with pretensions of every character, are offered to the uninstructed farmers, by men whose sole object often is the accumulation of money by the establishment of a lucrative trade. This is an evil which can scarcely be avoided in the progress of knowledge. Those who know a little, impose, though not always intentionally, upon those who know less. The sure remedy for such evils will arise of itself, from the more general diffusion of a higher knowledge. In the mean time, those who are likely to suffer—the practical men—should provide themselves with, or should secure access to an authority on whom they can rely, till another generation springs up which may more safely rely upon itself.

Thus far it appears that out of the study of manures there have sprung up long trains of chemical research—throwing light upon old practices—pointing out improvements—suggesting new methods more certain, more economical, or more productive—and giving to the art of culture something of a secure and scientific foundation.

But all these researches could not be carried on without giving rise to speculations, more or less crude, in regard to the food of plants in general, and to those various points in vegetable physiology which are so closely connected with the nature and influence of the principle of life; and with the conditions under which life begins or can continue to manifest itself.

Among these speculators the boldest and most fanciful are Liebig and Dumas. Their works, the titles of which are placed at the head of this article, have had a wide circulation in this and other countries. Between these two writers there are certain points in dispute, both as to fact and as to priority of publication, with which it is not our intention at present to interfere. We shall advert only to one of Liebig's more important speculations, which, though really unsound, has been adopted by many in deference to his opinion, and is likely, in various ways, to exercise a hurtful influence both upon the progress and upon the practice of scientific agriculture.

Plants, as we have seen, consist of two parts, a combustible and an incombustible part. The latter is derived wholly from the soil; and though it is comparatively small in quantity, we have already shown how important it is to the growth and productiveness of the plant. The combustible or organic part forms from ninety to ninety-eight parts of the whole weight of our hay, corn, and root crops. Whence is this organic part of plants derived? We know only two sources from which it can be obtained by the plant—from the soil or from the air—from the one by its roots, from the other by its leaves and young stems. But to which of these sources is the plant most indebted?

The organic part of plants consists of four *elementary* substances, as chemists call them—carbon, hydrogen, oxygen, and nitrogen. Water is composed of two of these—hydrogen and oxygen. This water enters into plants both by their roots and by their leaves, is capable of being decomposed into their interior, and thus may alone be supposed, under favourable conditions, to yield an ample supply of hydrogen and of oxygen to the growing plant. But whence do plants derive their carbon and nitrogen, and in what form do these elements enter into the vegetable circulation.

It is generally agreed that plants drink in from the air, through their leaves, a variable proportion of their carbon, in the form of carbonic acid *—the rest they extract from the soil by their roots. But in what form does the latter portion enter into the roots?

Again, it is believed that the nitrogen of the atmosphere does not enter *directly*, or in its gaseous form, into the circulation of plants in general, either by their roots or by their leaves. But this gas is necessary to their existence. In what form of combination, then, does it enter into plants, and is it by their leaves or by their roots that in this form it chiefly gains admission? On these two points Liebig maintains—

1. That the carbon of plants enters into their circulation *only* in the form of carbonic acid; that the leaves inhale it from the air, and the roots from the soil; and that (neglecting the nitrogen it contains) the chief use of the vegetable matter of the soil is to yield this carbonic acid to the roots.

2. That the nitrogen enters plants only in the form of ammonia;† that this ammonia exists in the atmosphere, and is partly extracted from it by the leaves, and partly washed down by the rains which convey it to the roots.

* Carbonic acid is the kind of air that escapes from champagne and soda water, when it effervesces. It consists of carbon and oxygen. Atmospheric air is a mixture of oxygen and nitrogen gases, with about one two-thousand-five-hundreth of its bulk of this carbonic acid.

† Ammonia consists of nitrogen and hydrogen, and when it enters by the roots or leaves, may yield both of these elements to the growing plant.

According to these hypothesis, carbonic acid and ammonia form the sole organic food of plants; and we have only to present these compounds in sufficient abundance, along with the inorganic substances which they also require, to make plants grow, at our will, with greater or with less rapidity and luxuriance. This theory is simple, is easily intelligible, and has been widely assented to by certain classes of readers. We almost regret that it is not universally true.

To establish his first proposition, Liebig enters into an elaborate argument to show that certain insoluble compounds of the humic and ulmic acids, which are known to exist in the vegetable matter of the soil, cannot enter in such quantity into the roots of plants as materially to augment their substance, or to aid their growth. All that he says on this point may be true, and yet the conclusion to which he jumps, is certainly not warranted by his premises. There are soluble compounds of these fluids which are formed in the soil, and soluble compounds of other kinds which contain carbon, which may, and we believe do, enter into the roots of plants, and which minister in a variable degree to their substance and growth. We do not hold, therefore, that plants derive their carbon wholly from carbonic acid, or that the organic matter of the soil yields carbon to their roots in no other form. It is more consistent with experience and with all the scientific evidence we possess upon the subject, that we may, and can, aid the growth of our crops, by putting within the reach of their roots other organic compounds also, of which carbon forms a part.

Again, the main, we might say almost the sole, support of the second proposition, in regard to the source of the nitrogen of plants, rests on the fact, that ammonia exists in minute quantity in the atmosphere. This fact we grant, and we grant also, that it is often brought down in minute quantities in rain water. But we believe also that it exists, and is formed in the soil, and that one of the functions of the vegetable matter of the soil is to aid in this formation, at the expense of the nitrogen of the atmosphere. We agree that this ammonia enters into plants, and ministers to their growth; but we think in opposition to Liebig, that the largest proportion of this compound which plants do assimilate, *is derived*, not from a magazine of it existing in the air, but from stores of it produced in the soil—*which production of it in the soil the skilful husbandman can promote by skilful management of his land.* In addition to what is contained in Johnston's *Lectures* upon this subject, our readers will turn with profit to Mulder's work;—a work which is, in our opinion, the soundest and safest gift which Chemistry has yet presented to general Physiology. Only part of it is yet before the public, even in the original Dutch. When it comes into our hands in a complete form, we shall be better able to draw the attention of our readers to the novel researches, the profound reasonings, and the beautiful results it contains.

But further, there are almost countless compounds containing nitrogen, which are capable of being dissolved by water. Some of these descend from the air with the falling rain, some exist in the waters of our springs, some in the manures we add to the land, and some are formed during the decay of the vegetable matter in the soil. These enter into the roots, and no doubt supply a valuable proportion both of carbon and nitrogen to the growing plant. And lastly, over the whole surface of the globe, wherever animal and vegetable substances are undergoing slow decomposition, there is a constant tendency to the production of nitric acid;* and in the air, whenever the lightning flashes, it is formed in minute quantity from the elements of the air itself. We cannot tell how much of this acid is continually produced in nature, but it must be very great, and it may safely, we think, be regarded, in the general vegetation of the globe, as one of the main forms of combination in which nitrogen enters into the circulation of living plants.

These views in regard to the organic food of plants, are not so simple as those of Liebig; but they are truer to nature, and far more likely to guide the practical man to a wise and profitable culture of his land. If our readers wish so to study this question, as to understand fully the force of the points we have put forward, we recommend them, upon the subject of carbon to the works of Mulder and Johnston; and, in addition to these, upon the subject of nitrogen, to the publications also of Boussingault and Dumas.

To all the researches and speculations to which we have hitherto alluded, as well as to others which we have no space to notice, the study of Manures has either directly or indirectly led. But manures are of chief importance—indeed derive their main interest

* Nitric acid (*aqua fortis*) consists of nitrogen and oxygen. It exists in nitrate of soda and in saltpetre.