excess of siliceous sand? The system of improvement must depend upon the application of clay and calcareous matter. Is there a defect of calcareous matter? the remedy is obvious. Is an excess of vegetable matter indicated? It may be removed by liming, paring and burning. Is there a deficiency of vegetable matter? it is to be supplied by manure. There has been no question on which more difference of opinion has existed than that of the state in which manure ought to be ploughed into the land, whether recent or when it has gone through the process of fermentation?

Sir Humphrey Davy says "as soon as dung begins to decompose it throws off its volatile parts which are the most valuable and most efficient and when it has fermented so as to become a mere soft cohesive mass, it has generally lost from one-third to one-half of its most useful constituent elements. It evidently should be applied as soon as fermentation begins that it may exert its full action upon the plant and lose none of its nutritive powers." But, no doctrine advanced by this talented chemist and general observer has been so generally condemned by practical men as this. While it must be admitted that he carried his views too far, there can be no doubt that occasionally much nutritive matter is lost by pushing decomposition too far, but the physical characters of the soil and the nature of the crops to be cultivated on it must regulate the degree of decomposition that is proper for manure; to allow farm manure to be exposed to Summer's sun and Winter's snow and Spring and autumnal rains is to allow all its valuable chemical constituents to leach out and to evaporate and to become a mere mass of vegetable matter in various states of decay which can only lighten heavy soils without adding any material of plant life to the land.

I am obliged to touch but lightly on many of the subjects that present themselves even in a preliminary lecture on agricultural chemistry, that perhaps the whole may appear a little disjointed, but there are so many principles involved in all and every one of the subjects that each one demands almost a separate lecture to itself, they, at the same time, are so many stepping-stones that lead up to the one subject in hand that it is scarcely possible to attain the object in view without touching them as we proceed.

As nearly everything connected with plant life is derived from the soil in which they grow it is self-evident that in order to keep up the vigor of growth it becomes absolutely necessary to restore to the soil those elements or principles which have been abstracted from the soil by a crop, in order to keep up the fertility of the ground and enable it to keep on producing crop after crop.

The phenomena of vegetation must be considered as an important branch of the science of organized nature; but though exalted above inorganic matter, vegetables are yet in great measure dependant for their existence upon its laws. They receive their nourishment from the external elements; they assimilate it by means of peculiar organs; and it is by examining their physical and chemical constitution, and the substances and powers which act upon them, and the modifications which they undergo that the scientific principles of agricultural chemistry are obtained.

According to these ideas it is evident that the study ought to be commenced by some general enquiries into composition and nature of material bodies and the laws of their changes, the surface of the earth, the atmosphere, and the water deposited from it, must either together or separately afford all the principles concerned in vegetation; and it is only by examining the chemical nature of these principles that we are capable of discovering what is the food of plants, and the manner in which this food is supplied and prepared for their nourishment.

By methods of analysis dependent upon chemical and electrical instruments discovered in late times, it has been ascertained that all the varieties of material substances may be resolved into a comparatively small number of bodies, which as they are not capable of being decompounded are considered in the present state of chemical knowledge as elements; these consist of about fifty metals, eight inflamables, and five bodies which unite with metals, etc; the chemical elements acted upon by attractive powers combine in different aggregates; in their simpler combinations they produce various crystalline substances distinguished by the regularity of their forms. In more complicated arrangements they constitute the varieties of vegetable and animal substances, bear the higher character of organization, and are rendered subservient to the purposes of life, and by the influence of heat, light and electrical powers, there is a constant series of changes; matter assumes new forms, the destruction of one order of beings tends to the conservation of another, solution and consolidation, decay and renovation are connected, and whilst the parts of the system continue in a state of fluctuation and change the order and harmony of the whole remain unalterable.

The necessity of water to vegetation and the luxuriancy of the growth of plants connected with the presence of moisture in the southern countries of Europe, led to the opinion so prevalent in the early schools of philosophy thot water was the great productive element, the substance from which all things were capable of being composed, and into which they were finally resolved; the *Ariston Men Hydes* of the poet, "Water is the noblest," seems to have been an expression of this opinion adopted by the Greeks from the Egyptians, taught by Thales, 640 B. C., who declared that water was the original element of nature, and revived by the Alchemists of later times; Van Helmont in 1610 conceived that he had proved by a decisive experiment that all the products of vegetation were capable of being generated from water. His results were shown to be fallacious by Woodward in 1691, but the true use of water in vegetation was unknown till 1785, when Mr. Cavendish made the grand discovery that it was composed of two elastic fluids or gases, inflamable gas or hydrogen, and vital gas or oxygen.

Air like water, was regarded as a pure element by most of the ancient philosophers. A few of the chemical engineers in the 16th and 17th centuries formed some happy conjectures respecting its real nature. Sir Kenelon Digby in 1660, supposed that it contained some saline matter which was an essential food of plants. Boyle Hooke and Mayhow between 1665 and 1680, stated that a small part of it only was consumed in the respiration of animals, and in the combustion of inflamable bodies; but the true statical analysis of the atmosphere is a comparatively recent labor achieved by Scheele, Priestly and Lavoisier; these celebrated men showed that its principal elements are two gases, oxygen and nitrogen, of which the first is essential to flame and to the life of animals, and that it likewise contains small quantities of agneous vapours and carbonic acid gas, and Lavorsier proved that that this last body is in itself a compound elastic fluid, consisting of charcoal dissolved in oxygen.

Jethro Tull in his treatise on Horse Hoeing, published in 1733 advanced the opinion that minute earthly particles supplied the whole nourishment of the vegetable world, that air and water were chiefly useful in producing these particles from the land, and that manure acted in no other way than in ameliorating the texture of the soil, in short that their agency was mechanical. This ingenious author of the new system of agriculture having observed the excellent effects produced in farming by a minute division of the soil, and the pulverization of it produced by exposure to dew and air, was misled by carrying his principles too far. Duhamel in a work printed in 1754, adopted the opinion of Tull, and stated by finely dividing the soil, any number of crops might be raised in succession from the same land. He attempted also to prove by direct experiments that vegetables of every kind were capable of being raised without manure. This celebrated horticulturist lived however sufficiently long to alter his opinion. The result of his later experiments and more refined observations led him to the conclusion that no single material afforded the food of plants. The general experience of farmers had long before convinced the unprejudiced of the truth of that opinion, and that manures or the products of their decomposition were absolutely consumed in the process of vegetation. The exhaustion of soils by carrying off corn crops from them, and the effect of feeding cattle on lands and of preserving their manure, offer familiar illustrations of the principle, and several philosophical engineers particularly Hassenfratz and Saussure, have shown satisfactorily by experiment that animal and vegetable matters deposited in the soil are absorbed by plants and become a part of their organized nature, at the same time it should be known that plants only require a certain amount of manure and an excess may be detrimental, and cannot be useful.

The theory of the operation of alkaline substances is one of the parts of agricultural chemistry most simple and distinct. They are found in all plants, and therefore may be regarded as amongst their essential ingredients, from their powers of combination, likewise, they may be useful in introducing various principles into the sap of vegetables, which may be subservient to their nourishment.

I should like to dwell at considerable length on the important subject of lime, but the time allotted me will not allow of any lengthy discourse or novel views thereon. Slaked lime was used by the Romans for manuring the soil in which fruit trees grew. This we are informed by Pliny. Marl had been employed by the Britons and Gauls from the earliest times as a top dressing for land, but the precise time in which burnt lime first came into general use in the cultivation of land is, I believe, unknown. The origin of the application from the early practice is sufficiently obvious; a substance which had been used with success in gardening, must have been soon tried in farming, and in countries where marle was not to be found, calcined limestone would be naturally employed as a substitute.

Burnt lime, in its first effect, acts as a decomposing agent upon animal or vegetable matter, and seems to bring it into a state in which it becomes more rapidly a vegetable nourishment, gradually, however the lime is neutralized by carbonic acid and converted into a substance analagous to chalk, but in this case it more perfectly mixes with the other ingredients of the soil, is more generally diffused and finely divided, and is probably more useful to land than any calcareous substance in its natural state. A question concerning the different kinds of limestone to be employed in cultivation often occurs, to determine this fully in the common way of experience would demand considerable time, perhaps some years, and trials which would probably be injurious to crops but by some simple chemical tests the fitness of a limestone either as a cement or a manure may be discovered in a few minutes.

Nothing is more wanting in agriculture, than experiments in which all the circumstances are minutely and scientifically detailed. This art will advance with rapidity in proportion as it becomes exact in its methods, as in physical researches all the causes should be considered, a difference in the results may be produced, even by the fall of half an inch of rain more or less in the course ot a season, or a few degrees of temperature, or even by a slight difference in the subsoil, or in the inclination of the land.

In proportion as science advances all the principles become less complicated and consequently more useful and it is then that their application is most advantageously made to the arts. The common laborer can never be enlightened by the doctrines of philosophy, but he will not refuse to accept any practice of the utility of which he is fully convinced, because it has been founded on those principles. The mariner can trust to the compass, though he may be wholly unacquainted with the discoveries of Gilbert on magnetism, or the refined principles of that science developed by the genius of Orprinus.

The great purpose of chemical investigation in agriculture ought, undoubtedly, to be the discovery of improved methods of cultivation. But to this end general scientific principles and practical knowledge are alike necessary.

There is no idea more unfounded than that a great devotion of time and a minute knowledge of general chemistry is necessary for pursuing experiments on the nature of soils, or the properties of manures. Nothing can be more easy than to discover whether a soil effervesces or changes color, by the addition of an acid, or whether it burns when heated; or what weight it loses by heat. And yet these simple indications may be of great importance in a system of cultivation. I could, did time permit, point out a few simple and easy means of arriving at definite conclusions as to the nature and capability of soils, but am afraid that I should soon exhaust your patience, at the same time I hope I have shown you, this afternoon, the importance of chemistry to agriculture, and that this department of science is worthy of attention, and that it is likewise connected with great practical benefits and advantages.

A wise saw says that the man who makes two blades of grass grow where only one grew before is a benefactor to the whole human race. That being so it follows that any system of agriculture which multiplies the means of existence must be of immeasurable benefit to the world at large and more particularly the farmers here present.

Discoveries made in the cultivation of the earth are not merely for the time and country in which they are developed, but may be considered as extending to future ages, and as ultimately tending to benefit the whole human race, as affording subsistence for generations yet to come, as multiplying life, and not only multiplying life, but likewise providing for its enjoyment.