improved so much during the last fifty years that even we who live in the days of the telegraph, ocean steamers, railroads, and steam power presses, do not at all realize the magnitude of the change. Fifty years ago such a business as is transacted by more than one firm in New York could not have been created even by the greatest business capacity. In creating these immense concerns, the proprietors have had the aid of cheap printing to advertise them, of railroads to bring them customers from distances that fifty years ago would have occupied months to traverse, of the telegraph to transmit orders, and of a hundred of other improvements. The steam elevators, that raise their numerous customers to the acres of floors in the upper parts of their buildings, are patented machines. The bills and forms, which enable them to transact their business without confusion, are executed cheaply by patented machinery. The paraphernalia of their counting rooms include numerous patented helps to business. The very goods they sell are mostly manufactured by patented looms, driven by patented water wheels or steam engines.

Even the currency is so improved that the counterfeiter finds his deception more difficult and more easily detected.

But there is a still more indirect way in which general business is benefitted by the patent system. In this Yankee land, where the masses are constantly enlightened by the agency of the common schools and newspapers, every lad before he is fourteen knows something of the nature of patents, and has heard of money made and to be made in the invention or in the business manipulation of some patented improvement. The most ambitious often see, or think they see, that this way lies fortune. Many are thus induced to interest themselves in machinery, and to acquire some knowledge of mechanism. We thus have become a nation of mechanics, ready at the moment any exigency of agriculture, manufactures, commerce, or war, suggests a want, to act upon the suggestion, and the needed improvement shall be forthcoming. The farmer's boy invents his churn, his dog power, his washing machine, before he is twenty, and, by the time he reaches middle life, understands enough about machinery to run a saw mill, or even something more complicated, if necessary.

It is this universal, although partial, knowledge of mechanics that has rendered the introduction of agricultural machinery so successful in this country, and has so increased the production of the soil, that every commercial artery is now plethoric with the teeming harvests of our inland domain. Who, fifty years ago, would have thought of cultivating a thousand acres of wheat? The chances of harvesting without serious loss this amount, by any help attainable at that time by a single farmer, would not have been one in a hundred. The modern harvester, the threshing machine, has changed all that, and no one now thinks of impossibility in connection with harvesting a thousand acres.

What has caused the unprecedented growth of this great commercial center, New York? New York, as it now is, would have been an impossibility without the improvements we have named. Not a bushel of wheat from Illinois or Minnesota could ever have found its way to this port; not a tithe of the large business houses which now crowd the lower part of the city would have been heard of; the busy manufacturing towns that fill their establishments with wares would have been nothing but hamlets, and the vast prosperity, that has made America the wonder of the old world, would never have been one of the most brilliant chapters in history.

AGRICULTURAL CHEMISTRY AND CHEMICAL MANURES.

The researches of that veteran chemist, Baron Liebig, and others in the analysis of soils and the use of artificial manures did not result in such extensive progress in agriculture as was anticipated. As the effort to apply the knowledge gained by these researches was made throughout the world by intelligent agriculturists, it became evident that there was still some lack in agricultural chemistry, some mysterious circumstance, relation or element, that defeated this endeavor. As a consequence, the idea of chemical farming became a thing to be ridiculed, and fell into an ill repute which still attends it. The prejudice thus created will for a long time impede progress; but there cannot be a doubt that the missing link, which, if found in Liebig's researches, would have resulted in success instead of failure, has at last been discovered.

In the light of this revelation, the cause of the failure to apply chemical principles to agriculture is plain. We find it fully explained in the lectures of M. Ville, a translation of which, as delivered at the experimental farm of Vincennes, France, now lies before us.* These lectures are, we believe, the most important contribution to agricultural science that has appeared during the last half century. In our review of them, which we shall not attempt to make exhaustive, we shall extract some passages which will give a glimpse of their character to such as have not yet read them. In the third lecture, M. Ville remarks:

A priori, one would think that a chemical analysis which has been pushed so far in our day, and whose methods have acquired at the same time so much delicacy and certainty, ought at least to give us a means of estimating with certainty the richness of the soil, and so guiding us in the choice of the manure best suited to its nature. There is none, however, and I defy the most skillful chemist to say in advance what will be the return from earth submitted to him, and what manures are most appropriate.

A few words will explain the reason why chemistry is powerless to furnish us with these indications: you must recall the distinctions we have drawn between the different elements of which the soil is composed.

*Chemical Manures. Agricultural Lectures, delivered at the Experimental Farm at Vincennes, by George Ville. Translated by Miss E. L. Howard. Third Edition. Atlanta, Ga.: Plantation Publishing Co.

Let us suppose a soil containing both quartz sand and felspar sand among its mechanical elements. For vegetation these two sands are equivalent, although the first is from silica and nothing but silica, while the second is a silicate based upon lime, potash and soda, besides containing phosphate of lime in very feeble but appreciable quantities.

Here, then, are two bodies whose composition, in spite of similitude of exterior, have no analogy; and which, however, are equivalent in an agricultural point of view, because, the felspar being insoluble in water, its *rôle* in regard to vegetation descends to that of the quartz sand, that is to say, to a simple mechanical element. But for the chemist, there are no insoluble bodies, so he confounds in one whole the potash, lime and phosphate of lime that the felspar sand contains, though they are of no use in vegetation, with the products of the same nature which we have ranged under the class of active assimilable elements. Thus is explained the insufficiency of the signs with which chemistry can furnish us.

In order to understand fully the meaning of this quotation, it is necessary to say that M. Ville includes all the essential constituents, of soils in which plants can grow, in the category of fertilizers; but he divides them into two classes, the first of which is azotic or nitrogenous matter, and the second of which includes ten mineral substances, only three of which, phosphate of lime, potash, and lime, are so directly connected with the growth of plants that they need occupy the attention of the agriculturist in his attempt to restore to soils what has been drawn from them by the growth of crops. The other minerals act mechanically and are hence called mechanical fertilizers; but M. Ville maintains that they exist naturally in sufficient quantities, and that it is not necessary to provide them. So far as the mere growth of plants is concerned, this is probably correct, but there are doubtless many cases in which it is desirable to add some material not directly concerned in plant growth, for the purpose of modifying stiff soils, or tempering light ones.

The most favorable conditions of soil for plant growth being the presence of azotic matter, phosphate of lime, potash, and lime, M. Ville calls a mixture of t ese substances "th complete fertilizer." The non-assimilable elements are considered as purely mechanical in their effects.

The following experiments are given to illustrate these facts:

In burnt sand, free from all additions but moistened with distilled water, wheat acquires but a rudimentary development—the straw hardly attains the dimensions of a knitting needle. In this condition, however, vegetation follows its usual course; the plant blooms, bears grain, but in each head there are but one or two dwarfed, badly formed grains. Thus, without soil, the wheat finds in the water it receives and the carbonic acid of air, aided by the substance of its grain, resources sufficient—sorrowfully, it is true, but at last —to run through the entire cycle of its evolution.

From 22 grains of seed, weighing nearly 18 grains, we obtain 108 grains of harvest. Add the ten minerals (phosphorus, sulphur, chlorine, silicium, calcium, magnesium, potassium, sodium, iron and manganese) to the sand, excluding the azotic matter, and the result is but little more.

Under these new conditions, the wheat is a little more developed than in the preceding case, but the harvest is still more feeble; it reaches 144 grains. Suppress the minerals and add only azotic matter to the sand; the growth will still be mean and stunted, but the harvest will slightly increase, as it reaches 162 grains. Let us follow the changes. In pure burnt sand, 108 grains; with minerals without azotic matter, 144 grains; with azotic matter alone, 162 grains.

In this last case, a new system is shown. As long as we operate only with minerals the plants are diseased, the leaves show a yellowish-green color. As soon as we add azotic matter to the sand the leaves change their color, becoming ing a dark green. It seems as if vegetation would take its usual course, but the appearances are deceitful; the harvest is still feeble.

Let us attempt a third experiment, which will, in a measure, be a synthesis of the three preceding. Unite azotic matter and the minerals in the burnt sand. This time you will be tempted to believe in the intervention of a magician, the phenomenon so far surpasses those preceding it. Just now the growth was languishing, doubtful, diseased; now the plants shoot up as soon as they break the ground; the leaves are a beautiful green; the straight, firm stalk ends in a head filled with good grain; the harvest reaches from 396 to 450 grains.

You see, gentlemen, relying upon experience, which is our guide by choice, we have succeeded in artificially producing vegetation to the exclusion of manures and all unknown substances.

You will acknowledge that this is an important and fundamental point. No more mystery, no undetermined power; some chemical products of a known purity, distilled water perfectly pure in itself, one seed as a starting point, and the result, a harvest comparable in all points to the best obtained in good earth.

We are, therefore, justified in saying that the problem of vegetation here receives its solution, for we have not only defined the conditions necessary to the production of vegetation, but the degree of importance of each of the concurring agents.

Azotic matter in its decomposition furnishes ammonia, and nitrates; and the clay constitutes a receptacle which holds and gives out gradually as may be required these important ingredients. M. Ville divides plants into two classes, according as they draw their nitrogen from the air or the soil. Thus wheat is a type of plants which prefer their nitrogen in the form of salts of ammonia, and take it from the soil. Beets prefer it in the form of nitrate and take it from the soil. Peas and the other leguminous plants prefer to take it as a gas from the air. The consequence of this distinction is that plants which take nitrogen from the air will flourish in a soil containing only the other elements of the complete fertilizer, namely, phosphate of lime, potash and lime. Therefore, by planting in a soil one of each of the two classes of plants, it is possible to tell whether the soil contains the azotic and mineral matters or not. Thus, if peas and wheat be planted in the same soil, and the peas yield well while wheat yields little, the land has the mineral elements but lacks the azotic or nitrogenous matters.

At Vincennes, previous to the fertilization of the soil, the land produced nothing, and hence was proved deficient in all the elements of the complete fertilizer, by the addition of which it has been made extremely productive.

As chemical analysis of soils fails for reasons above stated the richness of the soil is determined as follows:

Suppose you institute seven cultures of the same plant—it may be of the beet or wheat, as you will.

To the first give the complete fertilizer; to the second, the same fertilizer excluding azotic matter; to the third, the complete fertilizer deprived of phosphate of lime; to the fourth, the complete fertilizer less the potash; to the fifth, less the lime; to the sixth, less all the minerals—that is to say, reduced to the azotic matter; the seventh not having received any manure.

It is very evident that if, in the complete fertilizer, the effect proper to each component is manifest but as it is associated with three others, the comparison of the returns obtained from the seven strips of the little field ought to indicate what the soil contains and in what it is wanting.

In this system of investigation, the culture with the complete fertilizer becomes, in a measure, the invariable standard of comparison to which are referred the returns of the other strips of ground; and, according as they approach or recede, we conclude that the earth contains or does not contain the element which has been voluntarily excluded from the fertilizer.

To put the value of this method beyond doubt, M. Ville reports the results given under three different conditions.

At the experimental farm at Vincennes were obtained, in 1864, the following proportional returns from wheat:

With the complete fertilizer.....	5644
" " " without lime..........	4333
" " " " potash..........	4044
" " " " phosphate......	3466
" " " " azotic matter....	1888
Without any fertilizer..........	1588

The conclusion is evident. At Vincennes, the complete fertilizer was necessary; the azotic matter was most deficient.

An eminent agriculturist of the department of the Somme furnished a second example, which is upon the beet:

With the complete fertilizer..........	4504
" " " without lime..........	4103
" " " potash..........	3703
" " " phosphate......	3208
" " " azoticmatter....	3200
Without any fertilizer..........	2202

You see here, also, the earth is wanting in azotic matter, and, to put it under high culture, we must have recourse to the complete fertilizer.

The third example is from a culture of sugar cane, instituted by the Hon. M. de Zebrun, of Guadaloupe, a former delegate from that colony:

With the complete fertilizer..........	50666
" " " without lime..........	44444
" " " potash..........	32111
" " " phosphate	13333
" " " azote..........	49777
Without any fertilizer..........	2666

If I add that sugar cane particularly draws its azote from the air, you will conclude that the soil is particularly wanting in potash and phosphate of lime.

Here are, then, two methods of knowing the richness of the land. The first is founded on the culture of two different plants without any fertilizer, and the second, on the culture of the same plant with five different fertilizers. These two applications of the same principle lead to the same results, and verify and complete each other.

I need not add, that for each of these trials to have its full signification, the earth must not be used until the effect of each fertilizer has been spent.

By the aid of our experiments in burnt sand, and with only chemical products, we have realized a theoretic scale of culture whose progressive returns have shown us the laws which regulate vegetable productions. By the light of the collection of ideas, we were enabled to conceive and to realize practical processes of analysis accessible to all, whose testimony is of almost absolute certainty, and by means of which we can always say what a land contains, what it needs, and can consequently determine the nature of the agents to which we must have recourse to fertilize it.

In subsequent lectures, M. Ville gives tabulated statements of results from the use of what are ordinarily called chemical fertilizers, that is, such as are not directly of organic origin. These statements indicate that the chemistry of plant growth is destined to pass from under the odium of previous failures, and take its place in the sciences as a splendid collection of established facts, which will inaugurate a new era in agriculture.

We cannot extend our remarks and quotations further, but we will say that we have rarely examined a work more replete with interest, or perused a record of experiments in which the true scientific method has been more closely followed.

SHORT EXTRACTS FROM A FEW LETTERS.

An esteemed correspondent from Fort Concho, a remote spot in western Texas, forwards us a long list of subscribers, and states as follows: "This post is far west of any organized county, cultivated land, or signs of civilization of any kind. The citizens, if such they can be called, are mostly refugees from Mexico or outlaws from the States. Every one goes around armed to the teeth, homicides are common, and horrid shooting affrays are more so. Military law is the only law we have, and that has no control over these outside 'citizens.' When we reflect on the kind of men who recruit the army in time of peace, and what reckless men are willing to drive the mails, by stage, through these wild regions among hostile Indians and more dangerous 'citizens' (though the stage is always escorted by a soldier), we cannot wonder that there is no safety for money in the mails."

Another says: "I live in a small village, where there is more taste for whiskey than for science. It is hard to form a club of ten without cutting a club to break my own head. I have received five names by advancing the money for three, the fourth being a present to my brother in Nebraska; for the balance of the club, I am "going it alone. I hope