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SCIENTIFIC RESEARCH AND INDUSTRIAL DEVELOPMENT IN AID OF DEFENCE*

IN recent years, the connection between defence and practical utilisation of resources, or in other words, industrial development, has come to be more and more intimately appreciated, and nations which are not in a position to meet some of their essential needs have harnessed science to make good the deficiencies by evolution of new processes, utilisation of new raw materials and development of substitutes. Classic examples of these are: fixation of nitrogen to produce ammonia and nitric acid, a process developed with the object of doing away with dependence on imported Chile salt-petre, production of sulphuric acid from gypsum in Germany during World War I, an instance of using new materials to meet defence requirements and the Fischer Tropsch's and Bergius' processes for production of synthetic petroleum products from coal.

Defence also aids science and industry by accelerating the pace of industrial development,

thereby providing new sinews for the progress of science and its application to useful ends. Rapid developments in the use of radar and sonar in many spheres like radio location, detection of hostile aircraft, guiding of bombers and bombing and location of submarines, have opened up innumerable possibilities for the application of these sciences in civil aviation, commercial navigation and several other similar fields. The availability of radio-active isotopes in relative abundance as a result of quick developments in the field of nuclear energy has provided new tools for scientific investigations in agriculture, industry and public health. The rapidity with which penicillin, streptomycin, aureomycin, atabrin, DDT and several other insect repellents and insecticides were developed and produced under the stress of war has been an invaluable contribution of defence in prevention and avoidance of disease.

In India also defence has been giving a fillip to science and industry. The tempo of industrial development was stepped up during the two world wars, and production of many new

* Summary of an Address to the Defence Science Conference in New Delhi, delivered by Dr. S. S. Bhatnagar, on 21st April 1952.

items was established mainly to meet defence demands and in some cases to meet shortages created by war conditions. One of the major contributions of World War II was the rationalisation of production in cotton, woollen and jute textiles. Leather and rubber are some other industries which benefited similarly. The emphasis on industrial products coming up to certain specified standards has to a certain extent been responsible for introducing standard methods of production and raising the quality of some Indian products to bring them on a par with imported material.

Besides, an analysis of the statistical data relating to education in scientific subjects shows that World War II inculcated an increased interest in science, and the number of students taking the I.Sc. and B.Sc. examinations began to show an appreciable increase from 1940-41 onwards. The establishment of a Board of Scientific and Industrial Research in 1940 and the Council of Scientific and Industrial Research in 1942 was primarily intended to utilise science in making India an efficient supply base. This is borne out by the resolution creating the Board in which emphasis was particularly laid on the development of industries whose importance or possibilities had been prominently brought to the forefront as a result of conditions created by the war. The expansion of these activities to cover the whole sphere of industrial development was a logical consequence of this step.

The scope of these influences has, however, been limited because of the nature of the 'basic' political set-up obtaining till recently. Major defence requirements were obtained from the U.K. and other foreign countries and only the barest minimum were met from indigenous resources. These conditions have been gradually changing and greater reliance on the ability of industrial concerns within the country to meet defence requirements is evident, but the lack of an organisation in the Ministry of Defence which could look at problems from a scientific point of view retarded the healthy development of these impacts. The setting up of the Defence Science Organisation three years ago is an indication of the change in outlook and now that this Organisation has established itself firmly, it should assume a more active and prominent role in effectively influencing progressive developments in certain specified fields of scientific research and industry.

In America the expenditure of the War and Navy Departments, excluding A.E.C., on research and development totalled 500 million

dollars in 1947. Of this only 20 per cent. was spent in Governmental laboratories while 80 per cent. took the form of contracts with industrial and university laboratories. Not all this money was for applied research only; a portion, though a small one, of 35 million dollars also went to promote basic research. These figures are just illustrative of the extent to which defence organisations in the U.S.A. support research in Universities and other industrial laboratories. While it is not suggested that the Defence Science Organisation in India should at the very start begin supporting educational and research institutions on the same scale, a beginning in placing of research contracts with various research organisations is immediately called for. Besides promoting science in general, such a step will also assist in training of technical personnel in specialised fields to meet defence requirements.

In this respect the various National Laboratories of the Council of Scientific and Industrial Research offer a unique opportunity for active collaboration. For instance, the Central Food Technological Research Institute, Mysore, could take up investigation on canned rations of various types and their behaviour on storage under different conditions. It has already developed a canned vegetable curry which is highly nutritious and will, I am sure, be appreciated by the armed forces. Similar collaboration in ultrasonics and electronics particularly with the National Physical Laboratory can lead to very useful results. India has a long coast-line extending over nearly 2,500 miles, yet no detailed coastal map of India has so far been prepared. One of the major undertakings awaiting the Defence Science Organisation is a regular survey of the coastline and the surrounding seas and in the execution of this project, ultrasonics can play a major role.

Extension in practical applications of electronics is also possible in various fields and by subsidising research in this subject, defence will be laying the foundations for the establishment of an electronics industry within the country.

The same applies to other National Laboratories. The National Chemical Laboratory could, for instance, assist in evolution of simple devices for desalting of water. It could also undertake on behalf of defence basic studies of new explosives. The Fuel Research Institute could help in the study of improved methods of coking and carbonisation to obtain better yields of benzene, toluene, phenol and other similar essential chemicals. It should

also be possible to consider jointly how far establishment of petrochemical industries in meeting some of these requirements is feasible.

In the field of industry also, there are several items which defence should either take up on its own or subsidise directly with a view to establishment of industrial production of some essential raw materials. The priorities which defence requirements command carry the added advantage of ruling out ordinary economic considerations. In many cases establishment of indigenous production is essential although it is obvious that to start with, costs will be higher, appreciably higher, in many cases. An example that readily comes to mind is that of phosphorus, initiation of manufacture of which under present conditions would be uneconomic without direct support from defence.

Besides engineering industries, the ordnance factories of defence include a number of chemical industries which have now been running for a long period. In this connection, reference may be made to the manufacture of acetone from alcohol and oxidation of ammonia to produce nitric acid. The affairs of these factories are at present defence secrets, but I do believe that a stage has now been reached when it should be possible to reveal the economics of manufacture so that the experience gained may prove useful in arranging production of these materials for ordinary industrial purposes.

Subjects which will receive prominent attention during this week's conference are ballis-

tics, operational research, personnel research and environmental physiology. I am glad a whole afternoon is being devoted to the study of 'Ballistics in Universities' and I have every hope that in the contributions to the discussion, the significant need of support, both moral and material, to the development of this subject in the Universities will be fully brought out. The same remarks apply more or less to the other subjects, operational and personnel research.

As one of the largest employers in the country the defence organisation has indeed a unique opportunity of making substantial contributions to promoting the general welfare of the nation. Armed forces have under constant study various problems connected with the welfare of their personnel such as checking and avoidance of various diseases, causes of nutritional deficiency and ways and means of making these good, etc. These studies are at present restricted to particular areas and conditions obtaining in defence establishments and camps. Provision of facilities to State and social workers in extending these investigations and preventive measures to other areas in collaboration with defence personnel offer a unique opportunity for collaboration with defence in making effective contributions in promotion of general national welfare. This association cannot fail to have far-reaching educative effects on the masses of India and will doubtless serve to raise their general standard of living substantially.

TRACER TECHNIQUE IN AGRICULTURE

WITH the aid of radio-isotopes it has become possible to trace nutrients through the soil, into roots, and thence through plants, to measure the extent and speed of their movement; to determine at what stage in its growing cycle the plant needs fertilizer most; to know where and how fertilizer should be placed to give the plants the maximum benefit; to establish what kinds of fertilizers work best in the country's varied soils; and to answer other practical questions about the techniques of fertilizer use. Such probing is rather necessary as experiments made during the past few years have shown that crops differ widely in their abilities to use natural phosphorus from the soil or from commercial fertilizers. Also, tests made on many crop plants seem to emphasise that the beneficial effect of fertilizers depends greatly on the form of phosphate used, when it is applied, and where in relation to the seeds.

Other work with radio-isotopes relates to the biological sources of plant nutrients with a

view to study the mechanism whereby plants receive nourishment from organic matter in the soil and the way in which bacteria on the roots of bean plants build up the nitrate content of the soil to nourish future generations of growing plants. Still further research is being done on the nutritional diseases of plants and sickness of trees.

Crop pests do damage to the extent of 6 billion dollars a year in the U.S.A. alone. By building radio-active isotopes into the chemical structures of pest-killing preparations, researchers gain clearer knowledge of their basic action, their advantages and limitations. Radio isotopes are peculiarly useful in this field because insecticides and weed killers are ordinarily used at such low concentration that detecting them by other means is difficult or impossible. As tags on food given to air-borne fungi and insects, isotopes are used to 'label' these species and map their patterns of dispersion.