

Facts and Fancies about Fertilizer

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It is true in all walks of life, but particularly true in agricultural science that no sooner is one gloomy prophet proven wrong than another, with an equally startling theory, takes his place. One of the more recent of these calamitous concepts has to do with the supposed dangers from the use of fertilizer. They claim that these chemicals have bad effects on the soil, on the crops it produces, on the livestock that eats these crops and finally on man himself. These chemicals are even under suspicion as being responsible for what is said to be an increasing susceptibility of mankind to disease.

Followers of this specific cult insist that there is no safe substitute for correctly made composts. Rigorous rules are laid down for the production of such composts. They must contain animal manure as well as plant refuse and they must be made to undergo fermentation before they are made a part of the soil. If straw, green manures and similar crude organic materials are used, they must be composted or, at least, disked into the topsoil. They must not be plowed under in their raw state.

The claim is made that if well-made manurial composts are used the resulting crop plants have much greater resistance to disease than those that are produced by the use of chemicals; that they are able to pass their disease resistance on to animals and man; and that the seed of such plants will yield new generations of plants with continued high virility year after year. Such seed, it is said, does not "run out," in contrast to what, it is claimed, occurs if one sows seed from plants grown entirely by the use of fertilizers.

Letters of Inquiry

As a result of these widely publicized claims on the part of the advocates of manurial composts the agricultural colleges and experiment stations are now being besieged with letters of inquiry. Many of these are from people who see no good in science. They are in accord with the concept that nature is the only true guide and that any interference with her course on the part of man leads to disaster. They seem to forget that man himself is a part of nature, that he has been endowed with a brain with which to think, and that, having thought, he is quite likely to act in accordance with his best judgment. Out of such thinking has come a chemical fertilizer industry that has grown to tremendous proportions. In the United States alone, some 35 million tons of chemicals are applied annually to the soil. This is enough to fill three solid lines of 25-ton freight cars extending from New York to San Francisco. Can it be that this is a gigantic fraud?

Chemicals vs. Composts

Some very intelligent people, men who are well informed in their own fields but have little knowledge of soils and fertilizers, have been seriously disturbed by reading the outpourings of this "biodynamic" cult. Thus, the British House of Lords recently held three serious debates on chemicals versus composts. A number of these men thought there might be some truth in the concept that chemical fertilizers were ruining the health of the nation. A few of them were actually convinced of it. And some very important people in this country, aroused by reading such literature, have begun to raise questions about fertilizers that are not easily answered.

One of our most serious weaknesses in all of us is our tendency to accept opinions as facts. Opinions are dangerous because, with each repeating, they tend to gain prestige. Even the author of an opinion is often led astray by listening to his own voice. It becomes necessary, therefore, to go back from time to time to original sources in order to determine whether or not our present concepts are based on proven facts or merely on oft-repeated opinions that may never have been confirmed in the research laboratory.

One of the most dependable original sources, or "bench marks," for fertilizer was established by Theodore de Saussure of France, nearly 150 years ago. By applying refined chemical procedures to the analysis of plant ash he showed conclusively that this ash consisted of mineral elements that could have been obtained only from the soil. The composition of the ash was found to vary greatly, depending upon the nature of the soil, the manurial treatments it had received, and the age and species of the plant analyzed.

A second very dependable benchmark was established some 50 years later when Justus von Liebig, a world-famous German chemist, delivered a series of lectures on plant nutrition before the British Association for the Advancement of Science. In preparation for these lectures Liebig assembled all the then known facts on the subject. These facts were carefully summarized in two statements that are contained in the preface to the book in which his lectures were published. These statements are:

1. "The primary source from whence man and animals derive the means of their growth and support is the vegetable kingdom."
2. "Plants, on the other hand, find new nutritive material only in **inorganic** substances."

Previous to Liebig's time it had been generally assumed that soil organic matter was the food of plants. But Liebig pointed to the facts, established by the most capable chemists of his time, that the carbon of plants is derived from the carbonic acid of the atmosphere; that there is a carbonic acid cycle from the air to the plant and soil and then back to the air; that soil organic matter is transient; and that, as it decays, it yields up its mineral matter, which is the ash portion of plants. Finally, he pointed out that plants are the source of the soil organic matter—they are not derived from soil organic matter. Liebig, therefore, recommended the using of purely mineral manure.

Uses Liebig's Formula

Among the scientists in Liebig's audience was a young, well-to-do Englishman, John Bennett Lawes. Being commercially minded, Lawes immediately saw that Liebig's proposed mineral manures offered highly important possibilities for developing a profitable business. The question was as to the extent to which Liebig's concept could be applied in practice. No sooner had Lawes gotten back to his estate than he set to work preparing a series of mineral manures, in accord with Liebig's formulas, for use in field trials. This was the beginning of the world-famed Rothamsted Experiment Station, which celebrated its 100th anniversary in 1943.

One of the plots on the Broadbalk field of that famous old farm has received 1392 pounds of fertilizer per acre every year since 1852. This fertilizer supplied 129 pounds N, 66 pounds of P_2O_5 and 96 pounds K_2O , being approximately a 9-5-7 grade. The land has been sown to wheat continuously all the 95 years since that date. The average for the first 70 years was 35.6 bushels per acre. For the first ten years the yield averaged 36.1 bushels and, for the last ten, 27.4 bushels per acre. The only organic matter supplied to the soil was that left behind in the roots and stubble of the wheat crop and in the weeds that came on after the wheat was harvested. In other words, no manure or compost has been applied to the land and all the crop wastes and weeds have been plowed under without composting. The choice as to what fertilizer ingredients to use was made nearly a century ago, and practically no change in the grade has been made since.

Alongside the fertilized plot on the Rothamsted farm is another that has received 16 tons of farmyard manure every year during this same period. No fertilizer has ever been supplied to this manured plot. During the 70-year period the average yield of grain on this plot was 34.3 bushels per acre, or 1.3 bushels less than the yield of the fertilized plot for the same period. The yield on the manured plot averaged 34.2 bushels for the first ten years and 27.1 bushels for the last ten. If there is any evidence of superiority of manure over fertilizer, it is not to be found in the grain yields or in the state of productivity of these two plots of soil after nearly a century of direct comparison. These yield data provide another primary bench mark that has stood the test of time. They prove that chemical fertilizers are effective agents for maintaining crop yields at high levels for long periods of time.

Plants Can Grow Without Any Soil

In field tests of fertilizers, the soil as well as the fertilizer contributes to the mineral needs of the crop. Consequently, it was not long before the question was raised as to whether it was possible to grow plants without the use of soil. The answer to this question was soon obtained by J. Sachs, who reported that he had grown plants to full fruition in water solutions of purely inorganic nitrogen and mineral nutrients.

Sach's technique has been improved upon by adding traces of the minor elements to the nutrient solution and by applying this improved solution drop by drop to sand that is employed merely as an anchorage for the roots. Today, luxuriantly perfect plants are being grown on a large scale by the use of purely mineral solutions in pure quartz sand

that contains no earthworms and no organic matter. This principle is also being applied on an increasingly large commercial scale for the production of flowers and vegetables. Selected seed or cuttings from these plants produce perfect reproductions for generations.

Is there any evidence to the effect that chemically fertilized field crops are lacking in biologic value or that those who eat them are more subject to disease than they would have been if they had eaten manured crops instead? In the year 1850, before farmers had begun using fertilizers, the average life expectancy at birth in the United States was 40 years. By 1900, when fertilizers were being used at the rate of over two million tons annually, our life expectancy had increased to 49½ years. By 1940, our fertilizer consumption had increased over eight million tons and our life expectancy to 63 years. In 1944, fertilizer tonnage reached the 12 million mark and life expectancy rose to 66 1/4 years. These figures show that in proportion as our fertilizer tonnage has increased so also has our life expectancy. One would hesitate to claim that fertilizers are responsible for the 26 years longer lease on life we now possess than did our grandfathers a century ago, but certainly it is difficult to find a case against fertilizers on this score.

Increase in Senile Diseases Due to Marked Increase in Proportion of Old People

Why, then, do we have so much trouble with degenerative diseases of the heart, brain, liver, kidney and other vital organs? One answer to this question lies in the fact that there are between 13 and 14 million people in the United States who are over 60 years of age. In 1900, 4.1 per cent of the people in the United States were 65 years of age or older. By 1940, the number of people in this group had increased to 6.8 per cent of the population. It is apparent, therefore, that we are having more difficulty with the diseases of old age because we have more old people. Looking ahead, we can expect a further increase in such diseases since, by 1980, it is estimated that 14.4 per cent of our population, or nearly 24 million people, will be 65 years of age or older.

It is important to keep in mind that composts, on being "burned up" by microbes, yield up not only their nitrogen, phosphoric acid and potash, the constituents on which fertilizers are evaluated, but all the other ash elements that these plants were able to extract from the soil on which they grew. The animal manures that are applied to any field may contain elements that were derived not only from the soil of the home farm but from whatever areas any imported grain feeds may have been obtained.

Manures and composts provide only a temporary answer to the minor s element problem. Such deficiencies are increasing and some of them occur on livestock farms as well as on the entirely mechanized farms on which no manure is available for use. The minor element problem is now being met by the use of fertilizers that carry all the elements required by plants. Consideration is being given to reversing the tendency toward taking all the so-called "impurities" out of fertilizer materials. A very high analysis fertilizer can be formulated from ammonium nitrate, ammonium phosphate and the 60 per cent grade of muriate of potash. But in many cases the elements of salts that have been discarded in the process of concentrating the fertilizer material with respect to nitrogen, phosphoric acid and potash are very valuable. Thus the sulphur of sulphate of

ammonia, the sodium of nitrate of soda, the calcium phosphate of 20 per cent super-phosphate, and the sodium and magnesium chlorides and sulphates of impure potash salts all have value.

Neither manure or chemical fertilizer, or both, will necessarily deliver to the plant all the mineral elements required by the animals and man that consume it. Both iodine and cobalt, two elements that apparently are not essential for plants but are highly important to animal life, are lacking, even in luxuriant vegetation, in large areas of the United States. In fact, plants are not concerned with the needs of man but only in reproducing themselves.

Salt mixtures that contain small amounts of all the needed mineral elements are now being prepared and sold for feeding to livestock. It seems quite probable that the same principles will be applied to the production of table salt. Most table salt already contains iodine as a goiter-inhibiting agent. It seems reasonable to believe that the addition of small amounts of cobalt and the other essential minor elements is only a matter of time and that, by this procedure, all possibilities of mineral deficiencies in man will be removed.

The supplying of minor elements to plants and the providing of adequate amounts of them for animals present two separate and distinct problems. These elements are applied to the soil only in proportion as they will increase crop yields or materially improve any measurable feeding quality. To apply minor elements to the soil merely as a means of getting them into the animal by way of the crop causes a tremendous waste of these precious substances. Thus a very few grams of cobalt sulphate is a year's supply for a cow, if fed directly to her, but a much larger amount of cobalt will have to be applied to the soil to guarantee the delivery of even this small quantity to the animal by way of the crop.

None of the foregoing should be construed as an argument against the use of manure or as indicating a belief that organic matter has no value in the soil. In so far as we have been able to determine, however, there is nothing in animal manure that cannot be supplied equally well by the plowing under of sods, cover crops and green manures, except in those cases where the manure is the result of feeding imported grains. New York soils might profit by having Iowa corn, Kansas wheat and Minnesota oats fed to the cows of that state. But they might profit equally well by having some of the water from the Atlantic Ocean scattered over them. These same effects are being obtained, however, by the use of limestone, phosphate rock and crude potash salts, all of which had their origin in the ocean. Acidulation of phosphate rock does not subtract anything of value from it but, instead, it adds something of value to it.

The advocates of manurial composts claim that fertilizers destroy soil microbes, including the mycorrhizal fungi, and that they drive the earthworms away. The population of living things in any given soil in its natural environment is determined almost entirely by the amount of organic matter the soil contains and by the supply of available nitrogen and mineral nutrients. One of the most effective ways of maintaining a high level of organic matter in a soil is by the regular and liberal use of fertilizer, coupled with a crop-rotation program that includes sod or cover crops.