SYMPOSIUM ON "THE ROLE OF OPERATIONAL RESEARCH IN AGRICULTURE"*

SHRI B. D. PANTH, Director, Industrial Management Research Unit for Planning, Bangalore, who presided, explained that operational research was a new instrument which used diverse disciplines to solve problems confronting industry, agriculture, etc. Operational research was a war-baby. The techniques involved in operational research were evolved during the last war. The sole aim of operational research whether applied to industry or agriculture was like all other sciences, the ultimate benefit of not a single individual but the entire community.

Operational research in its final analysis meant the evolving of a synthesised solution for a problem, putting the work of many brains together and correlating and co-ordinating their work. This, however, was not a new technique but in the present context of the fast developing modern complicated world, it assumed added importance.

Dr. P. V. Krishna Iyer of the Ministry of Defence who initiated the discussion gave a general review of the theoretical developments in operational research. He pointed out that operational research was first initiated in Britain during World War II for providing solution to a number of problems confronting Operational Headquarters. Teams of scientists were attached to operations carried out by the defence forces. They collected data on various operations on which information was required and advised operational command on the optimal procedures to be adopted in various operations. Many outstanding contributions were made by the operational research group of the United Kingdom during the war. Now-a-days operational research helps executives of the government and military organisations to arrive at an optimum decision regarding various problems confronting them.

The success of operational research depends entirely on teamwork and study of the system or process as a whole. Further, piecemeal investigations of a system will not lead to fruitful results. This

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requires specialised knowledge of all sciences, mathematics, physics, engineering methods, statistics, biology, etc. Recent contributions to stochastic processes, game theory, linear and dynamic programming, decision theory, etc., made by economists, physiscists and mathematicians serve as powerful tools in providing the optimum solution to several problems. It is necessary that decisions at all levels of planning and production should be made after a careful analysis of data collected on a planned basis with the help of the above tools. Otherwise, they may result in considerable waste of our resources and energies. He explained how operational research techniques should be used in determining utilisation of fertilizers to land and in allocation of fertilizers between different regions and different crops and thereby determine the optimum quantities of fertilizers necessary for each type of land and for each kind of crop to secure optimum yields.

Dr. V. G. Panse, I.C.A.R., said that operational research was a scientific method to give the executive departments a quantitative basis for making decisions in regard to operations under their control. The operational research workers usually work in a group in direct contact with the executives and are engaged in studying operations as they are being carried out for finding out in what way they could be modified to increase their efficiency. The operational research team usually includes besides other scientists mathematicians and statisticians for applying the tools of their particular sciences in tackling problems arising in manufacturing processes in industry or any productive activity, in war and other fields, in administration or organisation. The work is twofold: to solve the problems that are posed and to think of new problems which must be solved in order to improve the processes. The executives cannot generally be expected to uncover these problems; otherwise they would not need the advice of operational research workers.

In making a distinction between the mathematical statisticians or other scientists and the operational research workers, Dr. Iyer referred to certain theoretical developments and models. The distinction may be made further clear by the contrast that the mathematical statistician is after an exact solution and approximates the observations or conditions of the living world to a theoretical model and then uses this model to obtain the solution, while for the operational research worker the observation is the precise basis on which he seeks a solution and does not mind getting even an approximate solution.

The tools of operational research are the various sciences *plus* common sense. New techniques like linear and non-linear program-

ming, information theory and other methods are coming into vogue as a requirement of operational research. The core of this research is however the tackling of problems confronting executives by whatever means the operational research workers can think of. Looking through the literature on operational research, we find that the classical statistical techniques and methods are still the main tools employed in this field. Therefore, we need not be led into thinking that operational research is built only around certain new techniques. Techniques are not operational research. They are some of the tools for the solution of problems.

The speaker then went on to indicate the possibilities of application of this idea to agricultural problems. An example that the speaker came across in the literature on the application of those tools to agriculture was that of a firm packing green peas produced in its extensive farms. The growth rates of the different varieties of peas were very carefully studied by scientists, and as a result of these studies they laid out a programme for planting different varieties, in such a manner that the packing plant could work under optimum conditions by being assured of a steady supply of the raw material. The speaker also gave an example from work being done in India in connection with rinderpest eradication campaign. Under this campaign, all susceptible animals in the country are to be vaccinated to make them immune to this disease. A very large field staff is employed for going systematically from village to village to vaccinate the animals. It is discovered from the analysis of the fieldwork made at the Indian Council of Agricultural Research that smaller field parties of 3 and 4 are more efficient than larger parties and as a result there is now a general tendency to reduce party size to 3. Another problem relates to the packing of the rinderpest vaccine containing a certain number of doses. It is found that since the vaccine does not remain effective for more than a couple of hours after the ampoule is opened, a considerable amount of it is wasted. The average wastage has been estimated and the proportion of the packs that should be of smaller size in order to reduce this wastage has also been determined. However, before using these results in practice it is necessary to see whether it is more economical to allow the present wastage or incur additional expense to pack a proportion of doses of smaller sizes.

The speaker reiterated that the urgent problem before us which must be solved expeditiously is the question of optimising our efforts for agricultural production. It is here that we must concentrate all our energy and attention in order to provide the executives, in this

context the directors of agriculture, extension officers and others, with procedures for action by which our existing resources such as fertilizers, improved seeds, irrigation, etc., would be utilised with maximum benefit to our agricultural production. For example, in regard to fertilizers, we have to analyse and use experimental results, and where necessary carry out further experiments, in order to decide how fertilizers should be allocated to different crops and what quantity should be applied, study the reaction of farmers to the use of fertilizers through surveys and devise extension techniques to secure their rapid acceptance. Other problems like transport for the timely distribution of fertilizers to farmers have also to be tackled. The use of fertilizers has further to be linked with available irrigation.

Shri V. R. Rao of the National Sample Survey began by saying that after hearing the previous two speakers he became more uncertain about the exact connotation of operational research and its role in agriculture. The prevailing confusion was perhaps due to the very recent origin of this subject and its development having been confined so far to limited fields like defence science. He agreed with Dr. Panse that the definition of operational research should be broad-based and suggested that it should comprise of rules and procedures which admit of quantitative measurement and which will provide objective criteria for deciding the best means of performing a specified operation.

According to this broad (and rather loose) approach the agricultural sector provided several situations where operational research could be of advantage. In agricultural planning particularly, operational research, he said, had a dual role—firstly, the determination, for a given amount of resources, of its optimum allocation among several factors of production in order to secure maximum produce and secondly a study of the progress of the Plan. The tools of linear programming are one set of operational research procedures to determine optimum allocation. But the more basic issue in this connection was to obtain information on rate of benefit per unit input, the cost of making it available, its acceptability, and the physical and other impediments in its spread. This implied an assessment of:

(*a*) the effect on the field of suggested technical improvements (use of seed and fertilizers, land reclamation, irrigation, etc.);

(*b*) the degree to which technical improvements were being put into practice; and

(*c*) the ways and means by which they could be secured.

On all these three aspects sample surveys provided speedy and reliable information. Shri Rao described some of the surveys already in progress under the direction of the National Sample Survey and the Indian Council of Agricultural Research for assessemnt of yield rates, cultivational practices and study of the impact of development programmes. While these surveys would go a long way in agricultural planning, Shri Rao felt that there was further scope for sampling studies on cost of production, farm management and efficiency of land reforms.

Dr. B. H. Iyer of the Indian Institute of Science said that operational research was applied commonsense and that it had come to stay as an important tool in the solution of difficult problems in industry and agriculture. He said that the several processes employed for solving problems in operational research are: inventory, allocation, waiting-time replacement and competitive processes. Allocation models are used to solve problems which arise when there are a number of activities to be performed and there are alternative ways of doing them; or when the resources or facilities are not available for performing each activity in the most effective way. One of the techniques finding useful application in solving allocation problems is linear programming. Linear programming is used for solving a general class of optimization problems dealing with the interaction of many variables subject to certain restraining conditions. The objectives of such problems are generally optimization of cost or profit of quantities produced. Recently iterative techniques have been developed to solve systems of equations as are obtainable in linear programming. Two of these important techniques are the transportation technique and the simplex technique.

He then illustrated the application of the transportation technique to the problem of distribution of fertilizers. Fertilizer produced in three factories have to be distributed to five destinations at different locations. Assumed values for production figures at factories, requirements at destinations, inter-factory-destination distances and unit transportation rate have been given. It is also assumed that the problem is self-contained. The object is to arrive at an optimum economic and feasible solution applying the transportation technique. He then discussed the various steps involved in arriving at the solution giving numerical results.

Dr. V. N. Patankar of Hindustan Lever Limited said that operational research is still a new technique for Indian industry. Though

Unilever in London have already started on this for some time in the past, a beginning has been made very recenly in Hindustan Lever here. There seems to be a great scope for application of classical operational research technique of inventory control of raw materials and finished products, linear programming for distribution of finished goods and for selection of raw materials, theory of games, etc.

He then went on to discuss some of the problems currently undertaken in the company.

A useful application of operational research in agriculture is in forecasting groundnut crop and groundnut prices. A correlation exists between the rainfall and the crop. By superimposing the rainfall data for a few years over the growth cycle of groundnut, it was possible to locate the crucial times when adequate rains are necessary for the proper growth of groundnut. Groundnut prices also seem to be dependent upon their arrival pattern rather than on the magnitude of the crop alone.

Dr. K. S. Rao and Sri. A. V. K. Sastri of the Directorate of Economics and Statistics, Ministry of Food and Agriculture, said that an operational research unit had recently been started in the Directorate and indicated in a broad outline the type of work which was proposed to be carried out. Besides this Dr. G. R. Seth, I.C.A.R. and Dr. K. Kishen, Agricultural Department, U.P., also participated in the discussion.