including water, acid-alkali extinguishers, carbon dioxide gas from cylinders, foam, and inert heavy vapours, such as carbon tetrachloride. Two separate principles are concerned, cooling the material to below the temperature necessary for combustion (combination with the oxygen of the air) or diluting the oxygen to the point when it will not support active combustion. As already stated, carbon dioxide acts in this way, and the same applies to carbon tetrachloride, used for motor car extinguishers, whilst water depends almost entirely on the first principle, reducing the local temperature. The firm make equipment using all the above methods, and foam for example, extremely valuable for many conditions, consists of a close aggregation of bubbles formed of a resistant film or skin filled with carbon dioxide gas made by mixing a special alkaline and acid solution. What is the best method to adopt depends upon the exact circumstances, and efficient fire fighting to-day is of course a highly complicated business using a great assortment of fast motor vehicles and rescue apparatus of different types.

Science in the Service of Indian Agriculture.*

THE material results of scientific discoveries have, as elsewhere in the world, greatly benefited rural India and her agriculture. Better transport, better illumination, the rural electric supply, the telegraph and the wireless are all tending to raise the standard of comfort in the villages. An even greater service is the application of the scientific method in the solution of the problems of agriculture which is largely an art and perhaps primarily a business. The conscious application of the scientific method is barely a century old but an immense amount of agricultural lore, gained as the result of experience, has accumulated which is both important and deserves to be scientifically interpreted. In India, the first attempts at improving agriculture took the form of the opening of model farms for copying the methods in vogue in advanced countries. The appointment of American cotton growing experts, the importing of agricultural machinery including steam ploughs and the opening of model farms in Madras, Bengal and the U. P. belong to this phase. The next landmark is the report of the Famine Commission of 1880 and its successor of 1901 to which we owe not only the development of irrigation, communications, rural credit, etc., but also what eventually became the Provincial Departments of Agriculture. The visit of Dr. Voelcker and his most valuable report followed, as likewise successively the appointment of individual experts like Mr. Mollison, Dr. Leather, Dr. Barber and Dr. Butler. In 1904 Lord Curzon's Government made the next great advance which resulted in the creation of the Imperial Department of Agriculture, the opening of the Pusa Research Institute and the starting of properly equipped scientific Departments of Agriculture in the Provinces. Steady progress has followed and thanks to the wise and far-reaching recommendations of the Royal Commission on Agriculture research can now be organised and financed with a precision previously unknown. With the Universities and kindred institutions co-operating with the Agricultural departments the stage has now been set for a great advance in rural uplift.

With this somewhat familiar historical background we may now describe the contributions of the different sciences to the improvement of Indian agriculture using the term however in its narrower sense of mere crop production. This improvement in crop production has been along three directions, *viz.*, the improvement of the plant, its better nutrition and better protection against pests and diseases. More progress has been made in plant improvement than in improved plant nutrition in India for reasons partly economic and partly technical. The rapid advance in the science of genetics and its application to plant breeding has naturally led to much attention being paid to the improvement of the staple crops of the country. As a result, the area under improved wheats alone is well over 16 million acres, to take the case a most important crop. Wheat indeed was one of the first crops to be studied the names of the Howards, of Milne and of Evans being associated with this important work. The varieties originated are all of high merit, one of them Pusa 12 having given double the yield of the local, over a seven-year period of trial. All are also of high milling value and Pusa 12 combines with high yield, earliness, hardiness and good milling and baking quality. The Pusa improved tobacco is a cross between the Adcock and the Pusa 28 and combines the excellence for cigarette making with the valuable agricultural features of the local parent; the improved linseed of Pusa combines the root system and the agricultural habit of one type with the high oil content of another; and the types of *Cajanus indicus* evolved in Pusa are largely resistant to the wilt disease.

The work on sugarcane improvement at the Coimbatore Research Station has resulted in the production of highly satisfactory crosses between the wild cane and the noble or tropical cane, eminently suitable for cultivation in Northern India where they now occupy some 60% of the total cane area of India. In the improvement of the cotton crop, tests for the spinning quality of the various strains evolved by plant breeders are systematically carried out at the Cotton Technological Laboratory of the Indian Central Committee, so that improved cottons undergo a rigid test on this important requirement of quality before they are pronounced as really

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* Summary of a lecture delivered by Sir Boyce C. Burt, at the Twenty-third Annual Meeting of the Indian Science Congress, Indore, 1936, on 3rd January.

improved strains. In this particular aspect of cotton improvement work, India can be said to be ahead of other cotton growing countries and our Technological Laboratory is in many ways a unique institution. The result of all this work on cotton improvement is that quite 4 million acres are now under these improved varieties and that but for this development India will be importing foreign cotton to the value of some 7 crores of rupees.

In respect of better plant nutrition the second line of improvement work has somewhat lagged behind. Numerous experiments have brought out however the great deficiency of nitrogen in Indian soils, the need for organic manures, of aeration and of drainage. All of these have been emphasised and composts and green manures studied and recommended. Work on soil colloids, on the laterite soils of Eastern Bengal, on rice and sugarcane soils in the Bombay Deccan and the C. P. is in progress as well as a comprehensive scheme for the study of dry-farming methods. Problems of excess water, of waterlogging, alkali troubles and kindred matters relating to irrigation are also receiving attention. In regard to artificial manures they have been found to be economic under certain circumstances and India now uses not only the whole of her local production of 13,000 tons of ammonium sulphate, but also had a net import of 38,000 tons in the year 1931–35. Field experiments covering manurial and other problems have become more precise in lay-out and interpretation, thanks to the aid of mathematical technique furnished by the Research Council.

The third division in crop improvement relates to the avoidance or reduction of losses caused by plant pests and diseases. These levy a heavy toll on agricultural wealth and there is need for all the help science can give. Taking sugarcane for instance, these pests comprise moth borers, the Hispa beetle, the cane hopper, mealy bugs, white fly and termites. By suitable varieties, cultivation methods and dusting with insecticides some of these can be controlled and biological methods also hold out promise. The pink boll-worm of cotton and the spotted boll-worm cause large losses annually, but simple methods of control have been devised and demonstrated, *viz.*, the heating of the seed in the first case and the removal of the cotton stumps after harvest in the second case. The heating of the seed has been found to impair neither the vitality nor the oil content of the seed.

Plant diseases are caused by fungi, bacteria or viruses and the best weapon to fight them with in India is the use of immune or resistant varieties, coupled with proper cultivation and rotation methods. Direct methods are also economic, and good instances of such work are furnished by Mysore where spraying arecanuts to prevent the nuts dropping and the coffee bush to prevent leaf disease is extensively practised.

Among improved implements, mention may be made of the large number of improved ploughs being sold annually and of that most recent introduction, the pneumatic tyre for bullock carts. The latter has been found to result in 50% increase in the hauling capacity, in less strain and jerking and fewer sore necks.

The scientific worker in India will find a wealth of material for research in agricultural problems intricate enough for the most ambitious. In all applied sciences, the most important problems often lie on the border line of two or more pure sciences and their successful solution leads to an advance in general knowledge or to the opening up of new fields of scientific investigation. [The address was profusely illustrated by a splendid set of lantern slides.]

Preparation of Fine Chemicals in India.

A SYMPOSIUM on the scope of preparation of fine chemicals in India was held at a meeting of the Chemistry Section of the Indian Science Congress 1936, under the Chairmanship of Dr. P. C. Guha, the President of the Section.

In opening the discussion, Dr. P. C. Guha stressed the desirability of considering seriously the question of preparing fine chemicals in India. A start has been made by the Organic Chemistry Department, Indian Institute of Science, Bangalore, where, since the inception of the Preparation Section in 1930, more than 200 research chemicals have been prepared (some of them in considerable quantities) in an economic way. When an experimental scheme of this nature has to be viewed on a commercial basis, several points demand careful consideration. Now that the preliminary efforts have proved successful, the time has arrived when Indian capitalists should make an attempt at commercialisation. The history of the Eastman Kodak Company of Rochester may be recalled in this connection, and this should serve as a stimulus. India possesses several advantages; for instance plenty of cheap expert and ordinary labour is available. A beginning can be made with the object of meeting the demands of the laboratories. Such an establishment with its *indispensable research section*, could undertake the preparation of other chemicals of general and every-day use in industries and also exploit the possibility of utilising the chemical resources of India. Caution is necessary in such an enterprise and external source of information and experience cannot be depended upon and the necessary technical skill being acquired by Indians themselves. India, like other advanced countries, must pass through a preliminary evolutionary period, but this instead of damping her spirit should make her all the more resolute and active. Prof. Guha appealed to capitalists to utilise the experience already available in the country and explore the possibility of starting industries in this line.

Dr. Wheeler (Bombay) endorsed the President's views and added that some firms in India should take the lead. He felt that the Council of the Indian Chemical Society might organise the production of a limited number of important research chemicals in the various university chemical laboratories. Dr. J. C. Ghosh (Dacca) supporting, instanced the case of a pupil of his, successfully starting the manufacture of gas mantles at Dacca. Dr. N. R. Dhar (Allahabad) felt certain that there is plenty of scope for the