

OPENING ADDRESS TO THE SYMPOSIUM ON POST-WAR ORGANISATION OF SCIENTIFIC RESEARCH IN INDIA.

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In a broadcast at the beginning of the war, H.E. Sir Robert Cassels lamented that India's industrial backwardness stood in the way of adequate military preparation. 'India's greatest asset is a large supply of the finest type of fighting men. Her great weaknesses are a low national income and a limited industrial development incapable as yet of supplying the technical equipment of a modern army. History has amply shown that victory is not the prerogative of a large organisation swollen with ill-armed soldiery but rather of small well-equipped armies modern for their period. This is even more true today than at any time before, and now-a-days ill-equipped armies are nothing more than sheep for slaughter.' If this war has proved anything beyond doubt, it is this—that human valour cannot compensate for technical and scientific efficiency.

The aim of every post-war reconstruction in India should be the removal of these two weaknesses—a low national income and limited industrial development'. And we are met together today to discuss how science should be organised in India so that this object may be achieved.

It will be a mistake to ignore the fact that there are powerful leaders and a well-organised party in India who have been so impressed by the evils of the modern world, that they do not hesitate to declare that the introduction of western methods for increasing our national income should be resisted, that it is no business of the State to help scientific and technical development which have led to two such world catastrophies in the course of 25 years. They would prefer non-violent non-co-operation to armed resistance against aggression. They would prefer the culture of cottage industries, peasant farming, and living on subsistence level with its inevitable doses of famine and pestilence, to the immense wealth but maladjustment and inhuman greed of modern societies. Men of science in India have to shoulder the additional burden of educating their masters out of this conservative view. We cannot preach too often that the powerful tools of science, which have been used for evil purposes by evil men, are capable of doing immense good if handled for the benefit of humanity; that the blame for our present trouble does not lie with science, but with the evil men and their duped followers who have made this world an insanity fair; that in these days of rapid communications we cannot live in isolation from the rest of the world even if we wish to do so; that life in India will be stagnant if we run counter to the characteristics of the present age, which consists in applying the principles, properties, and products revealed by scientific research to industries and agriculture; that stagnation is the half-way house to death, and to ignore science, which has changed the national economy and cultural levels of the rest of the civilised world by invading every industry, craft and art, will be to invite effacement. One would wish to remind them of the famous saying of Pasteur, than whom there has been no greater benefactor of humanity, that 'Science is the soul of all progress and the source of all prosperity'.

There is another school of thought in the country whose advocates do not believe that scientific and technical research is necessary for the industrial development of the country. They consider that all that is needed is to decide on general grounds if the country has the potential resources in power, raw material and transport, which will justify the establishment of any particular industry, and then import into the country the necessary machinery and experts for the purpose. They are in favour of providing such technical education in the country which will enable the industry to be run by indigenous talent after a period of probation under foreign experts. They would strongly support technical and vocational education, but stop at research as being more in the

nature of a luxury. I have often met this attitude in our powerful industrial magnates and *entrepreneurs* in business. To them the history of the dyestuffs industry should be an object lesson. The first synthetic dye was made in England by Perkin, but the industry soon found a congenial home in German soil. In Germany the practical outlook of businessmen is, more often than anywhere else, enthused by that faith in scientific research which comes from first hand knowledge. Thus, twenty long years of painstaking research were necessary at a cost of more than a crore of rupees before Bayer's process for the synthesis of indigo could be commercialised. But once it was done, the fate of the natural indigo of Bihar was sealed and it disappeared from the world's market in another twenty years. Of great topical interest is that exciting venture of the late Prof. Haber when in 1909 he demonstrated before the Badische Chemical Engineers that it is possible to obtain small quantities of ammonia by synthesis from nitrogen and hydrogen. Millions of pounds had to be spent before this discovery could be exploited commercially; and today synthetic ammonia, apart from its value in war, constitutes the biggest single item in the fertiliser industry with an annual production of more than 100 crores of rupees. The attitude in Great Britain, on the other hand, was one of complacent 'wait and see'; and the result was that in 1914 she had no dyestuffs industry of any importance. As the war progressed it was realised that the British dependence on Germany for dyes was tantamount to a much wider and more fundamental weakness of British Chemical Industry. Modern war depends for its successful prosecution on an abundant supply of a large variety of chemicals; and a dyestuffs and fine chemicals industry must be considered an integral part of every defence programme. The British Government took immediate and far-reaching steps. Beginning with a direct and large subsidy for the formation of a company, which ultimately was absorbed in the Imperial Chemical Industries, millions of pounds were spent on developmental research in every branch of the industry. Later on, the importation of dyes and even intermediates were prohibited. As a result Sir Gilbert Morgan in 1939 claimed with justifiable pride that of the five most fundamental discoveries in dyestuffs chemistry since 1921, the world owed three to British talent. The British dyestuffs factories are not only producing now their home requirements but have also in addition a considerable export trade. This altered attitude in Great Britain is reflected in the Ormsby Gore report of 1928 which observes that 'no nation can advantageously depend only on the efforts of other nations for the purpose of promotion of knowledge. This is not only because such dependence is an ignoble parasitism, but also because in the field of international relations no less than in national life, the power that comes from knowledge comes from its early and rapid use and from close contact with men who have created this knowledge'. The conviction has now become universal that the nation, which will enjoy the benefits of science in the day-to-day progress of its industries and agriculture, is the nation which habitually applied to them scientific method and scientific knowledge; and it is that nation which will be able to seize the advantages of the more spectacular achievements of science in its economic life.

We are reminded often in our country of the distinction that exists between pure and applied research. It is unfortunate that any great stress should be laid upon such difference even before we have made much progress in the field of scientific research. There are explorers to whom discoveries are ends in themselves, there are others who create new knowledge or utilise existing knowledge for practical purposes. They belong to the same family; their efforts are not antagonistic but supplementary. To a chemist the examples of Bayer and Haber, which I have already quoted, make such distinctions meaningless. The physicist and mathematician may be regaled with an anecdote about Heaveside. When this British mathematician was told that an American had made a million dollars by the practical use of his theory of distortionless telephone circuit, he replied that the American deserved a million dollars more for having understood his mathematics properly. It often happens that the application of a discovery may not be obvious to the discoverer himself or the progress in cognate branches of science and technology has not been such that the discovery can be taken advantage of at the time it is made. Great and perhaps equal credit is due to Marconi for the development of

radio communication as to Hertz, the discoverer of electromagnetic waves. To us in India both aspects of research should receive equal attention. We may differentiate between a long-range programme and a short-range programme. Both forms of research are generally good financial investments; while the short-range may bring some immediate return for the capital, the long-range programme is often an insurance against dark days, and its indirect return by fostering research-mindedness in the country and by training personnel with a flair for discovery is of inestimable value. It also often happens that the direct return of one fruitful piece of long-range research pays back many times over the cost of ninety-nine which may not find useful application. Synthetic ammonia is a case in point.

No informed person in Europe or America would disagree with the observations that I have made; but in our country the opinion of men that count, the custodians of the public purse, is not generally helpful. I remember the Hon'ble Sir Ramaswamy Mudaliar saying some time ago that as soon as the war broke out, a note was put up to the Hon'ble the Commerce Member by the departmental officials that as a measure of retrenchment the old Bureau of Scientific Research should be abolished; he had the foresight to note back that the old Bureau should be abolished not as a measure of economy but to make room for a Board of Scientific and Industrial Research with vaster resources and wider objectives; that in wartime, no economy can be too disastrous which starves industrial research and no expenditure can be too high which mobilises the scientific and industrial talent of the country for research and production of war materials. Thus was brought into being the Board of Scientific and Industrial Research in India in April 1940. The Board now receives an annual grant of ten lakhs of rupees from the Government.

Now that the victory of the United Nations is in sight, we feel that time is ripe for a critical examination of the facilities for scientific research and training that are available in India and drawing up plans for improving and co-ordinating such facilities. The agencies that are responsible for this work are the Universities, the Central Institutes under the Government of India, the Imperial Council of Agricultural Research, the Indian Research Fund Association, the Board of Scientific and Industrial Research, the endowed Research Institutes like the Indian Institute of Science, the Indian Association for the Cultivation of Science, the Bose Research Institute, etc. and the research laboratories of industrial concerns like the Tata's. It is difficult to estimate the total funds that are available to these bodies for the discharge of their onerous duties. At a very optimistic estimate, the total expenditure from all sources will not exceed seventy-five lakhs of rupees per year. In the more progressive countries scientific research is being planned with a crusading zeal, as it has been realised that modern developments in science and technology, if utilised to their fullest extent, can give to every individual a fuller and more satisfying life. In the new world of four freedoms, the able scientific researcher will be a key man and it is a matter of primary importance to enquire what economic and educational structure 'will produce this type in maximum abundance and satisfactory activity.' In Russia, they spent one per cent of the national income on scientific, technical and agricultural research, *i.e.* 1.2 billion roubles; and in 1938, the Soviet Union had 902 scientific research institutes with a staff of 29,000 research workers. We are full of admiration for the heroic Russian resistance, which has now fortunately become a mighty offensive. Determination and valour have no doubt played their part in the ordeal through which the Russians have passed, but no less important for success have been the high degree of scientific backing, the abundance of equipment and war materials which are the fruits of long planning and forced marches in industry. Yet science in Russia of 1915 was hardly in a better condition than science in India at the same time! The United States of America employed 70,000 research workers and spent seventy million pounds in scientific and technical research in 1940 which is 0.3% of the national income.

In India the national income has been estimated at Rs.65 per head. Even an expenditure of 0.1% of national income for research will amount to 2.6 crores of rupees. An annual grant of Rs.2.6 crores from the public exchequer for research and an equal

grant for training of research workers will, I hope, be not considered unreasonable in the first three years after the war. There is no end of new devices by which funds can be raised. I may commend to the attention of the Central Government the example of France, where an employer has to pay to the public exchequer two francs for every 10,000 francs paid in wages. This gave annually a sum of three crores of rupees which was devoted to technical and vocational education in France. At a recent Rotary lunch in Bombay, the Rotarian President Sir Vithal Chandavarkar said that he felt ashamed when he saw any scientific worker begging for funds which would give him facilities for research. His time and energy could far better be utilised for creative work for which he is best fitted. I wish every thinking person in India would re-echo the sentiments of Sir Vithal.

If, as we expect, funds become available in a generous measure for scientific research in post-war India, it is necessary that every care should be taken that they are utilised to the maximum advantage of the nation. In Soviet Russia, the Academy of Sciences is charged with this responsibility. I may quote from a recent speech of Prof. Crowther the following: 'The Academy of Sciences is directly responsible for the planning of scientific development to the Supreme Soviet. Its executive power is equal to its social prestige. The Academy determines the general lines of scientific work in accordance with the needs of the State and possibilities, in subjects and personalities. It sees that balanced attention is given to all sides of science, that no important branch is neglected, and overlapping is reduced' (not altogether avoided?) 'The planning proceeds as much from the top as from the bottom. In every institute, the research staff first prepares a programme for each year's work. It is then reduced and incorporated into the plan of the Institute and then given final shape by the Academy who calls a meeting of the Directors of all these Institutes for the purpose'. 'In the planning of the development of scientific research, the Soviet began with the finding and training of men and then built the Institute later. They did not start with paper-plans of Institutes into which men were subsequently made to fit'. ' In the early twenties, Prof. Joffe started the Physicotechnical Institute at Leningrad, collected promising students from all parts of the Soviet Union. By 1929, the Institute had grown to immense size with 700 students in various laboratories and about 1,300 assistants and workers'. It is the men from such laboratories that have been chiefly the brains and executives of the successive five year plans. The Board of Scientific and Industrial Research in India are now preparing plans for the establishment of the National Physical Laboratory, the National Chemical Laboratory, the National Metallurgical Laboratory, Glass Research Institute, Radio Research Institute, etc. I would remind the Board, of the Russian emphasis on the training and finding of researchers who would be called upon to man these All-India National Laboratories.

It is doubtful if in post-war India, Russian methods will find much favour. Reference to any Academy of Science in India also brings back unpleasant memories of the past. We may, however, study with care the work of the National Research Council of Canada where a young nation with a bold and vigorous outlook is rapidly securing a high place in the world's counsels and esteem. The National Research Council have their own research laboratories, whose annual budget in 1939, exceeded one million dollars. These laboratories supplemented the work of a thousand laboratories for research on process and plant control which are maintained by the industries themselves. In 1938, capital grants were available for building and equipping up-to-date research laboratories in Aeronautical Engineering, Hydraulics and High Voltage Electrical Engineering. By virtue of having under their control laboratories representing all branches of science, the Council are in a favoured position for the study of any important problem. It is not always easy to know in advance which branch of science can offer the solution; but the council can easily gather together experts in all related branches of science and set up a team to find such solution. It is a pity that our Imperial Council of Agricultural Research, which has been in existence for more than ten years, has not yet got any research laboratory of its own. Perhaps it is too unwieldy a body to be entrusted with the administration of a laboratory. While we should guard with zealous care the autonomous administration of a university laboratory, where a free lance researcher is exploring the borderland between knowledge and ignorance with no other guide but his own intuition, the laboratories

which are mainly concerned with short range programmes of research should be administered on a different footing. Such laboratories should, at least, have governing bodies, with interlocked personnel, and lay the greatest emphasis on team work. Better still if they are administered by an All-India National Research Council through properly constituted research committees functioning on their governing bodies. Such committees of the National Research Council in Canada 'settle the objectives of research, indicate the individuals or organisations which should undertake the several component parts of the enquiry, receive and co-ordinate the resulting information, make it available to those who will turn it to advantage and form a national plan into which all who are in a position to contribute information can fit their particular lines of research'. These research laboratories, however, do not monopolise scientific research in Canada. Assisted research through universities is an accepted policy of the Council. The advantages of bringing fresh minds in an academic atmosphere to bear on the solution of a problem are well understood. No worthwhile project of research is delayed for lack of funds with the result that there are sometimes more problems demanding solution than post-graduate students wishing to take up a research career.

The National Research Council, Canada, also manages another unique institution—The Research Enterprises Ltd. In war time every invention of value is immediately seized upon and exploited by eager businessmen for the production of war materials. In peace time, however, this does not generally happen. There is a long gap between the birth of knowledge and its availability for use. The Research Enterprises Ltd. is intended to bridge this gap and shorten the time lag. We should have in India a similar Development Corporation, which will be encouraged to take risks by a guaranteed annual subvention from the State, and introduce into industry and agriculture the inventions and processes which have been satisfactorily worked out under the auspices of the National Research Council. We have already the nucleus of such an organisation in the Utilisation Branch of the Geological Survey of India and the Utilisation Committee of the Board of Scientific and Industrial Research. It is definitely to be understood that such a corporation cannot be self-supporting. We remember with sorrow how the progress of scientific research in India for a decade after the last great war was blocked by the recommendations of the Incheape Committee. I am told that they recommended that the Imperial Veterinary Research Institute at Muktesar should become self-supporting by the sale of their biological products and that this recommendation was given effect to. I consider that this is a wrong policy to adopt. In normal peace times the research workers should not be saddled with the duties of commercial production of any material. If it is considered desirable that such production be carried out under the auspices of Government, and in many cases the consuming public will welcome such an arrangement,—it should best be done by a corporation of the type of Research Enterprises Ltd.

War is an ill wind that sometimes blows good things. It makes the public conscious of ulterior objectives. It takes them out of the hurly-burly of routine existence and creates an yearning for a new order of things. It stimulates enterprise in many fields and lifts vital problems clear of the arena of dispute. We hope that the post-war organisation of scientific research in India is one such vital problem and that every citizen of India will pull his weight in implementing the recommendations that may ultimately be evolved by representative gatherings of the type that have assembled here this morning.