ORGANIC *VERSUS* INORGANIC MANURES IN LAND IMPROVEMENT AND CROP PRODUCTION.

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The question of organic and inorganic manures and fertilizers is of the greatest interest at the present time in view of the urgent call for manuring for increased crop production.

The question is what system of manuring is the best, initially and in the long run, for soils, men and animals. In other words, how to grow more and better crops. In the year 1926, Viswanath and Suryanarayana in collaboration with R. McCarrison published the results of their studies on crops manured with organic and inorganic manures. Their results showed the importance of nutritioning the soil first for nutritioning the plant and through the plant the animal and in this respect organic manures were superior to chemical fertilizers. Since then two schools of thought developed, one favouring organic manures and the other mineral fertilizers. The answer to the problem lies in the knowledge and field experience gained during the past years, in the science and practice of manuring and plant nutrition.

Based on the mineral theory of Liebig, the chemical treatment of the soil was the dominating idea underlying the theory and practice of manuring in India, forty or fifty years ago. According to these ideas one had only to make a chemical analysis of the soil and to make the deficiency by the addition of the mineral salts indicated by analysis, to maintain the fertility of the soil. Experiment and experience has gradually changed the ideas. The whole problem has been slowly but steadily getting clarified by researches in soil science and plant science, and has, in recent years, brought about new knowledge and new outlook. The soil processes and the carbon-nitrogen and other organic and mineral cycles are becoming clearer and mineral or artificial fertilizers have begun to fall in their place as important but not as all important. The new outlook includes in its horizon, the direct and indirect effects of organic manures on crop growth and a consideration of plant growth in terms of the major biological cycle—micro-organisms—plant—animal—micro-organisms.

The scientific and practical aspects of the work of Viswanath and his associates may be briefly stated thus. It has been shown by experiments with Indian crop plants that:

(1) There is a close resemblance in the nutritional needs of plants and animals.

(2) Organic manures and organic matter, function directly in plant nutrition in a manner analogous to that of vitamins in animal nutrition and that a closer and direct connection exists between the micro-organisms in the soil and the plants growing therein.

(3) Micro-organisms liberate from the added organic matter and from their bodies an active constituent which is absorbed by the plant and passed on to the seed, thus influencing the nutritive and reproductive value of the seed.

(4) Plant metabolism and protein make up and the nutritive value of crops vary with the nutritional factors available to the plant.

In a later publication in 1932 Viswanath stated thus:

'The response to vitamins and the capacity to synthesize thus appears to be universal from the simplest unicellular organism to the most complex

multicellular organisms....It seems, therefore, reasonable to state that plants and bacteria do normally require auximones or vitamins and if they can get them in a readily available form they utilize them; if not they exercise their powers of synthesis.

In 1937, *Nature* reported that the Royal Society held a discussion and concluded that it appeared from the available evidence that the case established in the nutrition of animals is equally established in the nutrition of the most diverse varieties of cells, namely, that all cells from the lowliest bacterium to the cells of the highest animals are enabled to carry out the series of reactions between the sources of agency and nitrogen which result in the production of energy and growth, only by the agency of other substances mostly of a nature akin to those already described in animal metabolism—vitamins. The only notable difference between the various forms of life is that these accessory substances are normally synthesized by some cells and not by others.'

In 1942, M. Copisarow reviewed the more recent work on the differentiation between natural and artificial fertilizers. He noted that recent researches have shown that the contrast between natural and artificial fertilizers goes beyond the colloidal and nutritive properties of the soil organic matter derived from organic manures, and that certain organic compounds and complexes contained in the soil lies in their physiological function—growth promoting and protective agents. The combined effect of the growth promoting and protective agents in the humus in conjunction with the activity of nitrogen-fixing organisms leads to the general well-being of the plants both by improved nutrition and disease resistance. In this respect Copisarow observes that the environmental influence of the remains of past organic life as modified by the micro- and macro-biology of the soil, in determining or influencing form and function of the emerging new growth is reminiscent of and certainly complimentary to the hereditary—influences occluded in the seed or the chemical orientating force exercised in the organizer cells.

In 1950, K. I. Semergei reports that cotton plants grown with high nitrogen nutrition gave seed which retarded plant growth in the third generation, while high phosphate nutrition had a stimulating effect. The author observes that the results of his experiments indicate that a particular form of manuring carried for two to three generations alters the nature and behaviour of the plant.

A review of manurial experiments carried out in different parts of India and reported in journals, bulletins and annual reports shows that the most responsive crop was paddy (rice), the least responsive was cotton. Other crops like sugar-cane, wheat, tobacco, millets occupy intermediate positions. The biggest controlling factor in these cases of differential responses between the different crops, is the supply of moisture in the soil. If this is lacking manuring particularly with chemical fertilizers does more harm than good. In regard to the manures themselves, the broad inference that may be drawn from the data, is on the general usefulness and superiority of organic manures and their importance in any system of manurial treatment for any crop. There is a very strong indication that in the presence of organic manures, there is better utilization of artificial or chemical fertilizers. There is also the indication that the availability or utilization of organic manures is stimulated by the presence and action of artificial fertilizers. Organic manures have also been found more beneficial to soil tilth than artificial fertilizers. Besides this, organic manures have to undergo micro-biological changes in the soil before they are ready to be utilized by the plant. The plant, is in consequence fed more steadily and continuously, than with artificial fertilizers which become available to the plant in a rush. Here then is the advantage of organic manures over artificial fertilizers for the majority of Indian soils.

In our country, because of the rapid destruction of organic matter that occurs in soils, it is advantageous to use organic manures in association with small

quantities of chemical fertilizers. The basic principles underlying such associated use may be briefly described thus:

Manures like farm-yard manure or green manure contain on dry basis about 2·2% nitrogen and 40% carbon. When these manures are incorporated into the soil the substances undergo micro-biological decomposition and ultimately become part of soil humus. In this process of fermentative decomposition loss of some nitrogen and more of carbon occurs and ultimately the final product contains about 20% of carbon and about 2% nitrogen. That is, the process stabilizes round about the theoretical C : N ratio of 10 : 1. There being initially a large excess of carbon, the micro-organisms will require nitrogen for the continuance of their life cycle and life processes.

If on the other hand a chemical fertilizer like ammonium sulphate is applied to the soil some loss of nitrogen has to take place to get near the ratio of 10 : 1 unless there is available in the soil sufficient organic matter to supply the carbon required by the micro-organisms.

It is to this fermentable or decomposable carbon of the organic manures, that the valuable interaction between organic manures or artificial fertilizers is due. The nitrogen held by the carbon or humus is gradually released for the benefit of the plant and before this release takes place the nitrogen is protected from loss by leaching action.

The proportions in which organic and inorganic manures should be used in conjunction will depend, on the organic matter content of the soil, and on the composition of the manure. For instance the amount of inorganic fertilizer to be used with groundnut cake will not be the same as with farm-yard manure.

In 1940, E. John Russell and J. Watson reviewed the results of Rothamsted and Woburn experiments and the conclusions in respect of organic manures and inorganic fertilizers were:

(1) Average yields are approximately the same with both.
(2) Seasonal fluctuations in yield are smaller on the farm-yard manure plots than in mineral fertilizer plots.
(3) Deterioration in yield with time is slightly lower in farm-yard manure plots than in mineral fertilizer plots.

These, in the main agree with those in India and the most important point is that farm-yard manure maintained steadiness in yields, which artificial fertilizers did not. The review in 1941 by A. L. Prince and his associates of 40 years of American experiments has shown that the only plots that did not deteriorate in fertility (as judged by N content or organic matter content and *p*H) were those that were systematically treated with farm-yard manure annually and periodically limed and green manured.

There is thus considerable evidence regarding the value of organic manures in any system of agriculture particularly in the *dry* tropics and *sub-tropics*.

Issued January, 1953.