan
Budget: *Rs. 5,53,500.*

MINISTRY OF INFORMATION, BROADCASTING AND COMMUNICATIONS

1 TELECOMMUNICATION RESEARCH CENTRE
Eastern Court Compound, Janpath, New Delhi: Established: 1956
Director: N. V. Shenoi
Research Staff: 124,
Budget: *Rs. 14,37,000.*

2 OFFICE OF THE RESEARCH ENGINEER
All India Radio, Indraprastha Estate, New Delhi 1: Established: 1937
Director: M. R. Rao
Research Staff: 42,
Budget: *Rs. 10,39,700.*

MINISTRY OF EDUCATION AND YOUTH SERVICES

1 ANTHROPOLOGICAL SURVEY OF INDIA
27, Jawaharlal Nehru Road, Indian Museum, Calcutta 13:
Established: 1945
Director: Dr. D. K. Sen
Research Staff: 76,
Budget: *Rs. 17,83,000.*

2 BOTANICAL SURVEY OF INDIA
14, Madan Street, Calcutta 13: Established: 1890
Director: Dr. K. Subramanyam
Research Staff: Scientific 165; Technical: 90,
Budget: *Rs. 37,57,000.*

3 GEODETIC AND RESEARCH BRANCH, SURVEY OF INDIA
P. O. Box 77, Dehra Dun, Uttar Pradesh: Established: 1800
Director: Col. K. L. Khosla
Budget: *Rs. 23,95,900.*

4 NATIONAL INSTITUTE OF FOUNDRY AND FORGE TECHNOLOGY
Dhurwa P. O., Ranchi 4, Bihar: Established: 1966
Director: Dr. K. B. Mehta
Research-cum-Teaching Staff: 10,
Budget: *Rs. 20,00,000.*

5 ZOOLOGICAL SURVEY OF INDIA
34, Chittaranjan Avenue, Calcutta 12: Established: 1916
DIRECTOR: DR. A. P. KAPUR
Research Staff: 134,
Budget: *Rs. 27,24,000.*

MINISTRY OF HEALTH AND FAMILY PLANNING

1 ALL INDIA INSTITUTE OF HYGIENE AND PUBLIC HEALTH
110, Chittaranjan Avenue, Calcutta 12: Established: 1932
DIRECTOR: DR. M. N. RAO
Research Staff: 105,
Budget: *Rs. 36,60,000.*

2 ALL INDIA INSTITUTE OF MEDICAL SCIENCES
Ansari Nagar, New Delhi 16: Established: 1956
DIRECTOR: DR. V. RAMALINGASWAMY
Research Staff: 700 (approximately),
Budget: *Rs. 2,07,58,000.*

3 ALL INDIA INSTITUTE OF MENTAL HEALTH
P. O. Box 15, Shantinagar P. O., Bangalore 27: Established: 1954
DIRECTOR: DR. K. S. MANI
Research Staff: 22,
Budget: *Rs. 11,36,000.*

4 ALL INDIA INSTITUTE OF PHYSICAL MEDICINE AND REHABILITATION
Haji Ali Park, Clerk Road, Mahalaxmi, Bombay 34:
Established: 1955
DIRECTOR: DR. M. V. SANT
Research Staff: 33,
Budget: *Rs. 8,20,400.*

5 ALL INDIA INSTITUTE OF SPEECH AND HEARING
Maharaja's College, Centenary Hall, Mysore 5: Established: 1965
DIRECTOR: DR. J. J. DHARMARAJ
Research Staff: 7,
Budget: *Rs. 3,13,000.*

6 B. C. G. VACCINE LABORATORY
Guindy, Madras 32: Established: 1948
DIRECTOR: DR. J. C. SURI
Research Staff: 71 (including production staff),
Budget: *Rs. 4,85,000.*

7 CENTRAL DRUGS LABORATORY
3, Kyd Street, Calcutta 16: Established: 1937
DIRECTOR: DR. D. GHOSH
Research Staff: 38,
Budget: *Rs. 6,00,000.*

8 CENTRAL LEPROSY TEACHING AND RESEARCH INSTITUTE
P. O. Box 1, Chingleput, Tamil Nadu: Established: 1955
DIRECTOR: DR. C. G. S. IYER
Research Staff: 87 (includes medical, scientific, technical, and nursing),
Budget: *Rs. 15,00,000 (approximately)*.

9 CENTRAL RESEARCH INSTITUTE
Kasauli, Uttar Pradesh: Established: 1905
DIRECTOR: DR. A. K. THOMAS
Research Staff: 134,
Budget: *Rs. 26,79,000.*

10 VALLABHBHAI PATEL CHEST INSTITUTE
University of Delhi, Delhi 7: Established: 1953
DIRECTOR: PROF. A. S. PAINTAL
Research Staff: 24,
Budget: *Rs. 12,35,000.*

11 CHITTARANJAN NATIONAL CANCER RESEARCH CENTER
37, S. P. Mookerjee Road, Calcutta 26: Established: 1957
DIRECTOR: DR. B. MUKERJI
Research Staff: 50,
Budget: *Rs. 5,75,000.*

12 POSTGRADUATE INSTITUTE OF MEDICAL EDUCATION AND RESEARCH
Sector 12, Chandigarh: Established: 1960
DIRECTOR: DR. SANTOSH SINGH ANAND
Budget: *Rs. 1,23,50,500.*

13 JAWAHARLAL INSTITUTE OF POSTGRADUATE MEDICAL EDUCATION AND RESEARCH
Pondicherry 4: Established: 1956
PRINCIPAL: DR. D. J. REDDY
Research Staff: 72,
Budget: *Rs. 60,37,000.*

MINISTRY OF INDUSTRIAL DEVELOPMENT AND COMPANY AFFAIRS

1 CENTRAL BEE RESEARCH INSTITUTE
839/1 Shivajinagar, Poona-4: Established: 1962
DEPUTY DIRECTOR: C. V. THAKAR
Research Staff: 57,
Budget: *Rs. 3,85,232.*

2 CENTRAL MACHINE TOOL INSTITUTE
Tumkur Road, Bangalore-22: Established: 1962
Research Staff: 52,
Budget: *Rs. 19,44,000.*

3 INDIAN INSTITUTE OF HANDLOOM TECHNOLOGY
Manor House, Foulkes Compound, Salem-1, Tamil Nadu: Established: 1960
PRINCIPAL: S. SRINIVASAN
Research Staff: 50,
Budget: *Rs. 2,60,300.*

4 INDIAN STANDARDS INSTITUTION
9, Bahadur Shah Zafar Marg, New Delhi 1: Established: 1947
DIRECTOR-GENERAL: DR. A. N. GHOSH
Research Staff: 200,
Budget: *Rs. 90,72,000.*

5 JAMNALAL BAJAJ CENTRAL RESEARCH INSTITUTE FOR VILLAGE INDUSTRIES
Maganwadi, P. O. Box 4, Wardha, Maharashtra: Established: 1955
DIRECTOR: DR. R. K. SHRIVASTAVA
Research Staff: 205,
Budget: *Rs. 7,00,000.*

6 PINEAPPLE FIBRE RESEARCH CENTRE
Moodbidri, Mysore State: Established: 1956
ASSISTANT DEVELOPMENT OFFICER: R. V. NARSINGA RAO
Research Staff: 16,
Budget: *Rs. 72,000.*

MINISTRY OF IRRIGATION AND POWER

1 CENTRAL SOIL MECHANICS RESEARCH STATION
Exhibition Grounds, American Pavilion, Mathura Road, New Delhi: Established: 1964
DIRECTOR: DR. I. C. DOS M. PAIS-CUDDOU.

2 CENTRAL WATER AND POWER RESEARCH STATION
Khadakwasala P. O., Poona 24: Established: 1916
DIRECTOR: C. V. GOLE
Research Staff: 236; Ancillary technical: 262,
Budget: *Rs. 84,87,000.*

3 POWER RESEARCH INSTITUTE
P. O. Box 1042, Bangalore 12: Established: 1960
DIRECTOR: S. N. VINZE
Research Staff: 32,
Budget: *Rs. 15,00,000.*

MINISTRY OF PETROLEUM, CHEMICALS, MINES, AND METALS

1 GEOLOGICAL SURVEY OF INDIA
27, Jawaharlal Nehru Road, Calcutta 13: Established: 1851
DIRECTOR GENERAL: G. S. CHATTERJI
Research Staff: 914,
Budget: *Rs. 3,84,00,000.*

2 GOVERNMENT SALT TEST LABORATORY
Antop Hill, Wadala, Bombay 31: Established: 1950
DEPUTY SALT COMMISSIONER: C. L. MALHOTRA
Research Staff: 4,
Budget: *35,000.*

3 INDIAN BUREAU OF MINES
New Secretarial Building, Nagpur, Maharashtra: Established: 1948
CONTROLLER: K. S. MAHAPATRA
Technical Staff: 277,
Budget: *Rs. 28,75,000.*

4 RESEARCH AND TRAINING INSTITUTE
OIL AND NATURAL GAS COMMISSION, 9, Kaulagarh Road,
P. O. Box 40, Dehra Dun, Uttar Pradesh: Established: 1963
ADDITIONAL DIRECTOR: V. V. SASTRI
Staff: 501,
Budget: *Rs. 3,62,900.*

MINISTRY OF FOREIGN TRADE

1 CENTRAL COFFEE RESEARCH INSTITUTE
Coffee Board Research Department, Coffee Research Station P. O.,
Chikmagalur District, Mysore State: Established: 1925
DIRECTOR: R. L. NARASIMHASWAMY
Research Staff: 85, Extension Staff: 58,
Budget: *Rs. 19,76,900.*

2 CENTRAL COIR RESEARCH INSTITUTE
Kalvoor P. O., Alleppey, Kerala: Established: 1959
DIRECTOR: G. N. PRABHU
Research Staff: 5,
Budget: *Rs. 1,50,000.*

3 CENTRAL SERICULTURAL RESEARCH STATION
Berhampore, West Bengal: Established: 1943
DIRECTOR: DR. S. KRISHNASWAMI
Research Staff: 28,
Budget: *Rs. 5,45,900.*

4 CENTRAL SERICULTURAL RESEARCH AND TRAINING INSTITUTE
Shantivilas, Nizarabad, Mysore 1: Established: 1961
ASSISTANT DIRECTOR: DR. N. S. SIDHU
Research Staff: 23,
Budget: *Rs. 5,95,000.*

5 CENTRAL TASAR RESEARCH STATION
'Nirvan' No. 1, West End Park, Hehal P. O., Ranchi, Bihar:
Established: 1964
DIRECTOR: DR. MANJEET S. JOLLY
Research Staff: 20,
Budget: *Rs. 2,80,975.*

6 RUBBER RESEARCH INSTITUTE OF INDIA
Kottayam 9, Kerala: Established: 1954
DIRECTOR: V. K. BHASKARAN NAIR
Research Staff: 55,
Budget: *Rs. 13,23,700.*

MINISTRY OF RAILWAYS

1 RESEARCH DESIGNS AND STANDARDS ORGANISATION
Ministry of Railways, Alambagh, Lucknow 5: Established: 1957
DIRECTOR-GENERAL: M. SRINIVASAN
Technical Staff: 1,332,
Budget: *Rs. 1,66,33,000.*

Source: T. S. Rajagopalan and R. Satyanarayana, *The Directory of Scientific Research Institutions in India*, 1969, New Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 14

List of Universities and Institutions Deemed to be Universities 1968

(Arranged Chronologically)

Year of Establishment		*Name of the University*	*Location*
1857	1	Calcutta University	Calcutta
	2	Bombay University	Bombay
	3	Madras University	Madras
1887	4	Allahabad University	Allahabad
1916	5	Banaras Hindu University	Varanasi
	6	Mysore University	Mysore
1917	7	Patna University	Patna
1918	8	Osmania University	Hyderabad
1921	9	Aligarh Muslim University	Aligarh
	10	Lucknow University	Lucknow
1922	11	Delhi University	Delhi
1923	12	Nagpur University	Nagpur
1926	13	Andhra University	Waltair
1927	14	Agra University	Agra
1929	15	Annamalai University	Annamalainagar
1937	16	Kerala University	Trivandrum
1943	17	Utkal University	Bhubaneswar
1946	18	Saugar University	Saugar
1947	19	Rajasthan University	Jaipur
	20	Punjab University	Chandigarh
1948	21	Gauhati University	Gauhati
	22	Jammu & Kashmir University (now Kashmir University)	Srinagar
1949	23	Roorkee University	Roorkee
	24	Poona University	Poona
	25	M. S. University of Baroda	Baroda

Year of Establishment		*Name of the University*	*Location*
	26	Karnatak University	Dharwar
1950	27	Gujarat University	Ahmedabad
1951	28	S.N.D.T. Women's University	Bombay
	29	Visva-Bharati	Shantiniketan
1952	30	Bihar University	Muzaffarpur
1954	31	Sri Venkateswara University	Tirupati
1955	32	Sardar Patel University	Vallabh Vidyanagar
	33	Jadavpur University	Calcutta
1956	34	Kurukshetra University	Kurukshetra
	35	Indira Kala Sangit Vishva-vidyalaya	Khairagarh
1957	36	Vikram University	Ujjain
	37	Gorakhpur University	Gorakhpur
	38	Jabalpur University	Jabalpur
1958	39	Varanaseya Sanskrit Vishva-vidyalaya	Varanasi
	40	Marathwada University	Aurangabad
1960	41	U. P. Agricultural University	Nainital
	42	Burdwan University	Burdwan
	43	Kalyani University	Kalyani
	44	Bhagalpur University	Bhagalpur
	45	Ranchi University	Ranchi
1961	46	K. S. Darbhanga Sanskrit Visvavidyalaya	Darbhanga
1962	47	Punjab Agricultural University	Ludhiana
	48	Punjabi University	Patiala
	49	Orissa University of Agriculture and Technology	Bhubaneswar
	50	North Bengal University	Siliguri
	51	Rabindra Bharati	Calcutta
	52	Magadh University	Gaya
	53	Jodhpur University	Jodhpur
	54	Udaipur University	Udaipur
	55	Shivaji University	Kolhapur

Year of Establishment		*Name of the University*	*Location*
1964	56	Indore University	Indore
	57	Jiwaji University	Gwalior
	58	Ravi Shankar University	Raipur
	59	University of Agricultural Sciences	Bangalore
	60	Andhra Pradesh Agricultural University	Hyderabad
	61	Bangalore University	Bangalore
	62	Jawaharlal Nehru Krishi Vidyalaya	Jabalpur
1965	63	Dibrugarh University	Dibrugarh
1966	64	Kanpur University	Kanpur
	65	Meerut University	Meerut
	66	Madurai University	Madurai
	67	Saurashtra University	Rajkot
	68	South Gujarat University	Surat
1967	69	Berhampur University	Berhampur
	70	Sambalpur University	Sambalpur
1968	71	Assam Agricultural University	Jorhat
	72	Awadesh Pratap Singh University	Rewa
	73	Calicut University	Calicut University P.O.
	74	Gujarat Ayurveda University	Jamnagar
	75	Mahatma Phule Krishi Vidyapeeth Agricultural College	Baroda
1969	76	Guru Nanak University	Amritsar
	77	Jammu University	Jammu
	78	Jawaharlal Nehru University	New Delhi
	79	Punjabrao Krishi Vidyapeeth	Akola
		Institutions Deemed to be Universities	
1958	1	Indian Institute of Sciences	Bangalore
	2	Indian Agricultural Research Institute	New Delhi
1961	3	Indian School of International Studies	New Delhi

Year of Establishment		*Name of the University*	*Location*
1962	4	Gurukal Kangri Vishva-Vidyalaya	Hardwar
	5	Jamia Millia Islamia	New Delhi
1963	6	Gujarat Vidyapith	Ahmedabad
	7	Kashi Vidyapith	Varanasi
1964	8	Tata Institute of Social Sciences	Bombay
	9	Birla Institute of Technology and Sciences	Pilani
1967	10	Indian School of Mines	Dhanbad
		Institutions of National Importance	
1951	1	Indian Institute of Technology	Kharagpur
1958	2	Indian Institute of Technology	Bombay
1959	3	Indian Institute of Technology	Madras
1960	4	Indian Institute of Technology	Kanpur
1961	5	Indian Institute of Technology	Delhi

Source: University Grants Commission, *Report for the Year 1967-68*, New Delhi: The Commission, January, 1969, p. 35; *ibid.* List March 2, 1970, New Delhi: The Commission; T. S. Rajagopalan, of Vice-Chancellors and Registrars of Indian Universities as on and R. Satyanarayana, *The Directory of Scientific Research Institutions in India, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 15

List of University Centres of Advanced Study in the Natural Sciences and Mathematics

Subject and Major Field of Specialization	*Department/University*
Astronomy	1 Department of Astronomy and Nizamiah Observatory, Osmania University, Hyderabad
Bio-Chemistry Proteins, Lipids and Vitamins	2 Department of Bio-Chemistry, Indian Institute of Science, Bangalore
Botany Plant Morphology and Embryology	3 Department of Botany, Delhi University, Delhi
Plant Pathology and Mycology	4 Department of Botany, Madras University, Madras
Chemistry Applied Chemistry	5 Department of Chemical Technology, Bombay University, Bombay
Chemistry of Natural Products	6 Department of Chemistry, Delhi University, Delhi
Geology Himalayan Geology and Palaeontology	7 Department of Geology, Punjab University, Chandigarh
Structural Geology, Geomorphology, Petrology and Mineralogy	8 Department of Geology and Applied Geology, University of Saugar, Saugar
Mathematics Applied Mathematics	9 Department of Applied Mathematics, Calcutta University, Calcutta
Pure Mathematics	10 Department of Mathematics, Bombay University, Bombay

Subject and major field of specialisation		*Department/University*
Pure Mathematics	11	Ramanujan Centre of Advanced Study in Mathematics, Madras University, Madras
Pure Mathematics	12	Department of Mathematics, Punjab University, Chandigarh
Physics Theoretical Physics and Astrophysics	13	Department of Physics and Astrophysics, Delhi University, Delhi
Radiophysics and Electronics	14	Institute of Radiophysics and Electronics, Calcutta University, Calcutta
Biophysics and Crystollography	15	Department of Physics, Madras University, Madras
Zoology Cell Biology and Endrocrinology	16	Department of Zoology, Delhi University, Delhi
Marine Biology	17	Department of Marine Biology at Porto-Novo, Annamalai University, Annamalainagar.

Source: Government of India, Cabinet Secretariat, Committee on Science and Technology, *Report on Science and Technology, 1969,* New Delhi, Government of India Press, 1969.

TABLE No. 17

List of Some Research and Development Units in Industry

Private Sector

1 ALEMBIC CHEMICAL WORKS COMPANY LTD.
Alembic Road, Baroda Gujarat: Established: 1907
DIRECTOR OF RESEARCH: DR. A. H. AMIN
Research Staff: 188,
Budget: *Rs. 26,41,000.*

2 AMAR DYE-CHEM LTD.
Rang Udyan, Sitladevi Temple Road, Mahim, Bombay 16: Established: 1954
DIRECTOR: S. V. DESAI
Research Staff: 100,
Budget: *Rs. 5,00,000.*

3 ANIL STARCH PRODUCTS LTD.
Anil Road, P. O. Box 1062, Ahmedabad: Established: 1939
CHAIRMAN: KASTURBHAI LALBHAI
Research Staff: 10,
Budget: *Rs. 6,67,45,000.*

4 CENTRAL RESEARCH STATION
Associated Cement Companies Ltd., Shastri Marg, Wagle Industrial Estate, P. O. Thana, Maharashtra: Established: 1965
MANAGER: V. N. PAI
Research Staff: 26,
Budget: *Rs. 13,00,000.*

5 ARLABS LTD.
No. 6, Second Floor, India House, Fort Street, Bombay 1: Established: 1950
DIRECTOR: H. C. KHATIWALA
Research Staff: 5,
Budget: *Rs. 75,000.*

6 ATUL PRODUCTS LTD.
Atul, Bulsar District, Gujarat: Established: 1947
GENERAL MANAGER: B. K. MUZUMDAR
Research Staff: 35,
Budget: *Rs. 5,50,000.*

7 SIR PRAFULLA CHANDRA RESEARCH LABORATORY
Bengal Chemical and Pharmaceutical Works Ltd., 164, Maniktala Main Road, Calcutta 54: Established: 1901
MANAGING DIRECTOR: DR. B. N. GHOSE
Research Staff: 10,
Budget: *Rs. 60,000.*

8 BENGAL IMMUNITY RESEARCH INSTITUTE
39, Acharya Jagadish Bose Road, Calcutta 17: Established: 1947
DIRECTOR: DR. U. P. BASU
Research Staff: 100,
Budget: *Rs. 5,00,000.*

9 BIRLA RESEARCH INSTITUTE FOR APPLIED SCIENCE
Birlagram, Nagda, Madhya Pradesh: Established: 1965
DIRECTOR-GENERAL: DR. S. M. MITRA
Research Staff: 16,
Budget: *Rs. 2,23,015.*

10 CALCUTTA CLINICAL RESEARCH ASSOCIATION LTD.
6, Chowringhee Road, Calcutta 13: Established: 1937
TECHNICAL ADVISER: G. G. BANERJEE
Research Staff: 3.

11 CIBA RESEARCH CENTRE
Aarey Road, Goregaon, Bombay 63: Established: 1963
DIRECTOR: DR. T. R. GOVINDACHARI
Research Staff: 100,
Budget: *Rs. 50,00,000.*

12 CIPLA LABORATORIES
289, Bellasis Road, Byculla, Bombay 8: Established: 1935
DIRECTOR: DR. Y. K. HAMIED
Research Staff: 42,
Budget: *Rs. 3,00,000.*

13 RESEARCH AND DEVELOPMENT CELL
Dharamsi Morarji Chemical Company Ltd., 317-21, Dr. Dadabhoy Naoroji Road, Bombay 1: Established in Bombay: 1919; R & D Cell: 1960-61
Research Staff: 20,
Budget: *Rs. 2,77,000.*

14 RESEARCH AND DEVELOPMENT DIVISION
East India Pharmaceutical Works Ltd., 136, Pathakpara Road, Calcutta 34:
DIRECTOR: P. BAGCHI

15 GEOFFREY MANNERS & CO.
Bombay Agra Road, Ghatkopar, Bombay 77: Established: 1943
DIRECTOR: K. G. MAHESHWARI
Research Staff: 11,
Budget: *Rs. 2,60,000 (Approximately)*

16 GLUCONATE LTD.
70-A, Prinsep Street, Calcutta 13: Established: 1932
DIRECTOR: A. N. HALDAR
Research Staff: 10,
Budget: *Rs. 30,000.*

17 HINDUSTAN LEVER RESEARCH CENTRE
I. C. T. Link Road, Chakala, Andheri East, Bombay 69:
Established: 1958
DIRECTOR: DR. S. VARADARAJAN
Research Staff: 160,
Budget: *Rs. 26,00,000.*

18 INDIAN IRON & STEEL CO. LTD.
Burnpur, Burdwan District, West Bengal: Established: 1965
DY. GENERAL MANAGER (TECH.): DR. U. N. BHRANY
Research Staff: 25,
Budget: *Rs. 2,80,000.*

19 RESEARCH DEPARTMENT
Indian Leaf Tobacco Development Co. Ltd., Rajahmundry, East Godavari District, Andhra Pradesh: Established: 1928
MANAGER: DR. N. S. REDDY
Research Staff: 8,
Budget: *Rs. 3,00,000.*

20 RESEARCH AND DEVELOPMENT CENTRE
Jyoti Ltd., Chemical Industries P. O., Industrial Area, Baroda 5:
Established: 1962
DIRECTOR: NANUBHAI B. AMIN
Technical Staff: 70.

21 RESEARCH DEPARTMENT
Metal Box Co. of India Ltd., 92/1 Alipore Road, Calcutta 27:
Established: 1954
MANAGER: G. S. LITTLEJOHN
Research Staff: 90,
Budget: *Rs. 12,60,000.*

22 METTUR CHEMICAL & INDUSTRIAL CORPORATION LTD.
Mettur Dam 2, Salem District, Tamil Nadu: Established: 1936
DIRECTOR: R. V. RAMANI
Research Staff: 4,
Budget: *Rs. 65,400.*

23 RESEARCH DIVISION
National Rayon Corporation Ltd.
Mohone, Thana District, Maharashtra: Established: 1953
DIRECTOR OF RESEARCH: DR. S. I. TARAPOREWALA
Research Staff: 80.

21 REFRACTORY RESEARCH & CONTROL LABORATORY
Orissa Cement Ltd., Rajgangpur P. O., Sundargarh District, Orissa: Established: 1957
DIRECTOR: DR. J. D. PANDA
Research Staff: 20,
Budget: *Rs. 3,00,000.*

25 POLYCHEM LTD.
45-A, Swami Vivekanand Road, Goregaon, Bombay 62: Established: 1955
DIRECTOR: AMBALAL KILACHAND
Research Staff: 6,
Budget: *Rs. 1,00,000.*

26 RESEARCH AND CONTROL DIVISION
Raptakos, Brett & Co. Pvt. Ltd., 47, Dr. Annie Besant Road, Worli, Bombay 18: Established: 1951
DIRECTOR: DR. G. B. RAMASARMA
Research Staff: 6.

27 CENTRAL RESEARCH LABORATORY
Rohtas Industries Ltd., Dalmianagar, Bihar: Established: 1955
CHIEF RESEARCH OFFICER: DR. S. O. SHUKLA
Research Staff: 7.

28 SARABHAI RESEARCH CENTRE
Wadi Wadi, Baroda 7, Gujarat: Established: 1967
DIRECTOR: N. R. NADKARNI
Research Staff: 44,
Budget: *Rs. 20,00,000.*

29 SMITH, STANISTREET & CO. LTD.
18, Convent Road, Calcutta 14: Established: 1824
HEAD OF RESEARCH DIVISION: DR. D. CHAKRAVARTY
Research Staff: 17; Quality Control: 18,
Budget: *Rs. 1,31,000.*

30 SUDARSHAN CHEMICAL INDUSTRIES PVT. LTD.
162 Wellesley Road, Poona 1: Established: 1951
MANAGING DIRECTOR: DR. R. J. RATHI
Research Staff: 20,
Budget: *Rs. 1,50,000.*

31 TATA CHEMICAL LTD.
Mithapur, Okhamandal, Gujarat: Established: 1939
R & D MANAGER: SHRI PRABHAKAR
Research Staff: 6,
Budget: *Rs. 90,000.*

32 RESEARCH AND DEVELOPMENT DIVISION
Tata Iron & Steel Co. Ltd., Jamshedpur 7, Bihar: Established: 1967
DIRECTOR: DR. V. G. PARANJPE
Research Staff: 74,
Budget: *Rs. 30,00,000 (Approximately)*

33 UNICHEM LABORATORIES LTD.
4, 5, 6, Prabhat Estate, S. V. Road, Jogeshwari, Bombay 60:
Established: 1947
DIRECTOR: SHRI A. V. MODY
Research Staff: 15,
Budget: *Rs. 1,50,000.*

34 ZANDU PHARMACEUTICAL WORKS LTD.
Gokhale Road, South Dadar, Bombay 25: Established: 1960
DIRECTOR: DR. K. M. PARIKH
Research Staff: 3.

PUBLIC SECTOR

35 CENTRAL RESEARCH LABORATORY
Antibiotics Project, Indian Drugs and Pharmaceuticals Ltd.,
Virbhadra P. O., Rishikesh, Uttar Pradesh

36 BHARAT ELECTRONICS LTD.
Jalahalli, P. O., Bangalore 13: Established: 1954
GENERAL MANAGER: LT. GEN. A. C. IYAPPA
Research Staff: 151,
Budget: *Rs. 60,00,000.*

37 PLANNING AND DEVELOPMENT DIVISION
Fertiliser Corporation of India Ltd.
Sindri, Dhanbad, Bihar: Established: 1960
MANAGER: DR. K. R. CHAKRAVORTY

38 HEAVY ENGINEERING CORPORATION LTD.
Dhurwa, Ranchi, Bihar
Budget: *Rs. 5,62,00,000.*

39 ANTIBIOTICS RESEARCH CENTRE
Hindustan Antibiotics Ltd.
Pimpri, Poona 18, Maharashtra State: Established: 1954
SUPERINTENDENT OF RESEARCH: DR. M. J. THIRUMALACHAR
Research Staff: 90,
Budget: *Rs. 30,00,000.*

40 HINDUSTAN MACHINE TOOLS LTD.
H. M. T. P. O. Bangalore 31: Established: 1953
MANAGING DIRECTOR: DR. S. M. PATIL
Research Staff: 100.

41 RESEARCH AND DEVELOPMENT LABORATORY
Hindustan Photo Films Manufacturing Company Ltd.
Indunagar P. O. Ootacamund 5, Tamil Nadu: Established: 1966
DIRECTOR: DR. P. HARIHARAN
Research Staff: 22,
Budget: *Rs. 3,80,000.*

42 HINDUSTAN TELEPRINTERS LTD.
G. S. T. Road, Guindy, Madras 32: Established: 1960
MANAGING DIRECTOR: G. U. MENON
Research Staff: 5.
Budget: *Rs. 40,000.*

43 INDIAN RARE EARTHS LTD.
Udyogamandal P. O., Kerala: Established: 1950
Research Staff: 5,

44 INDIAN TELEPHONE INDUSTRIES LTD.
Dooravaninagar, Bangalore: Established: 1948
MANAGING DIRECTOR: U. SHANKAR
Technical Staff: 74,
Budget: *Rs. 5,33,50,000.*

45 CENTRAL LABORATORY
Neyveli Lignite Corporation Ltd.
Neyveli 1, South Arcot District, Tamil Nadu: Established: 1961
DIRECTOR: DR. C. V. S. RATNAM
Research Staff: 25,
Budget: *Rs. 4,12,800.*

46 NGEF LTD.
P. O. Bag 384, Bangalore 1: Established: 1961
DIRECTOR: M. SACHIDANANDA MOORTHY

47 CENTRAL PLANT LABORATORIES SYNTHETIC DRUG PLANT
Indian Drug and Pharmaceuticals Ltd.
Kukatpally, Balanagar P. O., Hyderabad 37, Andhra Pradesh
Established: 1965
PROJECT ADMINISTRATOR: DR. L. K. BEHI
Research Staff: 100,
Budget: *Rs. 6,00,000.*

48 TRAVANCORE TITANIUM PRODUCTS LTD.
P. O. Box 1, Kochu Veli, Trivandrum 7 Kerala: Established: 1946
MANAGING DIRECTOR: T. MADHAVA MENON
RESEARCH & DEVELOPMENT MANAGER: DR. V. S. VIJAYAN NAYAR
Research Staff: 10,
Budget: *Rs. 2,00,000.*

Source: T. S. Rajagopalan, and R. Satyanarayana, *The Directory of Scientific Research Institutions in India, 1969*, Delhi: Indian National Scientific Documentation Centre, 1969.

TABLE No. 18

List of Some Independent Research Organization and Professional Societies

1 ASSOCIATION OF SCIENTIFIC WORKERS OF INDIA
Delhi: Established: 1947

2 BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY
Lucknow: Established: 1946
DIRECTOR: DR. K. R. SURANGE
Research Staff: 34,
Budget: *Rs. 6,13,539.*

3 BOSE INSTITUTE
Calcutta: Established: 1917
DIRECTOR: DR. S. M. SIRCAR
Research Staff: 109,
Budget: *Rs. 14,72,000.*

4 INDIAN ACADEMY OF MEDICAL SCIENCES
New Delhi: Established: 1961
PRESIDENT: DR. K. L. WIG
EXECUTIVE DIRECTOR: DR. B. L. TANEJA
Fellows: 191,
Budget: *Rs. 1,24,848.*

5 INDIAN ACADEMY OF SCIENCES
Bangalore: Established: 1934
PRESIDENT: SIR C. V. RAMAN
Fellows: 239.

6 INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE
Calcutta: Established: 1876
DIRECTOR: PROF. B. N. SRIVASTAVA
Research Staff: 133,
Budget: *Rs. 35,80,514.*

7 INDIAN INSTITUTE OF SCIENCE
Bangalore: Established: 1909
DIRECTOR: DR. S. DHAWAN
Research Staff: 1,281,
Budget: *Rs. 1,15,09,712.*

8 INDIAN NATIONAL SCIENCE ACADEMY (formerly NATIONAL INSTITUTE OF SCIENCES OF INDIA)
New Delhi: Established: 1935
PRESIDENT: DR. ATMA RAM
ASSISTANT SECRETARY: S. MULL
Fellows: 363; Senior Office Staff: 10,
Budget: *Rs. 8,20,000.*

9 INDIAN SCIENCE CONGRESS ASSOCIATION
Calcutta: Established: 1934
GENERAL PRESIDENT: DR. B. P. PAL
GENERAL SECRETARIES: PROF. R. S. MISHRA, PROF. (MRS.) ASIMA CHATTERJEE
EXECUTIVE SECRETARY: N. CHATTERJI
Membership: 6,000; Administrative Staff: 8
Budget: *Rs. 3,50,000.*

10 INDIAN STATISTICAL INSTITUTE
Calcutta: Established: 1931
DIRECTOR: PROF. P. C. MAHALANOBIS
Research Staff: 250,
Budget: *Rs. 1,94,04,000.*

11 INSTITUTE OF HISTORY OF MEDICINE AND MEDICAL RESEARCH
New Delhi: Established: 1960
PRESIDENT: HAKIM ABDUL HAMEED
Research Staff: 10,
Budget: *Rs. 10,65,300.*

12 INSTITUTION OF ENGINEERS
Calcutta: Established: 1920
PRESIDENT: LT. GEN. R. A. LOOMBA, M.I.E.
SECRETARY: COL. B. T. NAGRANI, M.I.E.
Members and Associate Members: 17,374; Professional Staff: 9,
Budget: *Rs. 53,00,000.*

13 MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE
Poona: Established: 1946
DIRECTOR: DR. G. B. DEODIKAR
Research Staff: 36,
Budget: *Rs. 3,03,548.*

14 NATIONAL ACADEMY OF SCIENCES
Allahabad: Established: 1930
PRESIDENT: PROF. A. C. CHATTERJI
GENERAL SECRETARY: PROF. S. P. TANDON
Members: 715
Budget: *Rs. 83,000.*

15 RAMAN RESEARCH INSTITUTE
Bangalore: Established: 1943
DIRECTOR: SIR C. V. RAMAN

16 SHRI RAM INSTITUTE FOR INDUSTRIAL RESEARCH
Delhi: Established: 1950
DIRECTOR: DR. V. B. CHIPALKATTI
Research Staff: 60,
Budget: *Rs. 24,00,000.*

Source: T. S. Rajagopalan, and R. Satyanarayana, *The Directory of Scientific Institutions in India, 1969,* Delhi: Indian National Scientific Documentation Centre, 1969; Council of Scientific and Industrial Research, *Science in India*, New Delhi: Research, Survey and Planning Organization, CSIR, 1966.

TABLE No. 19

List of Some Scientific and Technical Institutes and Organizations Related to the Government of Andhra Pradesh

A) AGRICULTURAL RESEARCH

Regional Research Stations

Hyderabad
Anantpur
Rudrur
Srikakulam
Tirupati
Bapatla

Research Stations (areas of research given in parentheses)

Sompet (parasite breeding for coconut pests)
Amadalavalasa (Mesta)
Ragolu (paddy, millets)
Vizianagaram (millets)
Anakapalle (sugarcane, rice, millets, fruits)
Yellamanchili (oilseeds)
Razole (coconut diseases)
Razole (coconut pests)
Ambajipet (coconut)
Ambajipet (parasite breeding station on coconut pests)
Peddapuram (millets and pulses)
Kovvur (banana)
Maruteru (rice)
Pulla (rice)
Narasapur (parasite breeding station on coconut pests)
Machilipatnam (rice and oilseeds)
Bapatla (cashew research station, regional research units, entomology, pathology, chemistry and physiology)
Tenali (cotton, rice and pests)
Amaravathi (cotton)
Lam (chillies, millets)
Pedapalem (turmeric research station)
Nellore (rice, cotton)
Podalakur (millets)

Darsi (cotton and groundnut)
Perumallapalle (millet and sugarcane)
Anantarajupet (fruits)
Utukur (Betelvine and rice and chemistry)
Anantpur (millet, soil conservation)
Kadiri (oilseeds)
Yemmiganur (oilseeds)
(shifted to S. V. Agril. College, Tirupati)
Kurnool (vegetables)
Nandyal (cotton, millets)
Adoni (cotton)
Adilabad (rice, cotton and millet)
Mudhol (cotton)
Rudrur (sugarcane, rice, fruits, oilseeds)
Sangareddy (fruits, rice)
Karimnagar (maize and oilseeds)
Wyra (rice)
Madhira (millets)
Tirupati (to evolve suitable economic rations for poultry feeds)
Hyderabad (strengthening of disease investigation section)
Rajendranagar (to conduct research on revitalising grazing land)

B) MEDICAL AND PUBLIC HEALTH RESEARCH

STATE MEDICAL RESEARCH COMMITTEE

INSTITUTE OF PREVENTIVE MEDICINE

CENTRAL NUTRITION LABORATORY

MEDICAL COLLEGES

Osmania Medical College, Hyderabad
Gandhi Medical College, Hyderabad
Andhra Medical College, Vishakhapatnam
Guntur Medical College, Guntur
Kurnool Medical College, Kurnool
Sri Venkateswara Medical College, Tirupati, Chittoor Dist.
*Sri Ranga Raya Memorial Medical College, East Godavari Dist.
*Kakatiya Medical College, Warangal.

TEACHING HOSPITALS

S.V.R.R. Hospitals, Tirupati, Chittoor District
Government Hospital for Women and Children, Tirupati, Chittoor district
Government Leprosy Hospital, Akranpalli, Chittoor District
Government General Hospital, Kasinada, East Godavari District

*Colleges under Private Governing Bodies

Government General Hospital, Guntur
T.B. Hospital, Mangalagiri, Guntur District
Osmania General Hospital, Hyderabad
Niloufer Hospital for Women and Children, Hyderabad
Government Maternity Hospital, Hyderabad
Sarojinidevi Eye Hospital, Hyderabad
Radium Institute and Cencer Hospital, Hyderabad
Mental Hospital, Hyderabad
T.B. Hospital, Hyderabad
Fever Hospital, Hyderabad
Employees State Insurance Hospital, Hyderabad
Ear, Nose and Throat Hospital, Hyderabad
Gandhi Hospital, Secunderabad
Government General Hospital, Kurnool
King George Hospital, Visakhapatnam
Government Victoria Hospital for Women and Children, Visakhapatnam
T.B. Hospital, Visakhapatnam
Infectious Diseases Hospital, Visakhapatnam
Mental Hospital, Visakhapatnam
M. G. M. Hospital, Warangal
Government Meternity Hospital, Hanumakonda, Warangal district
T.B. Hospital, Hanumakonda, Warangal district.

C) PUBLIC WORKS RESEARCH

Andhra Pradesh Engineering Research Laboratory, Himayatsagar
Soil Laboratory, Hyderabad
Soil Laboratory, Vijayawada

D) INDUSTRIAL RESEARCH

Oil Technological Institute, Anantpur
Regional Research Laboratory, Hyderabad
Ceramics Research Unit, Gudur
Research and Design Centre, Hyderabad

E) UNIVERSITY DEPARTMENTS OF SCIENCE AND TECHNOLOGY

ANDHRA UNIVERSITY

Department of Civil Engineering, University College of Engineering
Department of Chemical Engineering, University College of Engineering
Department of Electrical Engineering, University College of Engineering
Department of Mechanical Engineering, University College of Engineering

Department of Botany, Erskine College of Natural Sciences
Department of Geology, Erskine College of Natural Sciences
Department of Zoology, Erskine College of Natural Sciences
Department of Applied Mathematics, Jeypore Vikarma Deo College of Science and Technology
Department of Applied Physics, Jeypore Vikarma Deo College of Science and Technology
Department of Chemistry, Jeypore Vikarma Deo College of Science and Technology
Department of Geophysics, Jeypore Vikarma Deo College of Science and Technology
Department of Meteorology and Oceanography, Jeypore Vikarma Deo College of Science and Technology
Department of Nuclear Physics, Jeypore Vikarma Deo College of Science Technology
Department of Pharmacy, Jeypore Vikarma Deo College of Science and Technology
Department of Physics, Jeypore Vikarma Deo College of Science and Technology

OSMANIA UNIVERSITY

Department of Civil Engineering, Faculty of Engineering
Department of Electrical Engineering, Faculty of Engineering
Department of Mechanical Engineering, Faculty of Engineering
Department of Mining Engineering, Faculty of Engineering
Department of Tele-communication, Faculty of Engineering Faculty of Technology
Department of Astronomy, Faculty of Science
Department of Botany, Faculty of Science
Department of Chemistry, Faculty of Science
Department of Geology and Geophysics, Faculty of Science
Department of Mathematics, Faculty of Science
Department of Physics, Faculty of Science
Department of Statistics, Faculty of Science
Department of Zoology, Faculty of Science

SRI VENKATESWARA UNIVERSITY

Department of Botany, Faculty of Sciences
Department of Chemistry, Faculty of Sciences
Department of Geology, Faculty of Sciences
Department of Mathematics, Faculty of Sciences
Department of Physics, Faculty of Sciences
Department of Statistics, Faculty of Sciences
Department of Zoology, Faculty of Sciences
Department of Engineering, Venkateswara University College of Engineering
Department of Electrical Engineering, Venkateswara University College of Engineering
Department of Mechanical Engineering, Venkateswara University College of Engineering

TABLE No. 20

List of Members and Terms of Reference of the Committee on Science and Technology (COST) to the Cabinet

COMPOSITION

Dr. B. D. Nag Chaudhuri, Member (Science), Planning Commission, New Delhi.

B. Sivaraman, Cabinet Secretary, New Delhi.

Dr. Atma Ram, Director General, Council of Scientific and Industrial Research, New Delhi.

Dr. Dasarathi Banerjee, National Rubber Manufacturers' Ltd., Calcutta.

Dr. D. S. Kothari, Chairman, University Grants Commission, New Delhi.

Dr. A. R. Kidwai, Member, Union Public Service Commission, New Delhi,

Scientific Adviser to Minister of Defence, New Delhi.

Dr. S. K. Mukherjee, Vice-Chancellor, Kalyani University, Kalyani, Nadia West Bengal.

Dr. B. P. Pal, Director General, Indian Council of Agricultural Research, New Delhi.

Dr. C. R. Rao, Director, Research and Training School, Indian Statistical Institute, Calcutta.

Dr. Vikram A. Sarabhai, Chairman, Atomic Energy Commission, and Secretary, Department of Atomic Energy, Bombay.

H. N. Sethna, Director, Bhabha Atomic Research Centre, Trombay, Bombay.

Dr. K. V. Subrahmanyam, Madras.

Dr. P. N. Wahi, Director General, Indian Council of Medical Research, New Delhi.

(As of March, 1970)

TERMS OF REFERENCE

The Committee will advise Government

(i) on the formulation and implementation of Government's policy on science and technology and determination of national priorities in these areas;

(ii) on the pace of development of scientific research and technology suggesting measures for correcting imbalances whatever necessary;

(iii) on coordination, cooperation and communication between Ministries of Government and between Government, semi-Government and non-government scientific and technological institutions in the country;

(iv) on the development and full utilization of the nation's scientific and technological resources and measures for ensuring a proper balance between these indigenous resources and purchase of foreign technology consistent with needs of national development;

(v) on scientific and technological cooperation with other countries and with international scientific and technological organizations; and

(vi) on any other matter that may be referred to it by Government.

The Committee will maintain close relationship with the Planning Commission so as to develop a unified policy of scientific and technological growth in the country.

TABLE No. 21

List of Members and terms of Reference of Committee on Organization of Scientific Research (COSR)

COMPOSITION

Dr. S. Bhagavantam, Former Scientific Adviser to Minister of Defence (Chairman).

Dr. B. D. Nag Chaudhuri, Member (Science), Planning Commission.

Cabinet Secretary.

Dr. D. S. Kothari, Chairman, University Grants Commission.

Dr. A. Ramachandran, Director, Indian Institute of Technology, Madras.

Dr. Vikram A. Sarabhai, Chairman, Atomic Energy Commission, and Secretary, Department of Atomic Energy.

(As of December, 1968)

TERMS OF REFERENCE

(a) To examine and report on the scientific work being done in the country.

(b) To indicate the steps that should be taken to enable the work to be carried on effectively, consistent with such economies as might be possible.

APPENDIX No. 1

Note on Statistical Data for Scientific and Technical Research and Development in India

A WORD of caution must be expressed regarding statistical data on scientific and technical research and development in India. There are wide variations in data from different sources purporting to measure the same kind of activity. Lack of uniformity in definitions of statistical categories limits comparability. And often figures which may give the appearance of being based on hard data are in fact only estimates.

There are two basic problems. The first is simply that there are incomplete data on a number of different aspects of research and development in India. For the first years after independence, there are little data at all. And even for more recent periods, important sectors of activity have not really been systematically measured—for example, research and development in industry.

The second is that there is not only lack of agreement on definition of what constitutes research and development but most statistical data are based on a process which is essentially that of "self-definition". That is to say, statistical categories are applied by the organizations concerned to themselves rather than uniformly by some central statistical data collecting agency.

These considerations become even more complex when any effort is made to construct international comparisons. The efforts by UNESCO and the Organization for Economic Cooperation and Development to construct uniform and internationally acceptable definitions for different categories of "science statistics" have by and large not been followed in India. And it is a moot point as to whether some of these categories would be appropriate for the Indian context, a question which really cannot be answered decisively until more

extensive efforts have been made to apply such definitions to research and development activity in India.[1]

A couple of examples of the present situation with respect to statistical data on science and technology in India will help to illustrate the limitations mentioned previously. The most substantial data available on scientific and technical man-power are to be found in the National Register of Scientific and Technical Personnel, a unit of the Council of Scientific and Industrial Research. The National Register covers about 40% of the existing scientific and technical manpower. While it is certainly possible to make some overall projections on the basis of this 40% coverage, it is obviously difficult to do so with great precision.[2]

A similar degree of imprecision is to be found in estimates of central government expenditure on research and development by different government agencies. Thus, according to an analysis by Rushikesh Maru, Planning Commission and Council of Scientific and Industrial Research figures for total R and D expenditure differ by, between Rs. 90 million and Rs. 180 million, depending upon what is added to the smaller Planning Commission estimate which is apparently based on a narrower defi-

1. For a critical analysis of science statistics in India, see Rushikesh Maru, *Research and Development in India and China: A Comparative Analysis of Research Statistics and Research Effort* (Preliminary Draft), Occasional Paper No. 1, Project on the Comparative Study of Research and Development in India and China, Lund, Sweden, and Delhi, India: Research Policy Programme, University of Lund, and Centre for the Study of Developing Societies, April, 1969. Useful summaries of some of the international efforts to standardize the measurement of scientific and Technological activity are found in two papers by Christopher Freeman —*Measurement of scientific and Technological Activities: Proposals for the Collection of Statistics on Science and Technology on an Internationally Uniform Basis*, Statistical Reports and Study Series, Paris: United Nations Educational, Scientific, and Cultural Organization, 1969, and *Measurements of Output of Research and Experimental Development: A Review Paper* (Paper Prepared for Working Group on Statistics of Science and Technology, Statistical Commission and Economic Commission for Europe, Conference for European Statisticians, Geneva, 2-6 June, 1969), Paris: United Nations Educational, Scientific and Cultural Organization, April, 1969 (Com./Conf. 22/8).

2. Ashok Parthasarathi, "Scientific Manpower—The Need for Better 'Book-keeping'," *Science and Culture*, September, 1969, pp. 458-462.

nition of R and D activity. These differences are substantial, constituting in this particular instance between 25 and 60% of the gross Planning Commission figure and as much as 35% of the higher CSIR estimate. (For 1963-64, the Planning Commission estimates for central government R and D expenditure is Rs. 304 million and the CSIR estimates is Rs. 478 million.)[3]

More precise statistics on the inputs in money and manpower for research and development will depend on the statistical collection and processing facilities of the central government, whether done through a centralized statistical agency or through an agency connected specifically with science and technology. While the collection of reasonably precise statistics on inputs for R and D activity, based on uniform definitions, is no easy matter, data on the "outputs" of this kind of activity are even more elusive. And yet it is only through the comparison of outputs to inputs that reasonably "objective" judgements about the effectiveness of particular public policies towards science and technology can be made.

The Administrative Staff College Science and Technology Programme is concentrating its attention at the present time on this difficult and complex problem of measuring the "results" of scientific research. Some experimental techniques for making such measurements are now being explored informally in co-operation with different types of research institutions in the hope that some useful and generally applicable approaches can be identified.

3. Maru, *ibid.*, p. 52.

APPENDIX No. 2

Scientific Policy Resolution of 1958 (No. 131/CF/57)
(Adopted by the Indian Parliament)

New Delhi, the 4th March, 1958/13th Phalguna, 1879

1. The key to national prosperity, apart from the spirit of the people, lies, in the modern age, in the effective combination of three factors, technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of new scientific techniques can infact make up for a deficiency in national resources and reduce the demands on capital. But technology can only grow out of the study of science and its applications.

2. The dominating feature of the contemporary world is the intense cultivation of science on a large scale, and its application to meet a country's requirements. It is this, which, for the first time in man's history, has given to the common man in countries advanced in science, a standard of living and social and cultural amenities, which were once confined to a very small privileged minority of the population. Science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism.

3. It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of a recognition of this possibility that the idea of a welfare state has grown. It is characteristic of the present world that the progress towards

the practical realization of a welfare state differs widely from country to country in direct relation to the extent of industrialisation and the effort and resources applied in the pursuit of science.

4. The wealth and prosperity of a nation depend on the effective utilisation of its human and material resources through industrialisation. The use of human material for industrialisation demands its education in science and training in technical skills. Industry opens up possibilities of greater fulfilment for the individual. India's enormous resources of man-power can only become an asset in the modern world when trained and educated.

5. Science and technology can make up for deficiencies in raw materials by providing substitutes or indeed, by providing skills which can be exported in return for raw materials. In industrialising a country, a heavy price has to be paid in importing science and technology in the form of plant and machinery, highly paid personnel and technical consultants. An early and large development of science and technology in the country could therefore greatly reduce the drain on capital during the early and critical stage of industrialisation.

6. Science has developed at an ever-increasing pace since the beginning of the century so that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward our utmost effort into the development of science that we can bridge the gap. It is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today.

7. The Government of India have accordingly decided that the aims of their scientific policy will be:

(i) to foster, promote, and sustain by all appropriate means, the cultivation of science, and scientific research in all its aspects—pure, applied, and educational;

(ii) to ensure an adequate supply within the country of research scientists of the higher quality, and to recognise their work as an important component of the strength of the nation;

(iii) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

(iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;

(v) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom;

(vi) and, in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Government of India have decided to pursue and accomplish these aims by offering good conditions of service to scientists and according them an honoured position, by associating scientists with the formulation of policies, and by taking such other measures as may be deemed necessary from time to time.

APPENDIX No. 3

Some Indian Periodicals on Science Affairs

Note: In this Appendix are listed some periodicals which deal primarily with Indian science affairs (along with related developments in science-based technology), as well as some general periodicals which carry articles on these affairs from time to time.

The list includes both periodicals currently published and several which have ceased publication but are important sources for the period during which they were issued. It is confined to periodicals published in India, although a number of journals published abroad carry articles occasionally on Indian science affairs. Excluded are scientific and technical periodicals which are largely confined to substantive research in science and technology and provide little coverage of organizational or policy developments in their respective fields of interest.

The Citizen and Weekend Review, Fortnightly, 1969-1970 (?). Impact Publications Private Ltd., C-7 Nizamuddin East, New Delhi 13.

CSIR News, Fortnightly, 1951-, Council of Scientific and Industrial Research, Rafi Marg, New Delhi 1.

Eastern Economist, Weekly, 1943-, Eastern Economist Ltd., C/o. Hindustan Times, Connaught Circus, New Delhi 1.

Economic and Political Weekly, Weekly 1966-, Sameeksha Trust, Skylark, 284 Frere Road, Bombay 1.

Indian Journal of Public Administration, Quarterly, 1955-, Indian Institute of Public Administration, Indraprastha Estate, Ring Road, New Delhi.

Journal of Scientific and Industrial Research, Monthly, 1942-, Publications and Information Directorate, CSIR, Hillside Road, New Delhi 1.

Link, Weekly, 1958-, United India Periodicals Private Ltd., Link House, Bahadur Shah Zafar Marg, New Delhi.

Lok Udyog, Monthly, 1967-, Bureau of Public Enterprises, Ministry of Finance, New Delhi.

Mainstream, Weekly 1962-, Perspective Publications Private Ltd., F-24 Bhagat Singh Market, New Delhi 1.

Manpower Journal, Quarterly, 1963-, Institute of Applied Manpower Research, Indraprastha Estate, Ring Road, New Delhi 1.

Nuclear India, Monthly, 1962-, Department of Atomic Energy, Apollo Pier Road, Bombay 1.

Research and Industry, Quarterly, 1956-, Publications and Information Directorate, CSIR, Hillside Road, New Delhi 1.

Science and Culture, Monthly, 1955-, Indian Science News Association, 92 Acharya Prafulla Chandra Road, Calcutta 9.

Science in Parliament, Quarterly, 1963-1965 (?), Indian Parliamentary and Scientific Committee, 2 Telegraph Lane, New Delhi 1.

Science Reporter, Monthly, 1964-, Council of Scientific and Industrial Research, Rafi Marg, New Delhi 1.

Science Today, Monthly, 1966-, Bennett Coleman & Co. Ltd., D. N. Road, Fort, Bombay.

Seminar, Monthly, 1960-, P. O. Box 338, New Delhi 1.

Technical Manpower, Monthly, 1959-, Council of Scientific and Industrial Research, Rafi Marg, New Delhi 1.

University News, Monthly, 1963-, Inter-University Board of India & Ceylon, Rouse Avenue, New Delhi 1.

Vijnan Karmee, Monthly, 1949-1969 (?), Association of Scientific Workers of India, C/o. Council of Scientific and Industrial Research, Rafi Marg, New Delhi 1.

World Science News, Monthly, 1964-, 5 Kohinoor Building, Katra Baryan, Delhi 6.

Yojana, Fortnightly, 1957-, Planning Commission, Business Office, Publications Division, Patiala House, New Delhi 1.

ERRATA

Page No.	*Incorrect*	*Correct*
2	f.n. 3	f.n. 1
3 Diagram	LINKAGES Functional and Normative	LINKAGES Direct and Indirect
	Administration	Administrative
3 f.n. 4	Cabinet Secretary	Cabinet Secretariat
6 f.n. 9	Manager of Publications	Government of India Press
9 Table 1	(DROD)	(DRDO)
19 f.n. 17	Steven Dedji	Stevan Dedijer
19 f.n. 19	A. Rehman	A. Rahman
21 f.n. 22	Kelman Silvert	Kalman Silvert
28 f.n. 6	five years elsewhere	few years in the Appendix.
34, note 1	are Complete.	are Incomplete.
50 f.n. 14	See above (p. 18)	See above (p. 13)
52 Chart No. 4	Joint committee of CSIR and Governing Body.	Joint committee of BSIR and Governing Body.
75	A recent study (See Table No. 11) reveals	A recent study reveals

Page No.	*Incorrect*	*Correct*
75 f.n. 43	(Survey Report No. 10)	(Occasional Paper No. 3)
76	(Survey Report No. 10)	(Occasional Paper No. 3)
82 f.n. 51	Appelby	Appleby
92	RGIONAL RESEARCH LABORATORY Hyderabad A.P. Established: 1959	REGIONAL RESEARCH LABORATORY Hyderabad A.P. Established: 1949
120 No. 17	Research Staff: 160 *Budget*: Rs. 26,00,000	Research Staff: 190 *Budget*: Rs. 55,00,000
124 (Heading)	Independent Research Organization	Independent Research Organizations
	ADDENDUM	
132	Dr. K. N. Raj, Vice Chancellor, University of Delhi.	