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Preface to Baron Liebig's
"Einleitung."

Translated. M. Gilbert.
Jan 2. 1863.

Introduction to the Natural Laws of Agriculture.

by Justus von Liebig. Brunowick. 1862.

Preface

to the 7th Edition of "Chemistry in its application to Agriculture and Physiology."

In the 16 years which have elapsed since the publication of my "Chemistry applied to Agriculture and Physiology" I have had abundant opportunity of estimating the impediments which stand in the way of scientific doctrines passing into the domain of practical Agriculture.

The reason of which is, especially, that no connexion was formed between Practice and Science.

Agriculturists have apparently had a common prejudice that less cultivation may suffice for their industry than for any other, so that reflection may endanger the practical ability of an Agriculturist if he appropriates to himself what Science may have won for his improvement and placed at his disposal; what they were able to comprehend was considered as Theory, which as the exact opposite of Practice, was little esteemed or not noticed. It was a fact that scientific doctrine or Theory frequently brought only injury to the practical man as soon as he turned his attention to it; what he attempted was often enough quite wrong: he knew not that its right application did not depend on itself, and that it had to be learnt in the same way as the dexterous management of a complex instrument.

No one will consider it a matter of indifference whether the ideas which influence a man and determine his actions are true or false.

By this want of all intelligence, Practice saw no means of improvement in all the correct ideas which Science gave into her hand, in the elucidation of the growth of Plants and of the share in it belonging to soil and air, to tillage and manuring; while Agriculturists were unable to find out the connexion between scientific teaching and the Phenomena which their industry presented to them, they from their stand-point, arrived at the conclusion that generally no connexion existed between the two.

The practical farmer allows himself to be guided by certain facts observed, during a long period, in his neighbour-

:hood, or, if he aspires to more general views, by certain Au-
:thorities whose system of management is considered a
pattern. No words could prove this system, no scale exists
to measure it.

What Thaer found to be good and useful upon his fields in Möglin, is considered equally good and useful for all german fields, and the facts ascertained by Lawes upon a quite small strip of field in Rothamsted, are re-
:garded as axioms for all english fields.

Under the dominion of Tradition and Faith in Au-
:thority the practical man has renounced the power of rightly comprehending the facts which come daily under his notice, and at length he is unable to dis-criminate them from mere opinions. And so it has come to pass, that when Science has doubted the Truth of her explanations they have affirmed that Science has disputed the existence of facts. If the former says that it may be desirable to supply the deficiency of Stable-manure by its Operative constituents, or that superphosphate of lime may be no specific manure for roots, and Ammonia no specific manure for corn-plants, they have supposed that Science has denied their efficacy.

About misunderstandings of this kind there has been a long warfare; the practical man has not comprehended scientific conclusions and has believed himself obliged to defend his traditional notions; his dispute was not with scientific principles which he did not at all understand, but was with his own mis-conceptions of them.

Before this quarrel is settled, and Agriculturists themselves become the arbitors in it, little real help can be expected from Science, and I much doubt whether that time is yet come. However, I fix my hopes upon the young generation, who start in Practice with an entirely different preparation from that of their fathers. As far as I am concerned, I have attained that age when the elements of the dying body betray a certain longing to begin a new career, when one thinks of setting his house in order, and when one dare not keep back what one has still to say.

Since every experiment in Agriculture endures a year or more before its full results are given, so there remains scarcely any prospect that I shall live to see the results of my teaching. Under these circumstances the best that I can do seems to be so to arrange them, that for the future it will be impossible for those to mis-understand them, who take the trouble to thoroughly acquaint themselves with them. From this point of view must the polemical parts of my book

be judged. For a long time I believed that in agriculture, as is customary in Science, it was sufficient to teach Truth in order to diffuse it and not to trouble oneself about Error. At length, however, I perceive that this has been a false way, and that the altars of lies must be destroyed before Truth can obtain secure ground. Every one will concede to me the right of purifying my teaching from the defilements which, for so many years, have, without dis-cernment, been heaped upon it.

I have been reproached on many sides for describing modern Agriculture as a system of Robbery (Raub-wirthschaft), and after the communications which many Farmers have made to me respecting their management, my charge against such cannot be maintained. I have been assured that in North Germany, in the Kingdom of Saxony, Hanover, Brunswick, &c, very many Farmers most carefully give very much more to their fields, than they take from them, so that in their case we cannot speak of a "Rob-culture". But taken as a whole, it is relatively only the few who know how it is with their fields.

I have never yet met with a Farmer who had taken the trouble, as is customary in other trades for satisfaction to one's self, to keep a credit and debit account for each of his fields in order to register what he gives to and takes away from each.

It is an old inherited disease with Farmers for each to judge Agriculture in the whole from his own narrow standpoint, and if one avoids doing wrong, it is a sufficient proof to him that all do right!

The enormous exportation of bones from Germany is a matter-of-fact proof how small, generally, is the number of agriculturists who trouble themselves about the requisite compensation of phosphates, and if only one small Manufactory in Bavaria (Hensfeld) exports into Saxony about 1½ million pounds of bones from the neighbourhood of Munich, it can only be done by robbing the Bavarian land.

The great plunders the small, the learned the ignorant, and this will always be.

But also the future history of the german beetroot sugar manufacture, may perhaps still prove to many of our contemporaries that in many parts of north germany a mischievous robbery of the land is perpetrated.

By the application of Superphosphate of Lime & Guano very ~~high profits~~ large crops of roots for sugar have been obtained, and as this has continued already for many years without diminishing Harvests, the root-planters believe in their

unintelligent minds that these good crops will always be got, in the face of the fact that by this management the Potass in their fields is always being withdrawn, and must at length be exhausted. Potass, they say, may be a much too costly a manure, and as, for its price, they are able to purchase from three to four times more superphosphate and guano, they believe that by this addition they do better for their land. Certainly they do not know how high the price of the potass in the stable manure is with which they try to compensate for it.

Nothing can be more certain than that they deceive themselves in their supposition and that ~~their land is destroyed by~~ in the molasses & refinery charcoal they export the most important matters of sugar production, and therewith their fields ~~the molasses and refined carbon~~. They will find by experience, perhaps in ten years, as is incontestably the case already in France and Bohemia, that by this method after a certain time, not gradually but suddenly, the sugar contents of the roots from 11 and 10 per cent, will sink down to 4 and 3 per cent, and that superphosphate and guano will no longer be able to increase the produce of those same fields which formerly yielded such large crops of Sugar.

And thus, two generations hence, those countries in which sugar culture is flourishing now according to this system, will be cited as instances of what the foolishness of man could do in an industry which, according to its nature, can continue for ever on the same land without exhausting it.

In England exactly similar practice has been followed. In all turnip fields from which the roots have been taken without restoring compensating the potass, an equal deterioration of their quality has resulted, and only in those places where the roots have been fed off by sheep upon the field itself, thus restoring the potass-contents, have the crops remained unaltered in quantity and quality.

In the first volume of this work the ~~abstract~~ section contained in the earlier editions on "the chemistry of fermentation, ~~fottenness~~ decomposition, and putrefaction" has been excluded, not being immediately connected with Agriculture. By the comprehensive and important works of Pasteur, Berthelot, H. Schroeder & others, our knowledge of the processes of fermentation and putrefaction has, since 1846, been very essentially enlarged, so that I consider it suitable to devote a separate work to the subject, on which I am now engaged.

Munich. Sep. 1862.

Justus von Liebig.

Einleitung.

Liebig

Translation.
First Draft.
M. Gilbert.

Introduction

Agriculture before 1840.

In the last quarter of the last century no right conceptions were entertained of the reasons of fruitfulness of the fields or of the growing sterility by means of husbandry. Excepting sun shine, dew, & rain, the Agriculturist knew as good as nothing of the requirements for the growth of plants, and many believed that the Earth Soil only served as a standing place for plants.

For centuries the husbandman had known that working (tilling) the land, increased the crops, and that they were also increased by applying to them the excrements of animals & men.

It was believed that the action of Stable-manure depended upon a certain quality, in itself incomprehensible & not capable of imitation by art, which the food of animals and men received in their passage through the organism.

It was believed that the quantity of manure upon any farm might be produced incessantly at pleasure by means of a certain exchange from growth in the Stock of animals belonging to it, and as the crops and fruitfulness of his land increased in proportion to the industry & skill with which the Farmer cultivated it, the idea took root that high crops were within the range of the will of man, and that he who possessed the art might turn apparently barren sandy plains into fruitful meadows. Facts were abundant enough that upon the same farm one was ruined while a second grew rich, and that the rents of an estate rose or fell according to the man who managed it.

It was thought that the powers which produced the fruits of the field lay in the seeds and the soil, and in the same way as men or beasts were fatigued with labour and required compensation, so the land, whose strength had been exhausted by bearing fruit, was again restored by rest & stable manure.

But since the manure, as well as the crops, are products of the land, or of its strength it was, accordingly, believed that the land was in some way like a machine which was ever reproducing the strength which was consumed by work, if a portion of its products was restored to it. What this strength, or energy, of the soil was, was not known.

Later it was believed that this energy in the soil might be incorporated in some special substance, and that Humus might be this substance, designating by this a certain not exactly definable combustible matter of organic origin, a kind of manure, which need not require animals for its production

it was believed that the diminution and increase of the produce of the fields was in proportion to the contents or decrease or increase of the Humus in the field, and that the Humus was increased as well by Stable-manure as by means of skilfully conducted management.

There was truth in the assumption that more plants grow upon a fruitful than upon an unfruitful field, and that even on this very account, more organic residue accumulates upon a rich than upon a poor soil.

It was thought that greater crops might be grown on poor land, if the Farmer only understood how to produce more Humus within it.

Thus, according to this view, the next element of soil fertility was, an energy dormant in the soil and capable of being roused by the art of the Farmer, similar to the nourishing or healing virtues which the old physiology and medicine supposed to exist in food and physic. And it was considered that the activity of this energy, in reference to the augmentation of produce, depended upon a circulation of organic matters, which, in the form of Humus interposes in the life of plants, and in the form of plants again returns into the life of animals & men. The energy, man thought, might be everywhere. And indeed, in all regions of the earth, in all climates, upon all varieties of soil, upon Granite, basalt, sand & lime soils, the same plants were seen to thrive, often with equal luxuriance, and little seemed to depend upon the nature of the soil.

After it was thought to be discovered that Humus was the source, or the "Carrier" of soil fertility, the barrenness of a field was naturally ascribed to a deficiency of it. Certain mineral substances, such as marl, gypsum and lime, which increased the harvests when put upon the fields, were supposed to be the means of arousing this energy of the soil, as, perhaps, in men, salt and spices accelerate certain processes of digestion and the circulation of the juices. The action of bone-meal was ascribed to the organic substance (gelatine) which it contained.

Practical management was founded upon the production of dung as the means for recruiting the lost soil energy, and therewith insuring the return of the same crops. Certain plants, such as Fodder plants, were considered as dung-producers, and dung was thought to make the crops.

Every thing depended on fodder; much fodder made much flesh & manure, much manure made large corn crops; if there were plenty of fodder the corn came of itself.

From this theory that Stable-manure was the raw-material which the art of the Agriculturist converted into Corn

and flesh, came the doctrine that only corn and certain commercial crops exhausted and weakened the soil, and that fodder improved and saved it.

If straw crops, grown one after another on the same field did not continue to yield profitably, it was said: the field must be exhausted, but if other plants, for instance, clover and roots, did not continue to thrive, it was said the field ~~is~~ must be sick.

Two conceptions were entertained of one and the same phenomenon. At one time the failure in growth was attributed to the want of certain matters, at another to the disturbance of the normal activity or strength; the exhaustion of the corn-fields was treated with manure, while for that of the fodder fields they looked about for physic, or a whip as for a lazy horse.

The practical man managed his ~~managed his~~ business as the shoemaker does his handicraft, but without seeing as the latter does regarding his stock of leather, that he is always approaching to the end of it; that the plant was a living substance with its own especial requirements did not enter his head.

In Germany the farmer managed his land as if it were a piece of leather without an end, which, cut away at the top, increased at the bottom; and dung was the means to enable him to stretch the leather and make it pliant for the cutting off.

Agricultural Institutions taught the art of cutting as many pairs of shoes as possible from the inexhaustible stock of leather in the soil, and he appeared the best teacher who had brought this intensive system of husbandry the farthest.

As it was believed that man made the crops, credit for intelligence and skill was given to the agriculturist who succeeding in obtaining high continuous or increasing produce and gaining wealth, which he owed to his soil which freely gave what others, with all sagacity and industry, were not able to win from theirs.

Innumerable instances of the decrease of produce in all countries & regions were easily met with, but the stupidity of the agriculturists attributed it only to the tillage or manure. He who could still produce fine clover and root crops on his fields did not understand why another with the greatest expense in labour and manure could not make his clover-sick land fertile for clover: that his rich clover & root soil should ever become sick was, with the first, an impossible thought.

If man makes crops as the shoemaker his shoes, nothing depends on the situation of the workshop, and as a shoemaker in Petersburgh can make use of the advice and experience of a Pa-:risien shoemaker, an agriculturist in Rothamsted or in Saxony ~~can~~ might give good lessons in respect to the management of his fields to another in Yorkshire or Bavaria, and as many countries distinguish themselves by special manufactures, Russia by its Muscovy leather, France by its Morocco leather, Bavaria by its fine varnished leathers, it was believed that danish, english, french, and german agriculture might be looked at in the same light.

Ideas of a similar kind upon agricultural manufacture, governed, at that time, agricultural literature; the great and im-:portant investigations of De Saussure, and even of H. Davy, received no attention from the practical man, who believed that they stood in no relation to practice.

A system of husbandry carried out on a small piece of land in Möglin was a pattern for all farming in Germany. It was believed that there had been discovered that a given quantity of dung may produce an equivalent in corn, and that everywhere and in every country, the same quantity of corn must be the re-:sult of an equal amount of manure, gone already away from the stand-point that dung may be the material which the farmer may transform into corn or flesh. It was believed that all meadows, natural and artificial, gave the same hay, and that all hay possessed an equal feeding value; the feed-:ing value of other foods was estimated by hay-value; even common salt had a hay-value; every food had its manure--value; sheep manure was "heating", horse-manure dry "warm", soft cow manure was equally useful for all fields.

The manures which had a favourable effect upon the fields in Möglin, would have the same effect every-where. Bone meal which there had no influence upon the corn crops was assumed to be equally ineffective on all german fields.

Nothing depended on the latitude of the place or country, the elevation above the sea, the annual rain fall, the distribution of rain according to the seasons, on the average number of clear and rainy days, the mean temperature of the Spring, Summer and Autumn, on the extremes of temperature in the seasons, on the physical, chemical, and geognostic nature of the soil, - all these relations were overlooked in the good advice which was given by opposing agriculturists, or in the improvements which one recommended to another.

With the word "Theory" the practical man designated the casual fancies or explanations with which one or another ~~gave an~~

interpreted the phenomena of husbandry, and it was re-
=garded as self-evident that "Theories" possessed no value &
that in his business, the practical man dare not suffer him-
=self to be led by "Theories", but by "circumstances" & "conditions"
What these "circumstances" or "conditions" specially might be
he knew not. The "being able" or "Practice" may be the main
point, but no importance was attributed to the knowledge
of what "being able" depended on.

Man may abide by experience, with Theory he will not be
able to make lean fields fat.

Agriculture was an Art whose success depended upon
skill, said practical folk for centuries, so long as husbandry
was employed on fruitful land, and until distress came;
and when distress did come, when Fodder plants would no
longer flourish, and the rich humus land would produce
no more dung, then it appeared that the man of experience
was as helpless as a child & that his experience had no bottom;
what he so called was not genuine experience that would
stand a test.

"Were natural science to give into our hands the means of
cultivating these plants (clover, luzern, sainfoin) with contin-
=uous uniform success, oftener on the same spot, than is the case
according to present experience, the Philosophers' Stone would
be found for Agriculture, for we would already take care of
its transformation into forms corresponding to human require-
=ments (see "The maintenance of cultivated plants", by C. Waltz, Director of
the Agricultural Academy in Hohenheim. Stuttgart, Cotta 1857. P. 127.)
Thus, does an eminent practical man from the school at that
time, beg the help of Science!

Agriculturists had, at the close of the last century, with
gypsum, & earlier still with marl, obtained material by which
without dung or humus,
they succeeded in increasing the clover crops, and with them
the production of dung, and when this magic agency would
no longer operate, might not natural science furnish them
only
with a small piece of the Philosopher's Stone, in order that again,
now that their own skill & experience were insufficient,
they might make clover, or also roots, pease and beans grow? they
thought God would work a wonder for them, not on account
of the preservation of the human race, but to save them
from thinking of the sources from which His blessings flow.
None were in the position to answer the question how long
from that time he could calculate on his crops? The great
majority believed that there would be no end to them, and that
it did not rest with the soil whether it continued to be fruitful.

Every practical man knew indeed that his fore-fathers
had, from the same land, obtained as high, and even higher crops of corn

without purchasing any manure from without, but it did not come into any one's mind to consider why the growth of fodder (futter-gewächse) was no longer so good as in former times! That the true ground of the failure of manure, which then afflicted him, lay in his soil, was to him, an opinion entirely out of the question.

But the practical man is the same through a thousand years. He, the sworn enemy of all "Theory" himself made the theory that his soil was inexhaustible in fertility, and the modern farmer regulates all his affairs according to the Theory that the foreign sources which still give him the means of restoring the produce to his fields, are inexhaustible!

What would become of his fields, his country, & its population, were these sources really exhausted, troubles him not. The careless, ignorant householder, always believes that it will be tomorrow as it is today.

Agriculture since 1840.

These were the leading ideas in agricultural management up to the Year 1840.

At this period Chemistry had so far taken its standing among the natural sciences that it could take a share in the development of other departments, and when the labours of Chemists were directed to the investigation of the conditions of life in plants and animals, they here touched upon agriculture. Plant physiology was already acquainted with the changes which the air undergoes by means of the processes of vegetation as well as with the influence of Carbonic acid upon the increase of carbonaceous constituents in vegetable growth, and of the power of the green parts of plants under the action of sunlight, to separate Oxygen, but ignorance prevailed upon the origin of the hydrogen and nitrogen of plants; it was believed that certain salts and earthy matters, which remained in the ashes of plants after incineration might be accidental constituents varying with the place of growth and geognostic characters. Chemistry, according to its severe methods, began to study plants most minutely, in all their parts; it investigated what was in the leaves, stalks, roots, and fruit; it followed out the processes of nutrition in animals, and the results of the food taken in the body; it analysed soils from the various regions of the earth.

It appeared that seeds, fruits, roots and leaves, took up certain constituents of the soil, and, indeed, the same from all kinds of soil; that the constituents of the ash were not accidental constituents which varied according to the place of growth, but that they

served to build up the frame of the plant; that thus, these ash-
-constituents may be the same in the nourishment of plants as
are bread and flesh to men, or fodder to animals; that fruitful
soil contained much, and unfruitful little of these foodstuffs;
that barren soil became fruitful when the amount of these mat-
-ters was increased.

From this it followed of itself, that soil must by degrees
become unfruitful, if, by the cultivation of vegetables and
their carrying off of them, the store in the ground of these food-mat-
-ters is continually lessened; that in order to keep the soil fertile
that must be fully restored to it which has been taken away;
if the reparation be not complete the return of the same produce
cannot be calculated upon, and only by increasing such
constituents in the soil can crops be augmented.

Chemistry then showed that the food of men and animals,
compared with a rude figure, behaved in their bodies, as in
a stove in which they were burnt. The urine and solid excre-
-ments are the ash of the food, mingled with soot and the imper-
-fect products of its combustion.

According to this is easily explained the action of Stable
dung upon the land, as in it that can be returned to the land which
has been taken away in the fruits of the field; but that the
durability of the fields cannot be secured with the manure
produced upon the farm, as nothing is returned to them for that
carried off in the
corn and beasts brought to the towns.

The farmer, therefore, must take care, if he would secure
the continuance of high crops, to supply from other sources, the
food-stuff which is wanting in Farm yard Manure for the
contents of the fields in these matters are very limited and since
Chemistry has ascertained this with the greatest precision it is im-
-prudent to act as if the store were inexhaustible; if the farmer
does not concern himself about this compensation, there must
come a time to each field when it can produce no more fruit.

The problem for the farmer is not to obtain high crops
at the expense of the land, which thus becomes impoverished only the sooner,
but, for his own interest, and that of human society, to obtain
high and continually increasing crops which will go on for ever.

If the agriculturist will take the trouble to reflect upon
his business, he will become aware that it is presumption
to believe that he possesses the smallest power over his fields,
and that any art or skill is able to produce a profitable crop of
any of the fruits of the field from a soil whose composition is not
adapted for it; but he may apparently have a choice, if not he,
but the field, selects the plants which suit it, if he presents them
before the field, and his acuteness sets itself to work to interpret

what the field says. What lies within the compass of his will & his Art, is limited to this, finding out the deficiencies, and re-moving the obstacles, which prevent his land from rewarding the care which he devotes to it.

What he calls "circumstances" and "conditions" according to which he regulates his management, are natural laws, which he must learn to understand if he would govern them, otherwise he will be the slave of these laws.

All that Science teaches respecting them, does not divert him from his purpose, but gives the true sort of prosperity to his acts, so that then his art, and what he calls his experience, are quite indispensable in order to make his knowledge of "conditions" and "cir-cumstances" serviceable and profitable.

"Knowledge" is not the antithesis to "Practice" ("Können") but gives only the right direction to Practice.

Science does not stand opposite to Practice as a strange thing, but associated with practice, assents when the right thing is done, and guards the agriculturist from errors which would bring him injury; it indicates to him in what his land is deficient, and what it has in excess, and how he may ma-nage it in order usefully to dispose of its wealth.

A glance at the history of the natural sciences, shows, that when a new doctrine has stepped into the place of a prevailing one, the new doctrine is not a further development, but the exact opposite of the old one. A false doctrine developes itself according to the same laws as a true one, but the first dies because it has no roots, whilst the other grows and prospers. The erroneous doctrine, leads, for its own substantiation, to conclusions and views which every one, at length, perceives to be contrary to rea-son and impossible in fact, and it then gives place to another which is the opposite of itself; for Truth is always the antithesis to Error.

In this manner the phlogistic Theory, according to which combustion was considered as a decomposition, was fol-lowed by the anti-phlogistic which taught that combustion was a process of combination, but we must keep in view that the new doctrine was a result of the development of the old, which must fall, as it led to the absurd conclusion that Phlogis-ton had a negative ponderability and made bodies lighter when it united with them, & heavier when it escaped from them.

The new Theory in reference to plant life, stood also in the same relation to the old one; the old one assumed that the proper food of plants, and indeed that upon which depended the increase in bulk in agricultural production, was of an organic nature, that is, engendered in plants or animal bodies.

The new doctrine assumed, on the other hand, that the food of all plants (exclusive of mushrooms) is of an inorganic nature, the mineral, in the body of the plant, becomes transformed into the bearer (Träger) of an organic activity; the plant produces from inorganic elements all constituents of plant-substance, and in it, from the lower, the highest components of the blood, from which the animal organism is formed.

On account of its opposition to the earlier doctrine, the new one receives the name of the "Mineral Theory."

History of the Mineral Theory.

As I, myself have had a decided share in the development of the mineral theory, my readers will allow me to examine it somewhat closely, particularly concerning the foundations upon which my views rest, that they may be able to form a correct judgment of the contradictions and opinions which, for twenty years, have stood opposed to this theory.

In relation to the nourishment of Plants I have made the following propositions:

"The food of all green vegetable growth is inorganic or mineral substances."

"The Plant lives on Carbonic acid, Ammonia (nitric acid), "Water, Phosphoric acid, Sulphuric acid, Silicic acid, Lime, Magnesia, Potass (Soda), Iron, many require Common Salt."

"A connexion exists between all constituents of the earth, "of water, and the air, which take part in the life of the plant, between all parts of the plant and the animal and its parts, so indeed, that if a single link failed of the whole chain of causes which effects the passing over of the inorganic matter to a carrier (träger) of the organic activity, the plant or the animal could not be.

"Dung, the excrements of animals and men, do not operate "by means of their organic elements upon the life of plants, but indirectly by means of the products of the process of putrefaction & "corruption, in consequence of the passing over of Carbon into carbonic acid and of nitrogen into Ammonia (or nitric acid). Organic "manure which consists of parts or residues of plants and animals, "accordingly supplies the inorganic combinations into which "it separates in the soil."

These propositions stood, in relation to all previous views, not only in no connexion, but in direct contradiction.

With respect to the source of carbon, the generally current doctrine was that of de Saussure; according to him ~~it was indubitable~~

the taking up of Carbonic acid and the passing over of its carbon to a constituent part of the plant, was indubitable, but he assumed different laws of nourishment for wild and cultivated plants; the first, which received their organic substance from Carbonic acid, being of scarcely any value in agriculture. Cultivated plants, on the contrary, received the chief bulk of their ternary and quarternary materials from the Humus and the soluble organic matters contained in fruitful soil. This is the most important part of the theory of manuring se / Annal d. Chemie und Pharmacie. Vol 42. p. 275)

This view would have nothing objectionable if a plant were considered as an existence for itself, which stood in no relation to other existences or to processes of other kinds; it might comprise within itself a circulation of Carbon which, for ever, could interpose for its being; what the plant cast off would come to life again, what it lacked would be supplied by the atmosphere.

The view itself was not proved, and by careful testing of all the customary arguments in favour of it, it appears to me incapable of proof. The arguments in favour of my view include no experiment, but rest upon the consideration of the relations, according to natural laws, of the plant, to the atmosphere, and to the animal, whilst I brought its life into relation with the chief functions of animal life, to the process of respiration and the constant oxygen contents of the air, it yielded, in the circulation of oxygen the only and principal source of carbon, which carbonic acid must be. This view has been directly and incontestibly established by the most recent experiments of Knopp & Stohrmann. (see Appendix). p. 16?

With regard to Ammonia as the source of the nitrogen of Plants (and of Animals), no one, with precision, could easily, with any probability, give utterance to this view before myself, for it essentially rested upon my investigations respecting the processes in the animal organism, and upon my acquaintance with the changes which all nitrogenous animal and plant matters undergo in the processes of putrefaction and corruption. (see "Upon the Phenomena of Fermentation, Putrefaction & Decay". Annal d. Chemie und Pharm. Vol xxx. P. 250, 1839). As I believe, I was the first to say, that all nitrogen which an animal, or a man, takes during his life in his food, re-appears in his urine, by far the greater part as urea, in the form of a chemical combination, which under the usual conditions of its occurrence, passes into carbonate of Ammonia with extraordinary rapidity, and that the final products of the changes of nitrogenous materials are Ammonia (nitric acid) and Carbonic acid. The nitrogenous structures of the many thousand dead bodies exhumed from the Paris Churchyard of

the "Innocens" had passed into gaseous combinations, even before the fat, and the residue remained behind as ammonia in the fat. By exposure to air and moisture similar changes are undergone by the nitro-genous substance of bones.

The observation of Scheele (opus c. II, 273), of de Saussure (A. Gehlin II, 691), of Solard de Maligny, that ammonia salts form in the mouths of bottles preserved in a room with Hydrochloric acid, or by exposure of a solution of sulphate of Alumina or of Sul-=phuric acid in the air, was not of importance to my theory, in the same way as my own dis-covery 35 years ago of the presence of ammonia and Nitric acid in rain water; for this could have been shown in the evidence of the constant presence of Ammonia in the air and rain water, and by the exclusion of all other ni-=trogenous combinations, ~~other forms~~ for, besides ammonia, nature
P. 17. has no other nitro-genous combination which can yield nitrogen to ~~the~~ plants.

In Schleiden's Hand-book of Botany, page 189, we find the following:— "That salts of Ammonia are the source of the nitrogen in plants was with sagacity, first ~~developed~~ pointed out by Th. de Saussure, & has been since further illustrated by Liebig." Schleiden here quotes the german translation by Voit, of De Saussures "Recherches sur la vegetation" p. 190. I have, in a note in my Agricultural Chemistry, copied a part of the same page in this work, where the word Ammonia only occurs, besides this in no other part of de Saussure's work, to ~~there~~ anything ~~besides~~ about ~~upon~~ Ammonia. With my note I wished only to declare particularly, that de Saussure was acquainted with Ammonia as a constituent of the air but not as a source of nitro-gen. Saussure supposed that several sources might be thought of, and that Ammonia was not one; upon this he has express-=ed himself quite positively & decidedly. (see Bibliothèque Univer-=selle. vol XXXVI, page 430, and Ann. d Chem: und Pharm. vol 42. p. 273). In this Treatise he appears as an opponent to my view, & denies that Ammonia is assimilated as food by plants, he ex-=plains that it operates beneficially in vegetation, because it serves as a solvent of the humus and the organic materials contain-=ed in the soil and air. Since, in my book, I have said nothing of the "sagacious explanations" of de Saussure, the underlying meaning of the above quotation from Schleiden can easily be seen, as if I had, in this matter, concealed de Saussures merit, and appropriated it to myself. But from my earliest youth my Mother made me attentive to my christian name, and taught me how beautiful it is to be just, and that only to the just is justice maintained ~~the right~~.

In my book I had attributed no especial importance to Nitric acid as food for plants, not because I depreciated its value,

but because my observations had led me to the result that the nitric acid formed in the earth, is, under all circumstances, a product of the decay or oxydation of Ammonia. If the plant employs nitric acid in its growth, this ~~usually~~ represents, according to my view, only the Ammonia from which it originated.

The explanation of the formation of nitre which I have given 20 years ago in my book, and later in my Chemical Letters (p-98), agrees, almost word by word, with the experiments and observations which a distinguished french Chemist has recently made known on this subject; my view upon the formation of nitric acid was founded upon observations which, for many years I had the opportunity of making on a true nitre bed (Salpeterplantage); it was the west wall of the Stables of the Gendarmerie-Station at Giessen, in the neighbourhood of my residence; on warm dry days it was covered with a crystalline, hairy, efflorescence (auswitterung) of dissolved Salts of nitre, which were continually renewed after being exhaled; I had investigated the fluids in the wall from the ground upwards, and, besides a very small quantity of a decayed material only found in them carbonate of Ammonia.

With regard to Phosphoric acid as the food of plants, I have alledged in my book (page 83) that already, 40 years before me, de Saussure had declared the necessity of its lime-salt for the development of plants, but that this view had nowhere received attention. "I have found this Salt," says de Saussure "in the ashes of all plants which I have investigated, and we have no ground for asserting that they can exist without the same." (Recherches sur la vegetation.)

De Saussure had submitted to investigation, the question respecting the necessity of Lime, Potass, and Magnesia, for the nourishment of plants, and it was certainly an unfortunate circumstance for the development of the physiology of plants, that his observations were limited to two upon woody plants (holzpflanzen) in whose ashes lime, magnesia & potass change with the nature of the soil. Such a change appears in wild plants, and frequently enough in such plants, as Tobacco, the vine, &c which do not serve for food, but not in those which are used for food. The Composition of seed ashes, or the ashes of food-plants is very constant, and the variations are comprised in very narrow limits; the phosphoric acid, the potass, the lime and the magnesia, always stand in a determined relation to the contents of the plants in blood-forming matters, the potass to the Sugar, &c.

The doctrine that Alkalies and alkaline Earths in the ashes of plants, are foodstuffs and not accidental constituents, is very frequently ascribed to Sprengel, who indeed, in his Notices on Soils (Bodenkunde) declares that all the ash constituents are necessary.

But his view upon the utility or necessity of these matters for plant life, found no response either in Science or Agriculture, because, according to the experiments of de Saussure, the roots of plants posses the power of taking up the dissolved salt from salt solutions of the most various kinds, and therefore, according to this, the presence of an ash-constituent cannot be considered as a proof of its necessity. This does not imply that Agriculture may not be greatly benefitted by Sprengel's view, if the efficacy of individual constituents of ash were demonstrated by agriculturists. This could happen quite as well empirically as upon the ground of Theory. Ash, from the earliest time, has been known as an efficacious manure.

The result of Sprengel's theory shows that he, as a matter of fact, was not acquainted with the ash constituents of vegetable growth. He adopts the same ash constituents for most plants, as in wood ash. He states, for instance, that the ash of Peas contains 18 per cent of Silicic acid and 4 per cent of Phosphoric acid, that Rye seed contains 15 per cent of Silicic acid, 8 per cent of Phosphoric acid, now, neither of these seed-ashes contain any silicic acid, and the first contains 38 per cent, the other 48 per cent of Phosphoric acid.

The necessity of these matters, and that they were food-stuffs could be ascertained, before the laws of connexion between the individual constituents were known, for instance, the relation of lime for the formation of Cellulose, of Phosphoric acid to the nitrogenous constituents, &c, relations which are not now clearly understood except as they are deduced from other indubitable relations. Potass is always found combined in plants with vegetable acids, with Tartaric acid, Oxalic acid, &c, and we see that all constant ash constituents of the food plants, play a very special part in the processes of nutrition of animals. Without the constant presence of phosphoric acid or of phosphat of lime in the food, the formation of the substance of the brain and bones would be inconceivable, quite as much so would be the formation of blood and the constituents of the muscles without iron and the alkalies. And I came to the conclusion that if the interposition of these matters be indispensable for the processes of the animal body, they must be also necessary for the process of vegetation, because, were they fortuitous, the change ~~to which they would be subject~~ in them would have endangered animal life.

As opponents of my doctrine upon the origin of carbon, and of my views upon the vital process in animals and plants, Messrs Moleschott and Mulder have made themselves especially prominent. I have to reproach myself that, in consideration of its importance, I have taken too easily the contradiction of these men, for as teachers in Universities, both exercise an influence in wide circles, and my doctrine ~~teaching~~ is generally considered untenable in Holland where it is believed to be refuted by Messrs

Mulder who is Professor of Chemistry in Utrecht. For this reason it will not be considered improper (or inadequate unangemessen) if I in a few words more accurately describe the scientific standing of these men; that of Herr Moleschott, undoubtedly, amongst Chemists, depends upon his Investigation of Frog-flesh (archives of Physio=logy - 1853) which he undertook some years after my investiga=tion of flesh.

In this work Moleschott described a series of experiments from which he drew the inference that two matters, Oxalic acid & Urea, are contained in the juice in the flesh of Frogs, which up to that time had not been observed in the juice of any flesh. He did not find in Frog-flesh Creatin, Creatinine, acid (Inosins-äure) and Lactic acid, which are constituents of flesh juices. After this it was soon pointed out by Grohe that neither Oxalic acid nor Urea are present in frog-flesh; what Moleschott considered to be Oxalic acid was phosphoric acid, and the cryptals which he took for nitrate of urea were cryptals of saltpetre; as for the rest, Grohe found that frog-flesh contained Creatin as well as the other matters which were recognised as constituents of the flesh-juice of animals. This is not the place to criticise Moleschott's work since it stands in no connexion with my own, but it is a characteristic sample of many, not only physiological, but also, agricultural investigations.

As no one can understand a book written in a foreign language which he has not learnt, it is just as impossible to understand and judge of chemical processes if the import of chemical phenomena is not known. The beginner in chemical analysis commences by learning the properties of bodies, or, as it is called, their reactions, and, in the eyes of the chemist, he who does not know how to separate from one another the best known & most easily recognised matters, has just as little claim to be heard upon chemical questions, as is al=lowed to a man in judging upon the ~~importance~~ meaning of a sentence in a language whose words he cannot spell. The con=founding of Oxalic acid with Phosphoric acid, of Nitre with nitrate of urea, are not excusable errors, but marks of a per=fect unacquaintedness with these things.

It is further evident that for the carrying out of a chem=ical operation, not every one is exactly suited to the ma=king of experiments; the qualitative and quantitative analysis, the skilful handling of chemical utensils and apparatus, and the precise knowledge of the conditions which must combine in order to make an experiment successful, are, all taken together, an art which must be laboriously learnt, and he whose vocation is to instruct others in it,

knows that the requisites for its acquisition are found as seldom as for any other art. We can understand that a man who has neither practice nor experience in chemical investigations, will, when he simply repeats the experiments of another, never find that which the other describes, and when he makes experiments according to his own ideas, will never find that which he should find. If he brings to his work a certain amount of self-consciousness, because he finds every-thing else different he will believe that he has refuted facts which are not capable of refutation, or he will believe that he has discovered new facts which only exist in his imagination. The contradictions to which he arrives are so much the greater, and the new which he finds (as, for instance, Oxalic acid in the blood of Carnivora) is so much the more astonishing, as he himself, according, is unskilful and ignorant.

Agriculturists are opposed to Chemistry in the same way as Moles-chott is in chemical-physiological questions. It is quite impossible for a Farmer who possesses no knowledge of Chemistry, to comprehend rightly the exhibition of chemical processes, and the significance of the matters to which they relate. If such a man resolves to make experiments in order to prove the correctness of chemical facts, he shows at once that he knows nothing of what he is about, the question he wishes to answer is not clear to himself, and, under such circumstances, the greatest exertions can lead to no rational results.

The worst is, that to the public, all facts are equally acceptable, from whichever side they may be brought, and that it does not know how to separate the true from the false, or the worthless from the valuable. The greater the mass of facts the more important they are considered, and the public is like a child who has heard that gold rings have sometimes been found in house-sweepings, and believes that in all house-sweepings gold or silver may be concealed.

When any-one in a country unknown to himself, looks out for a guide, if he be sensible he will certainly only make choice of one who is acquainted with the locality & who has often gone over, and knows the way; if he be foolish, any one who offers himself will be accepted, and it is no matter of surprise if he falls into a bog.

In the year 1846 Drs Fleitmann and Laskowski made investigations upon the Protein described by Dr. Mulder, the result of which was, that this sulphur-free element of the blood & animal structure according to him, did not exist & its

dis-covery was a delusion. I committed the error of believing that Dr. Mulder would thank me for communicating these results to him; I wrote to him, therefore, before their publication, and invited him to review his previous experiments, in order if he had erred, to correct the error himself. Hereupon I received two letters of very singular tenour from him, which I published in the 57th volume of my Journal. In them he expressed his intention of being my enemy as long as he lived, and that he would stake every-thing in proving ~~it~~ to the world that I was a great sinner; he would give me, however, fourteen days for repen-=tance, which, in reality, was, a declaration that the unfortu-=nate Protein existed.

Unhappily, I could not give him this pleasure, and Dr. Mulder came afterwards into the pitiable condition of strug-=gling the evidence for the non-existence of Protein, by means of two Treatises whose purpose was to prove the disputed existence of that substance. Since that time he has hon-=estly endeavoured to be my enemy; in his last work, "The Chemistry of Field soil" / "Chemie der Ackerkrume"), Dr. Mulder informs me how insufficient & incomplete are my experi-=ments upon Field soil. I know this, unfortunately, myself, and have only the consolation that I earnestly endeavoured to make them as good as I could, and I can but lament that I have derived so little instruction from them.

The change in my scientific opinions is particularly offensive to him! He places together those which I held years ago with later ones, and shows by this means, how incon-=sequent I am. This is a fault which I must acknowledge, & it can be excused by the circumstance that Chemistry makes desperately rapid progress, and that the Chemist who ~~wood~~ will keep pace with it, ~~exc~~ is in a perpetually moulting condition. As new feathers sprout, the old ones, which would no longer bear him, drop from his wings, and he flies, henceforth, so much the better without them.

How little true satisfaction must Science impart to a man like Mulder, if he consume his time and strength in dragging to the light the weaknesses and imperfections which will cling to all human efforts, in the often most laborious & difficult works of others. In him who works much, he will naturally find a large amount, and the glory of making no mistakes which belongs to him who does no work, is not par-=ticularly enviable.

It is related in a biography of Mulder / Illustrated News. Page 39. 1857 / that in the first year of his chemical course he had been able to understand nothing, which distressed him

but did not frighten him away from Chemistry - The course then required him to learn by heart the "Elements of Chemistry by Orfila, and afterwards the first volume of Thenard's "Hand-book of Chemistry" - "certainly a singular method of training a Chemist", but which explains much in his works.

I have, unfortunately, myself been the cause of the greatest injury to the acknowledgement and propagation of my doctrines, I was, by my own ignorance, their worst enemy, and this came to pass by means of the composition of a manure which should serve to restore the fruitfulness of fields exhausted by cultivation. Since this manure forms an epoch in the development of my Theory, towards which, without repentance, I now look back, as to ~~which~~ a much attacked Stand-point, it will not be considered unsuitable if I relate its history.

Perhaps, without this manure, Agriculture would still not have won the solid ground on which she now stands.

History of the Mineral Manure.

The necessity of a restoration of all the constituents which the soil lost in the fruits harvested & carried off from it, or a supplement to the constituents which Stable-dung had furnished to the crops, was clear to me. Without such a restitution the soil could not continue fruitful. The duration of the produce, the satisfaction of the requirement of a continually increasing population, can only be secured by restoring to the land, or adding to the Stable-dung, from other sources, that which the land wants.

I occupied myself with this question in the years 1844 and 1845. It was not difficult to learn, by analysis of the corn exported, and the other products, what was taken from the soil and what must be restored to it, in order to maintain its power of production, but how should this restitution be managed?

There existed no difficulty about the Phosphoric acid, but, on the contrary, respecting the Alkalies, was a great difficulty. Phosphoric acid, in the form of Super-phosphate, will diffuse itself every where in the earth, and it might be assumed that the soluble Phosphate ~~in the~~ in the soil, would, in all places, meet with lime enough to change it into ordinary phosphate, which, made soluble by the Carbonic acid water in motion in the soil, would be serviceable for food; no considerable loss need be thought of in consequence of the weak

diss-olving power of rain water. It was otherwise, however, with Potass. If Potass is put upon the land in the form of wood ashes or a soluble salt, it is to be supposed, that the rain water falling on the field will dissolve the salt in the shortest time, and, trickling through the earth, it will be carried to a depth where it is unattainable for the roots of the plants.

The view, that the water moving about in the soil, must & did dissolve the food-matters in it, & that by this means ~~they were carried (or conveyable) to~~ the plants were able to take them up, was general and uncontested. At that time, no one could believe otherwise.

After some experiments, I succeeded in finding out a combination of carbonate of Potass with Carbonate of Lime, which deprived the potass of its too great solubility, & protected the farmer who used it as manure, from the injury by rain-water. The most important problems for the preparation of an artificial manure, appeared to me to be solved.

My manure contained soluble phosphoric acid, potass, and sulphuric acid. The nitrogen of the nitrogenous constituents of Dung, was added to it in the form of Ammonia salts. I thought no compensation necessary for the silicic-acid, as, according to usual management, the straw is left in the field.

In regard to the addition of Ammonia, I gave it as my opinion, that it most probably was unnecessary for many Crops, especially it was not required by very leafy plants, such as Clover, Peas, & Beans, which farmers might consider with attention, for the exclusion of Ammonia very greatly diminished the price of manure. Notwithstanding this opinion, all sorts of manures were provided with an amount of Ammonia, corresponding to the fruit produced; in none was Ammonia wanting. (An address to the Agriculturist of Great Britain, explaining the use of artificial Manures. Liverpool. Printed by Thom. Baines - Castle-street. 1845).

Although my manure contained all the elements of efficacious manures at that time in use, yet, in practice, it produced nothing like the effect expected. my

In England a series of Experiments with Manures was made by J. B. Lawes, a manure manufacturer, upon his fields at Rothamsted, by which their small efficacy was proved. These experiments, as it appears to me, were made originally, not with the intention of subjecting my Theory to a test, but simply to try the Goodness or value of my manure.

I had convinced myself, by trial upon a piece of land which I obtained for this purpose from the town of Giessen,

b. 289.

that its action was small in the first year, and only first noticeable in the second and third years; the manures were not inefficacious, but were not applicable in Agriculture on account of the slowness of their operation.

I did not understand the cause of this.

Lawes made still further experiments with other mixtures, which were consolatory enough to me in relation to the correctness of my theory, but as far as concerned the reason of the inefficacy of my manure, they only puzzled me the more.

The experiments of Lawes, and the facts shortly afterwards communicated by him, would, perhaps, have received but little attention, and indeed would have found their right explanation as confirmations of my theory, if I had not had the misfortune of arousing an implacable enemy to my Theory in Philip Pusey, an early President of the Royal Agricultural Society. This is not the place to enter into the circumstances which made him its opponent, and it may be sufficient to refer to his expressions in the Journal of the Royal Agricultural Society of England, in order to prove that in that circle it had lost its authority (or title to existence)

In a true sense it was put to death by Wm. Pusey in an article of this Journal (Vol XI. Part II.) in which he expressed himself in the following manner on the influence of Chemistry upon Agriculture:- "The Mineral Theory, too "hastily adopted by Liebig: namely, that the crops rise & fall "in direct relation to the quantity of mineral substances "in the soil, or the augmentation or diminution of these "matters in the manure, has received its death-blow by "the experiments of Wm. Lawes. Wm. Lawes, our best authority, "has surely proved so far, that (much) of the two active constituents of manure ammonia is quite especially "efficacious for corn, and Phosphorus for roots. Excepting "Liebig's recommendation to dissolve bones in sulphuric-"-acid, and Sir Robt. Kane's to employ as manure the water "used in steeping flax, their is no improvement which agriculture owes to Chemistry. — It is a great mistake to "believe that we can make agriculturists, if we instruct "them in doubtful Chemistry."

Set against my Theory and to the facts established by Wm. Lawes, these expressions were, in the highest degree, remarkable. Lawes had successively tried all substances which I had pointed out as inorganic food-matter, Potass, Lime, and Magnesia, were without influence upon the produce of his fields; on the contray, Ammonia salts and Superphosphate of lime had a most favourable influence, of which two I had mentioned the last, as the most necessary

manure for the english fields. Both were inorganic foods-sub-
stances, and their action corresponded to the Mineral Theory;
that which I had previously affirmed, namely, that certain plants
could do without Ammonia as manure, had likewise verified
itself; for the increase of Turnip roots, the addition of Ammonia
was unnecessary.

As the turnip root is the most important Fodder
growth in England, if Ammonia salts were especially suitable
for the increasing of Corn crops, and Super-phosphate of lime
for the augmentation of root-produce, english Agriculture
had, in these two manures, received from Chemistry the most
precious gifts for the production of flesh and bread which
this Science could have given, for, before acquaintance
with the mineral Theory, the practical farmer knew nothing
either of Superphosphate or of Ammonia-salts.

I vainly endeavoured, by means of a note addressed
to the Journal of the Royal Agricultural Society, to correct
the erroneous interpretation of Lawes' experiments, and
to show that not one of them stood opposed to my Theory, but
that they were confirmatory of it. I willingly allowed, that
my manure, in some way unintelligible to me, was faulti-
-ly compounded, and that in its condition and in its
nature, not in its constituents, must lie the reason of its
small efficacy; it contained the same materials, phosphor-
-ic acid and Ammonia-salts, which Lawes had proved to
be efficaceous, so that the ~~deficient~~ defective activity of my manure
was no evidence of defect in my Theory.

The organ of the Royal Agricultural Society had no
room for me, and so I then determined to print what I had to say
upon the relation of my Theory to Lawes' experiments in the
3rd edition of my Chemical Letters published in the year
1851. I did not at that time know the reason of the inefficacy.

But this explanation was received worse than
my Theory. Already in the year 1847, Mr. Lawes in his trea-
-tise upon "Agricultural Chemistry" (Jour: of the Roy. Ag. Soc:
vol VIII. 240) had not only brought evidence that my manure
was bad, but had also laid down the ground for the refu-
-tation of my Theory, whilst he set up a theory of his own
which is contained in the following sentences:—

"Manures are commonly distributed into two classes
" organic and inorganic; organic manures are those which,
" by decomposition or in other ways, are able to furnish carbon
" hydrogen and nitrogen to plants. Inorganic Manures are
" those which contain the mineral constituents of which the ashes
" of plants consist."

From this theory of the practical man it followed necessarily of itself, that a mineral manure must be a manure which contain=ed only the ash-constituents of vegetable growth, and from the composition of which Ammonia-salt is excluded which belongs to the organic manures. In every chemical compendium Ammonia and its salts are indeed considered amongst in=organic substances, as an object of chemical manufacture, whilst organic materials cannot be made by men, and this circumstance might well have led to the conjecture that Ammonia was not neces-arily excluded from an inorganic manure. The Agricultural Chemistry of the practical man was evidently a peculiar chemistry which stood in no connex=ion with the ordinary chemistry, and in this relation his theory might well justify itself, but according to my Theory I openly took another stand-point. In his Treatise (p. 21) Mr. Lawes certainly allowed that my manure smelt of am=monia, and, therefore, contained an ammonia salt, but he intimated that this might be a little artifice in order to im=part an efficacy to my manures, which, according to his in=terpretation of my Theory, they should not possess.

In the first edition of my book, I had ascribed far too great importance to the value of Ammonia as nitrogen=ous food, and, relying upon a closer and more exact observa=tion of culture on the large scale, I endeavoured in the 3rd edition of my agricultural chemistry, to remove the evil effects of my previous incorrect view. In France and Germany the nitro-gen in manure had been pointed out as the most efficacious, or as the only efficacious constituent and the manure ranked according to its richness in nitro=gen, so that thus nitrogen appeared in the eyes of agricultur=ists as the measure of the value of manure which regula=ted its consumption & price. From this followed of itself, that Ammonia, as the richest in nitrogen of all sub=stances, was the most valuable and most efficacious manure.

But my investigations had led me to the full conviction that if the improvement of our land & increase of our crops were dependent on an addition of nitrogen-food purchased from abroad, progress in Agriculture must be for ever renoun=ced. (I will return later to my reasons for this, in order not now to interrupt the history of my mineral manure.)

I most earnestly warned agriculturists that they should not believe that Ammonia had, at any time, a higher value than another manure. By a great number of analyses which had been conducted in my Laboratory, I had learned

that all kinds of soil, even the worst, were much richer in Ni-
=tro-gen than the generality were in Phosphoric acid or Potass.

I knew from the determinations of the Ammonia in the air, that the atmosphere alone, without the assistance of the soil, might was able provide as much nitro-genous food as would be requir-
=ed by the most intensive (? concentrated) system, and that the maximum, which the atmosphere might furnish, was conden-
P. 34 upon the fields in the form of fodder and corn growths, only
2 by means of skilful treatment of the land and a judicious se-
=lection of the succession of crops.

According to my doctrine, the fields should be supplied with all in which they are deficient, in order to maintain a continuation of their fertility, and since it was impossible to know what was deficient in a field in Gumarkung Bogen-
-hausen, Schleisheim, or Rothamsted, all that could be done was to give advice. He who knew that he wanted, before every thing else, Potass, or Phosphoric acid, or Nitro-gen, did not need advice, but the many other farmers, who knew nothing about the wants of their fields, required a definite statement (anhaltspunkt) in order to understand to what matters to di-
=rect their attention; the most natural and suitable thing to say to them, was, that their first care should be to return (to the soil) those matters which they took from it in fruits or produce. Chemical analysis would show, what, and how much, that might be.

It was not said, that the farmer who knew that his soil contained a few hundred thousand pounds of lime, or another whose soil might be rich in Potass, was obliged to restore the few pounds of lime or the few pounds of potass, which he might carry off, but he who might not know this, might always do it because it would be but little expense, and the safety certainty of root or clover crops, might, possibly, direct-
=ly depend upon the few pounds of lime or potass put upon a soil deficient in lime or potass. The simple restitution of the matters carried off in a rotation may be sufficient to secure crops as good as the preceding ones. As a rule more cannot be given in Farm-yard dung; if higher crops are desired more must be given, and in order to restore the field to the con-
=dition in which it was, for instance, 50 years previously, he must import upon it what he has taken away in the course of these 50 years.

These have been the principles of my doctrine which I have set forth in my book; it is self-evident that the produce of the land rises or falls with the increase or decrease of the con-
=ditions of its re-production; and that these inorganic or min-

=eral matters are always in proportion to the increase or de=
=crease of the mineral foods. I had never at all set up an anti=
=thesis of organic & inorganic food-stuffs.

It was not denied, that for very many years, with only stable-dung and without any restitution of the food-stuffs car=ried off, ~~with~~ fine corn and root crops could be produced from the rich fields of the Oderbrüchen, or that at Rothamsted, high corn crops could be obtained by the simple addition of phosphoric acid or nitrogen, without supplying either potass or lime; but what I did say was this:— looking atten=tively on the British Islands, every man may see clearly what I mean respecting the practice of the British Farmers: every year they carry to the large towns in the produce of their fields, e=normous quantities of efficacious soil constituents, & these are all lost since they flow in the rivers to the sea which gives up nothing that it receives. The english farmer knows certainly that the produce of his fields will diminish if he does not make good these matters: that in England very many million pounds of cotton must be yearly spun, woven, bleached & printed, and very many razors and other steel and iron wares made, and much anxiety bestowed to ~~secure~~ their sale in all parts, in order to obtain money for the re-purchase of the deficient manurial matters, or for the buying of more corn: he would willingly expend millions of pounds sterling in order again to put his fields in a condition to furnish the great towns with as much meat and bread as formerly, and knows positively, that if he does not do this, England must lay out many millions of pounds sterling more ~~in~~ for the pur=chase of grain and cattle; Guano and Bone-meal are not bought by the english farmer from partiality but from the constraint of a natural law. From this follows, that in England, as elsewhere, the crops have risen when that has been restored to the fields which had been taken from them, and fallen, when no mineral food-stuffs (in guano, bone-meal, &c) have been added, thus, in proportion to the importation or exportation. And if all the fields in the whole of Great Britain were in the hand of one farmer, and the importation of manure constituents were in the hand of one Merchant, and the one knew the nature of his fields and their wants deficiencies, and the other knew exactly the composition of his manures, the farmer would say to the Merchant, I want for my fields in York=shire, Oxfordshire, Gloucestershire, Warwickshire, what is found in the Jura-formation, so much potass but no lime, bone-meal but no superphosphate, and little Ammonia;

for the Rothamsted fields, on the contrary, so much more Ammonia and superphosphate, also some lime, but no potass, and the merchant would then be in a position to give to each what it required.

But in this doctrine I did not say that I could not at all know, that all fields had an equal deficiency in potass, lime, phosphoric acid, &c, but, that when an Agricultural Chemist, for instance W. Lawes, asserted that "the fields contained an enormous excess of Potass, in 10 inches deep above 50. 000 lbs", a farmer in Oxfordshire or ~~any~~ in any other shire, must not be so silly as to believe that W. Lawes intended his field, for he could have no knowledge of the richness of any other field in a foodstuff, or of ~~the~~ its deficiencies.

In regard to my doctrine in relation to the contents of the atmosphere in Ammonia, which, as I asserted, may be sufficient for all fruits of the earth which the farmer wished to produce, if he only knows how to go about it in the right way, I said in my book, that the atmosphere in the whole (im Ganzen) offered enough for all vegetable growths, but within a given time not enough for some (einzelne): in the chapter upon the origin of nitrogen, I earnestly recommended the farmer to keep the Ammonia in his farm-yard-manure with the greatest attention & care, & to avoid every loss of it since the amount of the produce of many of his crops depended upon it, that an excess of Ammonia must be present, if the incombustible or ash-constituents in his manure shall have their full action. No foodstuff works by itself alone, all must be together in the right quantity and at the right time. Many cultivated plants, namely Summer vegetables, and generally those, which in a short period of vegetation to produce the maximum of plant-growth, required very much more nitrogenous food than during that period the air was able to convey to them, but that in his Fodder plants the Farmer had a means of collecting the nitrogenous food from the air and of accumulating it in his Farm-yard-dung, so that it lay quite within his power to give every year to the other, as much as was required. The art consisted in making the circulation perpetual. Figuratively expressed, the Farmer should act like the owner of a mill, who has only full work for his mill during a few months of the year, and who has a small brook which, indeed, always flows, but in Summer ~~does~~ has not water enough to enable him to grind as much as may be necessary to satisfy his customers; therefore, during the months when he wants little, he collects the water in a pond, and the store of water enables him to deliver the maximum of meal at the time when it is wanted. In a similar way, by a right Succession of crops, the farmer can collect in his Stable-manure the necessary excess of nitrogenous

food required for his straw crops.

Passing over the method of Wm. Lawes' argument, I come to the argument itself. By his theory of manuring he has es-=tablished that a mineral manure may contain no Ammonia: If any manure be a mineral manure, Ammonia composes none of its constituents. Now he showed by his experiments that the efficacy of my manure was very considerably increas-if Ammonia were added: "This is," said he, "the mechanical condition of form & quality upon which Liebig supposed the inefficacy of his manure might have been conditional; an organic manure must be present if the mineral manure shall act. More justly expressed and conformably to truth, he might have perhaps said that I had combined too little ammonia, had this been a dis-covery. But he gave to his ex-=periments a greater amplitude (Tragweite). Because of the augmenta-=tion of the ammonia in a field whose crops may have risen, it followed that my assertion was incorrect that the atmos-=phere is rich enough in nitro-genous food for corn plants, for were this true, the mineral manure without ammonia must have yielded the same increased crop as when Ammo-=nia was added. It is certain that the field loses nitrogen by the carrying off of corn from it; and his experiments have proved that the atmosphere does not restore it, it does not con-=tain & convey enough. In this way has he disposed of & contradicted my assertion.

The provision of ammonia, so Lawes expresses him-=self, is most especially important for practical husbandry; for the produce of a field stands more in proportion to the quantity of Ammonia provided, than to the quantity of ash-=constituents provided.

Because Wm. Lawes had made a series of other exper-=iments in which he had manured his plots of Lawes pieces of field (Stücke Feld) with mixtures of super-phosphate, Ammonia and other salts, combined according to his phantasy, and not with the by guidance of Chemical analysis in the choice and proportion of their con-=stituents, and because he had obtained as high, and even higher crops than with my wheat-manure, by the application of Ammonia salts, he comes to the following conclusion:- As the facts show that his (Lawes') mixtures, compounded without scientific principles, acted better, and gave higher crops than Lie-=big's mixtures, which were composed according to analysis of wheat ash and by scientific principles, it follows, that the practical man dare not allow himself to be led by chemical analysis or Science, but by Practice itself.

Wm. Lawes contradicts, in the following ingenious man-=

=ner, the third of my assertions that Ammonia is no especially im-
p.40? =portant manure, and has no action external to itself:- In the year
1844, he manured a plot of land, per acre, with super-phosphate of lime &
potass in such quantities that they were nearly equivalent to the efficacious
incombustible or fixed constituents of 1750 lbs of Guano, and after-
this, the same plot was manured in the next and the following years
with Ammonia-salts, that is with the efficacious volatile constituents
of Guano, thus with the total of Guano, but with the alteration, that he
gave its fixed constituents in the first year, and added the volatile
in the following years. Under these circumstances, a favourable
result of the manuring with Ammonia-salts was tolerably
sure, and indeed this same plot yielded for six successive years with
Ammonia-salts alone, an average yearly produce of 551 lbs of corn,
and 933 lbs of straw, the half more than an equal plot, unman-
=ured. In Germany, upon the surface of an english acre, with 1750
lbs of Guano, or its active constituents (superphosphate, potass, &
Ammonia-salts), we obtain eight corn crops and the same produce.
I do not know if Wm. Lawes was aware of the experiments made by
Schattenmann in France, in the year 1843, who obtained from ten
wheat fields manured with still larger quantities of ammonia
-salts alone, not one single pound of corn more, but in some
cases 558 to 608 lbs less corn, per acre, than from another plot
which had received no ammonia-salt. Any how, we see that Wm
Lawes had done all that was possible for him to do, to make the
facts fit to his conclusion. Nothing can be set against his evidence
that for many successive years, high increased produce may be
~~obtained~~ produced with Ammonia salts alone without the addition
of any other manure; for, in fact, for six successive years he obtain-
=ed largely increased crops by Ammonia-salts alone.

Just as if he were the best judge in these matters, Wm. Philip Pusey
did not fail, in a post-script to this treatise of Lawes' (vol X - II Part
Jour: Roy: Ag: Soc: 1851.) to set aside my doctrine in the following de-
=finitive manner:

"This important treatise "says he,"
" establishes what I said in the last
" number of this Journal, the entire
" failure of Liebig's Mineral Theory as
" a guide in the choice of manure
" in practical Agriculture."

My theory was accordingly knocked about and condemned
on all sides. Chemistry ceased to be the guide of the Agriculturists. But
a little more, and I, and my share in agriculture, which here, and there, was
accorded to me by a theoretical farmer, would be blown into the air, that
is, the ground would be taken from under my feet.

But it happily surmounted these trials, and I dare now say

that it is fresher and sounder than ever. When Lawes' treatise ap-
=peared in the year 1851, I did not then know where to look for the
reason of the small efficacy of my manure. If it lay in a deficien-
=cy of ammonia-salts, there was nothing more to do. One axiom of
my theory was then false, it was not possible to help the farmer.
Lawes' experiments showed that a provision of three hundred-weight
(centner) of ammonia salts per acre, is required, to raise the produce
of a field the half above that of an unmanured piece; with less he
did not, on the average, obtain this increase. According to statistical
receipts 25 to 30,000 tons of Muriate and Sulphate of Ammonia, or
600,000 cwts of both are annually manufactured in England,
France, Belgium, the German Confederate States, and Austria,
from Gas and animal refuse.

This quantity would not suffice for the Grand Duchy of Hesse,
if it were desired with the help of Ammonia salts to obtain from
an Hessian acre, a half crop more in corn and straw, than the
field would yield without this provision. If we reckon Prussia,
Austria, Bavaria, and the remaining German States, Great Britain,
France, Scandinavia, &c, perhaps the whole quantity of Ammonia
-salts manufactured in Europe, might be sufficient to give an-
=nually one pound to an acre!

The manufacture of gas for lighting cannot be arbitrarily
increased, just as the production of animal refuse, horn, hoofs, bones,
from which ammonia-salts are made, is confined within very nar-
=row limits; with the best will, therefore, the extension of the manufac-
=ture of ammonia-salts is not practicable. And if ten times as
much could be produced, it would be for the whole, but as a drop
in a bucket of water.

If nitro-gen really had the efficacy ascribed to it, it would
surely, be far more to the purpose to manure the field, instead of
with the Ammonia salts, with the animal refuse from which the
Ammonia is obtained; we should then have double the quantity
of nitro-gen at our disposal, since in the process of making ammo-
=nia salts, half of it either remains in the residue, or is lost.

But if Ammonia salts are substituted by the animal
products from which they are prepared, there is also still another
advantage which must be taken into consideration, namely this,
that these matters are always associated with incombustible food-
-stuffs, phosphoric acid, potass, and others, for which, then, no fur-
=ther care is necessary. If the richly nitro-genous, human wine and excre-
=ments ~~of cattle~~ are chosen, they are the best, as other requisite mat-
=ters are, therein, associated with the nitro-gen.

But if it is thought to supply Ammonia salts in the man-
=ures by the Animal matters from which they are prepared, the essence of this
doctrine is: that the farmer must endeavour to give to his land as much

animal manure as possible, as by that means he secures high crops. Certainly a very foolish doctrine. For plainly the deficiency we experience is in animal manures; we have not enough of it and we have not the power to increase it!

To say that, under these circumstances, ammonia-salts must be given, is like the opinion of the child, who, in a dearth of bread, asked his mother if the poor people could not have biscuits and cakes given to them, while bread was so rare and dear.

Consequently, two views in relation to the nitrogen stood opposed to each other:

Liebig says to the agriculturists, the production of more corn & more meat, which the increasing population expects from you, must excite you to ascertain how to obtain as good, and constantly improving crops, without purchasing Ammonia. Your progress depends upon your learning how to draw as much nitrogen as you want, from natural sources. Thousands of facts teach that this is possible.

Lawes says, the increased production of corn depends upon the purchase of as much ammonia salts as is possible, for there is no other method than this; the crops stand in relation to the provision of it.

It is true that Mr. Lawes' doctrine only related to the english fields, in his sense to agriculture as it is: "to apply to agriculture as generally practised in this country, that is to say, agriculture as it is" (Journal. Vol XVII. Part II. p. 452.) It is said, that in England, Oxen and Sheep have a quite different, and much better flesh, than in France or Germany; no other wheat can compare with the english wheat, and the english turnip-roots exceed in nutriment all other fodder growths, so think englishmen. An english Ox, indeed, may push as little as a german one, if he is gripped by his horns, but nevertheless, english fields may have a nature peculiar to themselves; this may be assumed as certain, that Liebig's theory is of no value for England; the proof of its falseness has been brought by Mr. Lawes. Similar to these are the logical conclusions to which Mr. Pusey, the head (Spitze) of the Royal Agricultural Society, arrived, and it cannot be wondered at, that, with such opposition, all my endeavours to raise my voice in explanation, in the organ of the society, were unsuccessful, and that my importunities were indignantly refused.

As must be seen, the core of the most important questions for Agriculture, had nothing in the least to do with my manure, in none of my books is there a word about it; my proposition was the first experiment in the manufacture of an artificial manure, this it is vain to attack it, first, the principles on which it was compounded, must be submitted to an exact examination, were they recognised as correct, the inefficacy of my manure

could be due, not to the incorrectness of my doctrine, but to un-
=skilful preparation.

As already often mentioned, ammonia was a constituent
of all my manures, but the quantity added was small, it was limi-
=ted ~~in an~~ from economical considerations.

The farmer estimates the number of gold-pieces which he
gives for a hundred weight of manure, according to the profit
which the investment brings; the price of the manure must stand
in exact proportion to the profits; the higher revenue gained,
must cover the expenses and leave a certain profit over. If,
by every pound of ammonia purchased in manure, five pounds
of flesh-constituents can be secured in the increased crop, the eco-
=nomical question is, whether the receipts for the sale of the 5 lbs of
flesh constituents, cover the expense of the pound of manure, in the
above mentioned way, or not; if this be the case, the question is ans-
=wered to the benefit of practice, if it be not, it is, and remains alway,
an interesting scientific fact, but one which, naturally, can have
no influence upon the ~~pa~~ management of the practical man, who
wishes to produce not merely food for other men, but also, bread &
meat for himself and his family. If he must give away again
his corn and meat, in order to get back into his hands the
means for their reproduction, naturally, nothing of what he pro-
=duced, remains over for himself and his family.

Wm. Lawes, in his experiments, had furnished, with a mar-
=vellous and almost incomprehensible candour, all the elements
for placing in the clearest light this all important point of view
in the manure question, and it is scarcely possible to find stronger
or more decisive proofs of my, many years previously given, view
of the inapplicability of Ammonia-salts in practical husbandry, than
are the facts, which he himself describes. They may be comprised
in a few words.

All his experiments taken together, showed, that two lbs
of wheat corn in increase, are reaped, with half a pound of Muriate
(salmiak) and half a pound of sulphate of Ammonia. That
is to say, as Mr. Maron expresses himself, in his report upon the
Japanese agriculture, that, of 30 gros-chen which is given to the land,
20 gros-chen are received back, or eight pence from a shilling;
this was self-evidently, only the case at a time when there was no
particular demand for Ammonia-salts by agriculturists.

On this Mr. Lawes expresses himself in the following way:

" I am disposed to believe, that for
" practical purposes, we can assume
" 5 lbs of Ammonia as necessary
" for the production of each bushel
" (60 to 63 lbs) of wheat-grain, in which
" (is) one pound of Nitrogen "

(Jour: vol VIII. I. p. 246.); further on he says, page 482:—

"We may remark, in passing,
"that under all, even the best condi-
"-tions, Ammonia has given to us
"no increase which is equal to that
"of our estimate."

I quote here his own words, because I could not venture to give them from memory.

If the practical man will take the trouble to reflect a little upon this result of Lawes' experiments, and also to look about him, even were there in nature a mine from which Ammonia-salts could be brought from the earth, perhaps like pit coal, but in a larger quantity still than pit coal, he will surely come to the opinion, that it is impossible for the recommendation of these salts, as the chief means for the augmentation of corn produce, to come from a man who does not trade with Ammonia-salts, or who has no particular passion for these salts.

If the practical man, with good faith in the action of Am-monia, were to suggest, that W. Lawes, had could, perhaps, erred in one point when he found that, from 5 lbs of Ammonia, only 1 lb of Nitrogen was recovered in the increase, this does not show that the rest of the nitrogen in the other 4 lbs of Ammonia may have become inoperative for future increased crops. What he may have less in the harvest of the first year, may be given to him in the future!? Las-ciate ogni speranza, but says W. Lawes (Jour: XVI. p. 475) what you once have given is gone for ever; you must each year again buy ammonia-salts: it is impossible to enrich a field in Ammonia for future crops. The fact is, after he had given so much Ammonia to his field for 6 successive years, that a residue of 1520 lbs, sufficient for 21 equally high increased crops, was accumulated in the field, this accumulation proved itself to be quite ineffective for the succeeding crops, the three cwts (centner) must always again be provided in order to obtain a produce equal to the preceding!

If now the practical man, in his thirst for Knowledge, fur-ther asks W. Lawes, what will become of the enormous quantity of Ammonia, which, by degrees, the english farmer must bury in his soil, he has an explanation ready to his hand; he answers him nearly in the following manner: "Ammonia may have a peculiar
"propensity to circulate in the air, but the acids in the ammonia-
"-salts do not permit this. On this account, the Creator of all things
"has endowed english plants with an arrangement to overcome
"the resistance of these acids; how this happens, we do not indeed
"know, but it is a fact that the roots of plants act as small pumps.
"This power, comprehended in its just significance, may make clear,

"that the ammonia, having from the soil arrived at the plant body,
"awaits a suitable appropriation, and that that portion for which
"the right place is not found, escapes through the leaves into the
"atmosphere; from 5 lbs of nitrogen 4 lbs." This view, consequently,
gave to the english straw plants, the remarkable function of fur-
=nishing to the wild plants which do not gladden themselves with
the care of mankind, and which depend on the ocean of air for their
maintenance, with the nitrogenous food which is indispensable
to themselves, so that thus, the law of nature in its care for all,
obliges man if he will have bread, to enrich the atmosphere
with Ammonia, and thereby to secure the increase of creatures
growing apparently at random, and lawless! For the pound
of corn which his field gives to him, he shall give to the air, & by
this to the wild growing plants, the means of producing in their
structures ~~about~~ 4 lbs of corn value!

We had believed since then that the same law existed for the main-
=tenance and continuation of wild growing (and) cultivated plants,
and that the manuring of a cultivated field was only necessary
to enable plants to grow again upon the same spot, but Mr.
Lawes, the first english authority, has, in his treatise upon the
cultivation of Clover, informed us of a better. He had a field
which bore no more clover, nor could it be persuaded to bear
clover again, to be restored from the sickness which by believed, had befallen it,
by any manuring, with all his experience of ef-
=ficacious matters. If he, according to the rules of natural-
philosophy, had first asked the clover plant, why it so obstinately
disdained the soil, which he had so well fed with all which at
other times suited it, with superphosphate, Potass, Ammonia,
Lime, &c, it would have probably answered him in the following
manner: "Friend" she would have said to him, "if thou hadst known
"a little about me and my requirements, thou wouldst have known,
"that that which thy straw plants above stand in need of, is neces-
"=sary to me underneath, possibly in wise fore-thought for others
"of my species, nature has ordained that I should so deep to suk for my
"food, and has, therefore, furnished me with entirely different
"roots. I proved to thee when I was younger, that I was thank-
"=ful for thy kindness, but when my roots had broken through
"the weak layer of soil which thou hadst so richly supplied with
"food for the barley, and came into the deeper layers, in order
"to prolong their existence, they there met with as little food as
"here-to-fore; I was not sick, nor was the innocent soil poisoned,
"there remained nothing more for me, than, with resignation, to
"die of famine; thy countrymen, Thompson and Way, had, indeed,
"said to thee, that all the foodstuffs which thou gavest, could not pene-
"=trate deep enough, when they brought thy plough, and looked at
"my roots, to see if it were deep enough & were of use to me. Thou art

"indeed, a practical man, in whom much must be excused,
"but respecting me, because thou dost not understand my nature, to
"degrade it to the base mushroom, which lives on more complex mat-
"-ters, as it were to a flesh-~~eater~~ feeder among plants, this is a scarcely par-
"-donable defamation. Thou holdest me ever as a dung pro-ducer,
"and if I must consume dung (complex combinations) in order
"to produce it, what advantage hast thou then?"

It may readily be believed that the fight against ~~with~~ such views, was well adapted to extinguish all hopes of a possible reparation or of future success, but I thought myself like a soldier, who struggles for a good cause, and will give it his last drop of blood, and who gets the victory not only by his valour and good weapons, but also by enduring hunger and thirst and all the hardships of a campaign, and knowing how to force his way through morasses and bogs, - and so I received the opposition which my doctrine met with, as of the nature of those hindrances which must be overcome by steadiness & perseverance.

The difficulty which I had to contend with from the Royal Ag: Society in England, was, indeed, insurmountable, but there were still other methods, and I endeavoured to facilitate a better under-
-standing of my doctrine, by my "Principles of Agricultural Chemistry" published in the year 1855. I set forth, that my doctrine sprung from experience itself, and that nothing was invented in it, and that ~~each~~ every experiment without any exception, which Mr. Lawes made, was confirmed & not ~~contradicted~~ reputed by it, I have certainly never given a receipt for producing corn and roots at Rothamsted, and, therefore, how impossible it is to maintain that I have fallen into an error; Mr. Lawes may certainly never have troubled himself about my doctrine, but gone his own and not my way, ~~what then~~ which nevertheless he must ~~to~~ have done, in order to see what I saw, and to arrive at the conclusions to which I arrived; he certainly may have the clearest things twisted into an inextricable skein of his misunderstanding, and they be made, thereby, unclear & incomprehensible; I ~~never~~ do not at all deny - that Ammonia may be useful and necessary for straw crops, and have never done it, ammonia is certainly an inorganic and not an organic manure, I may have, certainly, taught that the organic nitrogenous constituents of farm-yard-manure may be supplied by ammonia or am-
-monia-salts, and all his results, of which he is so proud, depen-
-ded upon that which had advised. I may not be an opponent of Ammonia, who denies its action, but an opponent of his opin-
-ion, which gives a rank and importance to this foodstuff, which for practical agriculture, it could never, and at no time, have, and maintain. I do not dispute the correctness of his facts, but the truth of his conclusions, which must bring injury to the farmer who builds upon them. But one only need to look round and ask, if, anywhere in Europe, a farmer who has once made

the experiment of manuring his fields with Ammonia salts has continued to do so. Nowhere, and in no place, had ammonia salts, ~~has~~ applied as manure in his method, by farmers who must, nevertheless, know well what is useful or injurious to them, been approved, and this is after all the best evidence of how little the farmer can rely upon their efficacy.

His entire comprehension of agriculture, proves that Mr. Lawes can have no correct idea of all the conditions for obtaining higher crops, as well as of the causes of the fruitfulness of the soil, and of the action of manure.

If it were once admitted as an established and incontestible truth, that carbonic acid, water, ammonia, phosphoric acid, potass, lime, magnesia, &c, were the food-stuffs of plants, this were for ever and every where true, and it would then be quite impossible, by any facts, to bring proof that their ability to serve as nourishment of plants, failed in any soil.

If potass and superphosphate of lime, applied to a field, does not increase its produce, this is no argument that both are inefficaceous.

And if Ammonia-salts, or Ammonia, or the nitrates augement the crops in a field, this proves nothing for their efficacy.

For the capability of action, or efficacy of all these matters, may be certain and established, and a denial of it quite inadmissible.

If, then, a manure known as efficaceous for plant growth, increase, or do not increase, these facts show nothing further than a certain condition, or a determinate nature of the field.

If the ammonia increase the produce of the soil, it shows that in the soil, a certain number of substances, in a certain proportion, were present, which would become active when the ammonia salt reached them; and if potass or superphosphate do not raise the produce of a field, this shows that certain other substances have failed in the soil, which must be there if an increased produce corresponding to the increase of the potass and superphosphate is to be obtained.

The produce of fields in practical management may be dependent upon, or stand in relation to, two factors, of which the soil is the principal factor, the manure, on the other hand only the supplementary factor. The soil, and that which may be in it, conditions (?) the crops, the manure merely secures that the following crops shall be as good as the previous ones. Now, as the fields in all lands and regions of the earth, may possess unlike qualities, that is, may contain, unequal

proportions and quantities of plant foods, and as the operation of the manure, is dependent upon the co-operation of the food-stuff in the soil fit for its reception, it follows, that one and the same manure applied in equal quantities upon a hundred thousand different fields, would produce a hundred thousand different crops. The difference in the crop producing power of the fields, is everywhere so known and acknowledged, that in those countries in which the State imposes a land-tax, it is estimated according to the goodness of the soil, in some countries there are sixteen gradations.

The experiences of husbandry in all countries, show, that the increase of crop obtained by equal quantities of the universal manure, Farm-yard Dung, is everywhere unequal, that equal quantities of bone-meal, guano, rape-cake, or ammonia-salts, produce everywhere, and in all places, a different result, & that neither Science, nor the most comprehensive experience of Practice, grants to a man the power of prognosticating the action of Super-phosphate, or any other manure, upon land to which he is a stranger, that consequently no special prescriptions generally exist for the manuring of a field or increasing its crop-producing power, and no mans be he who he may, can reasonably assume the power of concluding, from the effect which a given manure may have produced upon his field, that the same manure will produce the same effect upon any other field, with which he is not acquainted. Now, since the manure experiments made at Rothamsted, do not reach to those questions, whose solution would be useful for agricultural management in all countries, and for all land, what are reported in the language of Science, since Lawes does not occupy himself with the investigation of the laws and principles of agriculture, but solely endeavours to find out a manure suitable for a few fields in Rothamsted, in order upon these to increase the corn and root crops, and the facts observed by him can have for these, and for no other fields an equal significance, it follows that his experiments, however numerous they may be, do not possess the slightest value for practical agriculture in the whole. (im Ganzen)

What he observed upon the favourable effect of nitrogenous manures, and of Phosphate upon the english fields exhausted of these foodstuffs, was known long before him, has been established by innumerable facts, and foretold by Science, and nothing is more certain, than that no advantage has accrued to practical husbandry, by his endeavours and experiments. It was known long before him, that nitrogenous manure was frequently useful for straw crops, and long before him superphosphate of lime had been employed with profit for roots, and in fine, he has only in-

=creased the great mass of long known facts.

But it is not in facts that there is a want, but in the understanding of them, and about that he has not troubled himself, and if, for his private pleasure, he wished to test the action of various manures, he ought to have made choice of an entirely different field. How can it be possible to expect a marked effect from a manuring with Potass-salts, as he expected, on a field so quite exceptionably rich in Potass, that he, as he states, could obtain from it, for eight consecutive years, without interruption, by manuring with <u>Superphosphate of Lime alone</u> an average, per acre, of 764 cwts of roots? efficacy

The utility of superphosphate of lime (not its activity) which it always had) may be proved by <u>one</u> high root crop just as well as by <u>ten</u> successive ones, for if this manure give in the second year a less root crop, and in the third year none at all, this proves nothing against its efficacy, for the reason cannot then lie in the manure, since it had had so good an effect in the first year, but must be sought in the soil, and so by the eight successive root crops which he obtained, <u>Wm. Lawes</u> has not brought to light the astonishing utility of superphos=phate of lime, as simple (silly) ~~as~~ Farmers perhaps might believe, but, by these experiments he has proved the astonishing richness of his land in Potass; that the superphosphate of lime might have been without any effect if the soil had not been able to supply the Potass and the other elements necessary for the formation of the root, is quite self-evident, and no one can rationally believe, that from <u>all</u> fields without dis=tinction, eight successive root crops can be expected with superphosphate <u>alone</u>. But if this is not the case, if then the fact which <u>Lawes</u> has observed is only true for his fields, and incorrect, or not existing, for all others, what use then can such experiments have for practical Farming? Since, in the roots and leaves of eight root-crops, quite as much potass is taken away from the soil as in forty corn crops, his experi=ment with roots shows that his fields were rich enough in Potass to provide at least forty corn crops with Potass, and we can understand that upon such a field the manuring with potass-salts will remain without any action effect upon the following corn-crop, because it contained already very much more of it than was requisite for <u>one</u> crop.

To draw a conclusion respecting other fields, as this <u>Wm. Lawes</u> has done, from the fact that potass-salts had no effect upon the fields at Rothamsted, and that they required no supply of Potass for an entire series of years, and to assert that <u>all</u> english fields need <u>only</u> phosphoric acid & nitro-gen, in order to be fertile for corn and roots — is perfectly unallowable.

What quite other results would Mr. Lawes have had, if he had correctly understood the true sense of my doctrine, and had actually had the intention to submit it to a fair trial. I had said in my "Address" that the fixed quantity of manure for a field may be so calculated, that therewith may be restored to the field that which it had lost in the previous crop; were this potatoes or corn, then must be given potato or corn manure. After a four years rotation of Potatoes, Corn, Clover & corn, before the commencement of a new Course, that should be returned to the field which has been taken from it in these four crops. Should it be wished to begin again with corn, the field must be manured with potato and clover manure and with a double quantity of corn manure, just as is acted upon in the usual method, in which the field is manured with Farm yard dung, in quantity sufficient for the whole following rotation.

Now, how did Mr. Lawes proceed in the comparative trial of my manure? He reduced his field, by a series of previous crops, to the utmost degree of exhaustion (the field selected for the purpose had been reduced to the lowest state of fertility, vol VIII. p. 7.) and after this was accomplished, he manured it with 4 cwts of my wheat manure, calculated for the compensation of the constituents taken away by one corn crop only; to another Plot he gave 2 cwts of bone ash decomposed with 2 cwts of sulphuric acid, to a third he added to these matters 2 cwts of ammonia salts, a fourth he manured with 14 tons of Farm yard dung, and then compared the crops with one another, which for my wheat manure would naturally be unfavourable enough, for he had given to his second and third Plots about four times as much Phosphoric acid, and twenty times as much ammonia salts as my manure had contained, and it was, therefore, not to be wondered at if my manure did not equal his in its effect.

Such a procedure can be explained in two ways: Mr. Lawes either did not understand my advice, or he had from the beginning intended to find my manure as bad as possible; both suppositions prove the assertion that he has acted crookedly (ungenau) and without conscience. But if a man makes inexact and unconscientious experiments for the refutation of the views of another, he will not hesitate in arguing for the truth of his own, likewise to interpret his own experiments inexactly and without conscientiousness. As a red thread, indeed, this runs through all his experiments.

In the year 1843 he manured a plot with 2½ cwts of

superphosphate of lime, and 2 cwts of rape-meal, another with 15 bushels of clay and ashes of weed, and he harvested from the first plot 11 tons 7 cwts 3 lbs, from the other 11 tons 1 cwt 3 lbs of roots; from the plot which had received superphos-phate he thus harvested scarcely more than from the second, which had been manured only with clay and ashes. In the year 1844 he manured a plot with 400 lbs of bone earth, 258 lbs of sulphuric acid and 134 lbs of common salt, another equally large with the same quantity of bone earth, but transformed into superphosphate with hydrochloric acid instead of with sulphuric acid; from the first he gathered 14 tons 10 cwts of turnip roots & 6 tons 11 cwts of leaves; from the other, on the contrary, × 9 cwts of roots and 4 tons 6 cwts of leaves, consequently, 5 tons of roots and 2 tons 5 cwts of leaves less. What is now the reason of the equal crop in the one case, and the so unequal in the other? In the one experiment the manure was unequal and the crop equal, in the other the quantity of effective phosphoric acid was equal, and the harvest as unequal as possible. These questions did not occupy Mr. Lawes. Let him shuffle the cards as he would, Ammonia always laid close to corn and superphosphate of lime close to turnips, the other constituents, or what besides might have acted, was of no consequence to the crop.

It is not impossible that there may be still one other field in England, like the plot at Rothamsted, from which Mr. Lawes has gathered without any manuring, twelve years in succession, without interruption, a mean crop of 2856 lbs of wheat, corn and straw, in the 12th year 400 lbs more than in the first, or a second, from which can be obtained with superphosphate alone eight consecutive mean crops of 168 cwts of roots, but since I have learned from his treatise upon the growth of Clover (Vol 21. P.I.. page 192.) that he has a Sower who compounds the seed to be sown with another, that the manuring, reaping and weighing, of his crops, obviously or notoriously takes place without a strict and scrupulous control, it will be considered justifiable if I attach no value to the facts in general stated by him, by which I do not mean that he has intentionally spoken untruth.

My "Principles of Agricultural Chemistry" conclude with the following words:

1. Mr. Lawes has proved that his fields contained an excess of the mineral constituents, which seven crops of wheat, corn &

× Must be a mistake. I have copied the original (Einleitung. p. 58. near the bottom) M.G.

straw, require in seven years for their perfect development.

2. Mr. Lawes has proved as theory and sound common sense presuppose: that the crop of such a field can not noticeably, ~~be increased~~ or at best, in relation to the whole sum of soil constituents contained in the soil, be increased by manuring with the same mineral substances.

3. Mr. Lawes has proved, what Theory teaches: that the crop of such a field may be raised by manuring with Ammonia salts.

4. Mr. Lawes has refuted what he would have proved: that the increased crop, in this case, stood in relation to the Ammonia contained in the soil, that thus the single, double, and manifold quantity of Ammonia gave, not the single, double, manifold increase of produce, but that the increased produce is a constant quantity.

5. Mr. Lawes has proved what he would have refuted: that the whole produce stands in relation to the single constant quantity, which acted in his experiments, namely, to the Sum of the existing mineral food made operative; he has proved, what Theory teaches, that in a given time, Ammonia promotes the action of the soil constituents, that is, that a greater quantity of soil constituents enter into activity / become efficaceous.

I had in my "Principles" most emphatically directed attention to the fact, that his (Mr. Lawes') experiments contained in themselves the evidence, that the organic manure (farm-yard dung) might be supplied in its entire operation by mineral substances, for sulphate of Ammonia and Salmiac are mineral substances.

If my remarks in the Chemical Letters against Mr. Lawes' conclusions on my Theory fared badly enough, my new work pushed the bottom out of Mr. Lawes' well filled vessel of wrath; I will not enter more closely into his reply made made with art and skill, as the essence of it can be given in a few words. He brings in it evidence, namely, that I, who have for 30 years in my Lectures spoken of Ammonia as an inorganic or mineral substance, shared his erroneous view, and have considered it as an organic substance, & that I in a deceitful way wish to assume the merit of his experiments by which he has shown that Ammonia is the angle point of Agriculture and the special manure for English Corn fields.

"Thus then (Journal Vol XVI p. 447)
"Ammonia salts, Sulphate of Am-
"monia and Salmiac are to be

" classed now with mineral
" manures! This is indeed begging
" the whole question. But an ar-
" =tifice so transparent would
" be scarcely worthy of mention
" were it only addressed to the
" scientific reader!" So also
later (page 448) he says: "The
" case has not been entirely
" without success."

With this I have arrived at the solstitial point of the dispute, and do not consider it necessary to add a word further. Ammonia is, as Carbonic acid and water, an inorganic compound, and belongs, as its salts, to the Mineral manures. Chemistry alone determines in which class a chemical combination must be reckoned; there is no other definition than that of Science.

If Farmers are sufficiently intelligent to extract the right lesson from this dispute, it has been of advantage to agriculture. The entire dispute receives a comical aspect when it is considered that it is carried on against me by a man who had never taken a chemical compendium (Lehrbuch) into his hands in his life, and to whom practical agriculture, as it is, was a perfectly unknown territory. Mr. Lawes, a manure manufacturer, possessed, like every one else, full power to try the efficacy of my manure upon his fields, this might be useful to him or to others, but with my open and unreserved declaration of the non-applicability of my manure for practical farming, the dispute had become objectless for him. What he wished to obtain, was obtained, he should have been satisfied. But he went much farther ~~than he was entitled to do~~ beyond his right. Ignorant, without any knowledge in the province of chemistry and of agriculture, he believed that he, with the facts which spoke against the applicability of my manure, had refuted the correctness of the Principles of agriculture which were established by the most indubitable experiences and facts, and the natural course was, that after pulling up by the roots a scientific principle, he set his own in its place, giving it out for practical experience; but he did not know what ~~practical~~ experience is.

According to their nature, correct ideas must tend in their development (that is to say if we have learned to make a right use of them) to the advancement and improvement of practical management, and so the end to which

false and erroneous ideas lead, is, conformably to their nature, only to an error or something absurd.

Now, to what ends (zielen) have the ideas, and the principle-less (grunds-atzlos) experiments made by W. Lawes conducted?

One was that scientific principles have no application to husbandry, and that the prosperity of agriculture depends upon the accidental fancies of manure manufacturers, and that the profitableness of management is bound up in their manure recipes.

The other was a fundamental law for corn husbandry, which announced that the enhancing of corn crops was dependent on manuring with a manure which no Farmer could purchase, so soon as many wished to buy it.

The third, that in order to transform a pound of nitrogen upon a field into corn and meat, five pounds of nitrogen must be buried in the soil; that the excess of nitrogen which must be given, does not enrich the land but the air, and that this enrichment is of use for wild plants, but not for cultivated plants.

If the Farmer does not understand that this doctrine contradicts sound common sense and his own experience, certainly nothing can help him; nothing can help him if he attaches more weight to the opinions of others, than to what his own perceptions say to him, if he will only use his senses; if he believes that useful results, and unchangeable truths can be attained by an empirical method, through the accumulation of variable facts, which are not brought into combination ~~which~~ with each other, and which do not refer to all soils and all management.

Guano belongs to the nitro-genous and most richly ammoniacal manures, it has been in use for twenty years upon many thousands of fields, and I believe I am able to affirm, that very many farmers who, in the beginning considered this manure as a panacea for their corn fields, have altered their good opinion, and, with the same injustice, hold it in as small esteem now, as they formerly valued it, because they did not consider that any special manure must exhaust the land and occasion a deficiency in it, the reason of which they were not able to trace to its real cause.

With regard to superphosphate for roots, it is surely a very useful, and in many cases, necessary manure for roots, but, in order to understand its true value, we must ask the german and french Wot-sugar manufacturers, who possess infinitely more, and more careful experience in

root culture than all british turnip growers taken together, experience which is the more sure and reliable, because it depends on annual analyses made in every manufac= =tory with hundreds of thousands of cwts, for the presenta= =tion of the sugar depends upon a separation of the root Constituents, of which one, namely the sugar, is each time weighed. The root sugar manufacturers only very spar= =ingly employ superphosphate in their root cultivation, and if the high crops of the english fields ~~are pointed at~~ which are produced by superphosphate, are referred to, they will each reply that superphosphate has been most injurious to him for the english crops are show (or sham) crops (Schein= =ernten) whose size could only delude children. The enor= =mous root stems chiefly yield only water, and cellular or woody substance, little sugar, and the blood and flesh= =forming matters stand in proportion to the sugar, that is, they increase with the sugar, as is very decidedly ~~observed~~ perceived in the defecation of the juice.

In this respect turnip roots behave in the same way as the sugar roots, with the difference, that in the first, instead of sugar, other, so called Carbo-hydrates are present, and that it is far easier to be deceived respecting the quality and nutritiveness of turnip roots than of sugar roots, because the quantity of sugar is very much more reliably & easily deter= =minable than that of the tasteless carbo-hydrates.

The most offensive thing in the dispute, which not I but Mr. Lawes began, was undoubtedly, that the most influential organ of Agriculture in England, made for its own the views and assertions of Mr. Lawes, and, what is without example in the Journal of the Royal Agricul: Society, without any reason and object, stepped out as Judge, and decided who was right or wrong, and deprived me of the possibility, by an explana= =tion of my views which I alone could best interpret, of placing the questions in dispute on a better footing. This was not only an un-called-for usurpation, but a direct sin against a good thing. What could it matter to me, if I had not had far higher objects, how the english farmers cultivated their land, and what they thought of my views! ~~For~~ To my position and my vocation nothing could have been more indifferent, for if the farmers had held my doctrine as true, to me, per= =sonally this would have been of no service, and in the opposite case I lost nothing.

The language and the tone which Mr. Lawes permits himself to use towards me, as well as the whole stand-point which he assumes towards me in his last Treatise, is so

entirely improper & unbecoming (or indecent), that the present editor of the Journal, Mr. Thompson, felt that it was necessary to exculpate himself ~~respecting his reasons~~ for permitting it; and what are his grounds of justification? "Because" "I in my Principles had said, that it required all the cour-" "-age which the want of correct acquaintance with the" "subject inspired, in order to maintain that Ammonia" "was ~~surely quite~~ especially suitable for corn, and Phos-" "-phorus for turnips;" further "that Mr. Lawes has proved" "the exact contrary of that which he wished to prove"; farther in reference to Lawes' experiments "that they are the most" "indubitable evidence in favour of the theory which they should" "refute." — "How could it be doubted that after such attacks (he ought to have apologised for I did not attack Mr. Lawes)" "from such a man, Mr. Lawes was imperatively called" "upon to defend his views in this Journal?" Thus does Mr. Thompson excuse himself (Vol. XVI. P. II. p. 501.). Farther, he said above: "It is a fact, that the scientific confession" "of faith of the british farmer of our time, begins and" "ends with the two axioms, that nitrogen is the chief fac-" "-tor in a manure for corn, and Phosphorous in one for" "turnips."

What a childish confession of faith is this, in which the pith of the solution of two of the most important ques-tions affecting the welfare of whole populations, is put in a pres-cription of two lines, and what does Mr. Thompson receive as an axiom, if he believes that a few worthless facts, which have been observed on quite a small bit of land at Rothamsted are axioms? The dis-couragement in this is that these utterances do not come from an ignor-ant farmer, who can neither read nor write, but from one of the most intelligent men of Great Britain, who can even claim the merit of having been the first who has observed the power of absorption of Ammonia of field soil.

An incident of adventure which my theory met with, is characteristic enough to be mentioned here.

In a sitting of the Chemical Section of the Natural Philosophy Association at Glasgow (British Association) the following surprise fell to my lot. Dr. Gilbert the Chemical co-adjutor of Mr. Lawes (chemische Beistand) presented a treatise, wherein he, by a series of figure results whose value or correctness, ~~do~~ in a spoken discourse can readily be supposed, could not be judged of, brought evidence,
" that my doctrine of the Sta-
"-tics of Agriculture is incorrect,

"and refuted by the experi-
"-ments of Mr. Lawes & himself.
further" that I have not at
" all been acquainted with
" Ammonia and its effects
" on the land, as is clearly
" evident from the chapter
" on Fallow in my book,
" where not a word is said
" of Ammonia and where
" I, nevertheless, must have
" spoken of it, had I known
" what the Atmosphere and
" the rain conveyed to the
" Land in fallow.

Mr. Lawes mentioned this attack of Dr. Gilbert in the Journal of the Ag: Soc: of England (Vol XVI. p. 477.) in the following manner:
"During the last Meeting of the British Asso-
"-ciation for the Advancement
"of Science, in Glasgow, he
"(Liebig) undertook to treat
"these questions". He adds
further p. 488:— "in the chap-
"-ter in his book which is en-
"-tirely devoted to the useful
" effects of Fallow and the
" mechanical operations, he
" does not say a single word
" in relation to the accumu-
"-lation of atmospheric
" food (nitrogen) in the soil"

But I had devoted a whole chapter in my book to Ammonia, and if I did not speak of Ammonia in that upon Fallow, it was because I cherished the certainly very singular view that a fallow field is a field like any other, and that every field behaves towards air and rain like a Fallow Field, and a Fallow Field exactly like another upon which roots, corn, or potatoes are growing. I had stated separately, that the air and rain conveyed carbonic acid and nitrogenous food yearly to every field without distinction, quite indifferently, whether plants grew upon it or not, and naturally it could not enter my mind, that a

sensible man could believe that a Fallow Field receives more than another, because it is a Fallow Field.

As previously mentioned, I had even, fourteen years before, had the nitrogenous contents of twenty two different kinds of soil determined by Dr. Kroker in my Laboratory at Giessen, & knew by these analyses, which were unknown to Mr. Lawes, although they were printed in the appendix of my book in the edition of 1846 (page 368 of the german, page 275 of the english edition) that, in general, fruitful soils at ten inches deep, contains from five hundred to a thousand times more nitrogen, that is required by a full wheat crop, and than the soil receives by the richest manuring.

We now know, with similar determination, that during fallow, in consequence of the formation of nitrates which the rain carries down, the nitrogen contents of most soils rather lessens than increases.

All these things, and what besides may have been calculated from them, did not surprise me, for if, by reason and experience, the full conviction of the truth of a thing is carried to ones mind, contradiction, how violent so ever it may be, is but an arrow without a point; only when one is not sure of a thing, if one feels that contradiction makes its way (einschneidet) because it is true & we are in error, then, in the mildest form, it produces a sensitive wound, and a man is reduced to the moulting condition (see page 26 in the german, p. 16. translation) and if the old feathers pierce too deep into the skin the plucking out is painful; if a man can grow no new feathers, he prefers to keep the old ones, but then they behave like a bad tooth, which always gives the old pain on the least occasion.

What was a truly constant and never lessening trouble to me, was the circumstance that I could not understand why my manure acted so slowly; I saw everywhere, in thousands of cases, that each of its constituents acted, each alone, but when they were united, as in my manure, they did not act.

At length, three years ago, after I had submitted all the facts, step by step to a new and careful trial, I discovered the reason! I had sinned against the Wisdom of the Creator and therefore received my just punishment. I would have improved His work, and in my blindness I believed, that in the wonderful chain of laws, which (a link was forgotten) the life on the surface of the earth, which I, the weak, helpless worm, must supply. But it was provided for, and truly in such a wonderful manner, that the idea of the possibility of the existence of such a law had not, upto that time, been accessible to human intelligence. So many

facts spoke for it, but the facts which utter the truth be-
=come mute, or man hears not what they say, when they are overstepped by error.
It was thus with me. I imagined that the alkalies must be made insoluble, because, otherwise, the rain would carry them away! I did not at that time know that the soil held them fast when their solution came in contact with it, according to the law to which I was conducted by my investigations upon field soil. The law was this: "Organic life developes, "under the influence of the Sun, on the external crust of the "Earth, and the Great Architect has endowed the particles of this "crust with the power to draw to themselves, and to retain fast, "all the elements which serve for the food of plants, and therewith "also, of Animals, as the Magnet attracts & holds iron filings, so "that no particle is lost. In this Law the Creator included a "second, by which the plant-bearing earth becomes a monster "(an enormous) purifying apparatus for water, from which it "removes, by the same power, all matters injurious to the health "of men and animals, all products of the putrefaction and de-
"=composition of perished generations of plants and animals."

In my manure I had deprived the alkalies of their solu-
=bility, and as the soluble phosphates were, by a vivifying pro-
=cess, embedded in the substance used, I had also hindered their distribution in the soil, and so done all to weaken their effect on the land.

So, after so many years, I now first perceived why, in the experiments of Lawes and so many others, the individual elements of my manure brought on the land had been opera-
=tive, and why my art had made them inefficacious.*

What may excuse me is the circumstance, that the Man is the Child of his time, and that he is only able to ex-
=tricate himself from considering as true currently prevail-
=ing views, when a violent pressure compels him to summon all his strength, in order to free himself from the bonds of error. The opinion, that plants took up their nourishment from a
P. 71. solution formed in the soil by means of rain-water was the opinion of every body, to me it was a matter of con-
=viction (? ins Fleisch gewachsen). This opinion was false, and had been the source of my theoretical proceeding.

After I knew the reason why my manure had not acted, I was like a man who had received a new life, for with this were also explained all the occurrences of agricul-
=ture, and now after the law is recognised, and lies clearly

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* See my "Investigations upon some Properties of Field Soil. Annal. d. Chemie und Pharmacie. Vol. 105. P. 109.

plainly before the eyes of all, the wonder only remains, that it was not recognised long before; but the human spirit is a curious thing; what has not passed through the compass of Thought, does not exist for it. The facts observed ten years before, by Thompson and Way, swam about homeless in Science, everyone knew that they were there, as everyone knows that Atoms are in the air, which can only be seen when they are irradiated by the light of the Sun; and thus the scientific facts first received their true existence, when they, illuminated by the light of the Spirit, have become its possession.

I had put down in my book as the foundation of practical management, the fact, that the air and the rain conveyed yearly more nitrogenous food to plants and to the soil, than the plants required for their fullest development, for that according to this the succession of crops, and all the business of the Farmer must be directed if he would cultivate his land with the greatest attainable profit.

The fact was, in itself scientifically, incontestible, and corroborated by all subsequent investigations, but at the moment it was quite enigmatical and inexplicable, as it was known by determination, that the products of putrefaction, to which Ammonia belonged, were firmly retained by field soil, and not given up by evaporation. No other source of Ammonia than putrefaction (fäulniss) was known; no experience or facts indicated that the nitrogen of the air was able to assume the form, in
P. 72. which it could become food-stuff for plants. The increase of ammonia in the soil was certain, the upper layers always contained far more than the lower ones, instead of containing less as they should, did the cultivation of plants impoverish them, but the origin of this was quite obscure.

I consider it as a happiness, as the gift of a kind destiny, to have lived to know Schönbeins newest discovery, by which this origin has been explained, and a new, until now, incomprehensible, wonder, disclosed to the mind; amongst all, it is certainly the greatest. Indeed, no chemist could, from the facts as presented by Science, have come to the conclusion, that the passing over of the nitrogen of the air into nitrate or nitrite of Ammonia, was, in general possible, and the simplest experiments now show, that every flame which burns in the air converts a certain quantity of the nitrogen of the air into nitrite of

Ammonia, that every process of decomposition (corruption / verwesung) is a source as well of nitric acid as also of ammonia, yes, that the simple evaporation of water is a means of bringing about the formation of both plant food stuffs. How great indeed, is this wonder, if we reflect, that by the combustion of a pound of pit coal or wood, the air has not only returned to it the elements for the re-production of this pound of wood, or under conditions, of the coal, but that the process of combustion itself transforms a certain quantity of the nitro-gen of the air into an indispensable food-stuff for the production of bread and meat.

Truly, those only perceive the greatness and infinite Wis-dom of the World's Creator, who endeavour to understand His Thoughts in the Infinite Book of Nature, and all, besides, that men know and say of Him, appears, compared to it, as an empty, idle, report.

Many readers of this book who have more respect for ~~possess, with a closer consideration~~ the conclusions to which Mr. Lawes has arrived in his experiments, might easily be disposed to re-proach me with exaggeration, because they are so striking-ly contradictory of all common experience, and the sound common sense of mankind, and this repro-ach is strength-ened by the further reflexion, that it may not be assumed that these experiments and conclusions can be so entirely without foundation, since they appear in one of the first agricultural Journals in Europe, and have, at the same time been sanctioned by the best known agricultural authorities in England.

I have not myself understood how the experiments and conclusions of Lawes could receive any attention, since their final result was the exclusion of all reflexion and of all scientific principles; he had endeavoured to prove, and the Royal Agricultural Society had agreed to his views, that the first and only Theory which Agriculture had received from Science, was false and of no use in practice, without setting in its place a better, or anything better. Instead of helping to build, he destroyed the existing building. His whole struggle had no rational aim. I cannot myself yet understand it, and believe I can do nothing better to enlighten the reader, than by giving him the views (opinions) of a Friend upon the condition of Science in England, which will afford him ma-terials, by which he will perhaps be in a position to form a judgment for himself. My friend, a Physician, with whom I very often conversed on these relations and conditions, said respecting them as follows: —

The State of Natural Science in England.

" We are an eminently practical people, of a force and energy, of a boldness and perseverance in the adoption and carrying out of great undertakings, such as no other people possess, and this not merely in industrial, or Trade, or voyaging undertakings, but in all directions; look at the soldier in our small army in the Indian Campaigns, surrounded by a cruel and uncertain people, who only wait for his over-throw in order to tear him to pieces, in a sick bed, threatned by terrible illness, weakened by the most fatiguing marches under a tropical sun, and opposed to an unmerciless enemy, whom he himself instructed in all the arts of war. Look at the soldier in the Fight, his valour and his resignation, how no danger cows him, and how his strength seems to increase with every difficulty. Never has the world's history recorded more heroic acts, and in the native land, how the spectacle was applauded, how, as it were, the whole land, on the arrival of the indian post, turned into an arena round the dwellings of the people, following the movement with eager eyes and outstretched necks as well of each single soldier as of the whole Army; how each spectator has his favorite, to whom he cries: Courage, brave heart! we see all that thou doest for thy Country, for us!"

"This is the ground work of the english character. Place him amongst men, and in whatever situation he may be, you will find him a man, a complete man."

"We regard wealth, because it is a product of boldness, of indefatigable activity, of animal power (fleisch) and of perseverance, and so we regard the wealthy man, and in him the success of his trade; the motives, and ways and means of success, are beyond the knowledge and judgment of the great mass."

"But on the other hand, Nature appears to have denied the ability to us of improving her Gifts and our powers by Science, and I believe, that amongst the 30 millions of inhabitants of our Islands, there are not thirty born Englishmen, who know what Science is, and the aims she pursues. You will, perhaps, attribute this to a natural Law, which will not allow that all which generally makes a nation great and mighty should be combined in one, and it may well be so; for if the english indeed possessed Science, where would be the limits of their Power! Do not speak to me of our great Philosophers, Newton and Blake, of Adam Smith, or of Davy or of Faraday, or of J. Stuart Mill & Buckle whom we have on our lips often enough, for the enquiries

of these men do not strike root in the people itself, they, properly speaking, only make apparent, how sparingly, in the whole, we are endowed with Science, and how lustrous and rich she is when she is manifested in an individual, for in him is reflected the great abilities which are peculiar to the nation, only in another direction."

"Whilst, in Germany, the Problem of Science is: Rerum cognoscere causas, the investigation of the "causes" of things; with us it is: Rerum cognoscere superficiem, the investigation of "the surface" of things. Our science is only dilettanteism. Formerly, Botany and Geology were the departments to which we gave some attention, now it is to Zoology. These are essentially the Sciences which treat of external things. I know well that you will again dispute my statements with the names of Robert Brown, Owen, Lyell and Phillipps, but these men, although if everywhere they are mentioned with high respect, do not belong to those whose books are read or understood. He only is intelligible who knows how to fold up his knowledge in the cover of dilettanteism. Tyndal's work upon Glaciers and Glacier ice, whose scientific value can be condensed into two propositions, brings him more fame than his deeply considered investigations on magnetism, electricity, and other things. Listen, for instance, to your spirited friend, the Duke of Argyll, ~~how~~ how he reputed with dialectic dexterity and elegance, the arguments of Darwin upon the Origin of Species; it is as if he allowed gilded balls to dance in the sunlight, in order to make them disappear in his sleeves with the adroitness of a Bosco. Disputed scientific questions, which the Duke of Argyll was able to decide, who can however, only occupy himself with them for pleasant pastime, can certainly only be considered dilettanteism."

"The works of our genuine inquirers, W. Thomson in Glasgow, Strokes (Stokes?), Th. Graham, and others, have really only their home in Germany, as to what happens besides in Europe, is, for the most part, much farther removed from us, than if it happened in China.

"As far as regards Chemistry in particular, this Science belongs to those, which are least known amongst us; if you take away the Physicians and a few Manufacturers, who consider it a Science; we do not possess one word in our language for a man who is called a Chemist in France or Germany. We have no Journals for Physic (Medicine?) and Chemistry, as you have upon the Continent. The

Philosophical Magazine is a kind of lumber room in which you find Mathematics, Physics, Chemistry, Mineralogy mixed, higgledy piggledy up together. Quite lately the Journal of the Chemical Society appears to wish to take the form of a Chemical Journal."

"If you take into consideration, that with very little exception, our teachers of Chemistry have from their Professorial Chairs themselves, an income scarcely sufficient to defend them from hunger, that they are obliged to make themselves servants of ignorant Manufacturers, that the time which they have remaining for scientific inquiries must be employed in work which will bring in money, you will not wonder that our share in the scientific investigations of the time, is small without ~~etc~~ proportion."

"We understand here by a practical man, a man who makes money, and by a scientific or theoretical man, one who thrashes empty straw. Our famous Surgeon B. is quite unhappy that his early scientific career as Professor sticks to him like an indelible stain and robs him of the confidence of many. In short, we confound "Facts" with "Reasons or Causes", and are like the Chinese, in that we despise the true, scientific form, and stand proudly upon our Practice, that is, upon our Ignorance."

"Every speculation calculated on our ignorance, is sure of success, the principal thing is the energy required, and in this we are not wanting. Take, for instance, Morrison who has made such a colossal fortune with his Pills, How cleverly he begun in order to persuade John Bull to swallow his pills. He first brought together in a thick book all the facts upon the good effect of Aperients with representations of intestines which he had formally disposed of by means of his pills, rather like Snakes who cast off their old skin; in short, he convinced the people that it only depended upon him to invest them with a new stomach & bowels; from this naturally followed that a great deal of the suffering which prevails amongst us could be removed by aperients, and for what a sick man could have got for three pence, his ignorance permitted him patiently to pay three shillings."

"Thus, because you do not know our Country, your judgment upon Laws, as well as upon the Royal Agricultural Society, is perhaps not just, for if you consider the low state of the mental cultivation and instruction of our agricultural population, it seems directly unjust to condemn persons, whose views, however, are only symptoms of this state. I consider it as quite certain, that, originally, Laws aimed at no manure speculation, and

it is quite as certain that the members of the Royal Ag: Society are not imbeciles; on the contrary, this society comprehends quite the essence of the intelligence of the country, Ministers, Members of Parliament and Gentry, by which we generally designate people who do not require to work, but live on their rents, all consider themselves agriculturists, partly because they possess land & soil, or are practically engaged in agriculture. Two-thirds of them live upon the Incomes from their Estates, but do not understand agriculture. The other third is acquainted with it, but does not understand scientific doctrine. You can be tolerably ~~certain~~ sure that each of the 104 Governors, and 4600 members of the Society has read your book, but nothing can be more certain, that not one of them has taken the trouble, to compare what actually was in your book, with that which Lawes quoted from it."

"With you, scientific works are studied, with us they are read, and without having any preliminary science, them are quite convinced that they are able to judge of the weight and bearing of scientific evidence. With this is united the prejudice that no one believes he is personally interested in a scientific doc:=trine or Theory, as we call it, because only that which is called "Practice" is considered to insure profit."

"Then you must take into consideration, that an agricul:=tural Society with us, cannot, as is elsewhere the case, be regarded directly as a confederation which sets before it the problem of the progress of Agriculture. All societies, whatever name they may bear, obtain with us a political standing, for Politics are what we best understand. Be the confederacy founded for the preser:=vation of the race of Pug-dogs or for agriculture, it is for its ob:=ject tolerably indifferent what name it takes, for the names only separate from one another the classes of society. Therefore you always see political men at the head of their great meetings, this is even the case with the British Association for the Ad:=vancement of Science, and is it not an interesting spectacle to hear Lord Palmerston speak in an agricultural meeting, how he speaks like a well-meaning school-master about artificial manures, Farm-yard-manure, and Draining, so that the prac:=tical man, full of admiration must say to himself:—he is a great Man, and his politics are truly english."

"In order to understand the nature of the Royal Ag: Soc: only take up a few volumes of its Journal, I do not believe that you will find in its 22 volumes a dozen works, which foreign ag:=ricultural Journals have found it worth while to translate or to diffuse, or the knowledge of which is of actual use to the practical man who wishes to make progress. The principal con:=tents consist, as a rule, of bespoken insane des-criptions, and

fruitless reports of the management in this or that county, or in France, or Denmark, which nobody reads. If you take out a few really good botanical Essays, which would be quite as suitable for a Penny Magazine, and the contributions of Hoskins, Tanner Way, Voelcker, and a few others, there will remain but very little which any member of the Society has, at any time, read twice over, and which challenges reflection and imitation."

"The numerous experiments of Lawes and Gilbert upon the feeding of Pigs, Oxen and Sheep, must, in those who have only an idea of the transformation of matter, of Digestion or Nourish:ment (nutrition) of physiological processes altogether; and all the many important ~~experiments~~ works of Bischoff and Voit, of Bennenberg, of Pincus and others, by which the laws of nutrition, flesh, fat, and milk production were established, have remained in England, quite unknown and unnoticed acquisitions."

"What is attainable by perseverance, patience, and endur:ance, we certainly do attain in England, you can see this, for instance, in the admirable success of our cattle breeders, who transform a race of animals, as if the animal were a piece of soft clay; but what is only attainable by reflection we do not attain, because we are sworn foes to reflection. With the abundant means which are at the command of our Landlords on account of their wealth, certainly double the quantity of meat and corn would be produced in Germany, than is obtained in England, and the reason of it is, that we are raw empirics, ignorant, con:ceited, and inaccessible to the representation that there is some:thing better in the world than that which we consider good. If the statistical statement is true that England imports a million cwts of butter, english agriculture is condemned for butter is, amongst agricultural productions, one of the few, which may be produced for ever, without exhaustion of the soil, without the addition of manure from abroad."

These are the opinions of my friend, which must be received with greater circumspection, because he, as an Englishman, is accustomed through the english press, to exa:ggerate every thing, the praise of the Good, and the blame of the Bad, a method which is just and equitable to all sides, were there not, in all, what is openly allowed, an admixture of personal considerations, party views, and passions, which makes it difficult for anyone who has not lived long in the Country, to see what is right in the Confusion of opinions.

My own experience, obtained personally in England, entitles me, in the highest degree, to corroborate some facts concerning the Condition of Chemistry, and the views prevalent about this science in England. I was present at the British Association in York, and in a Sitting

when the renowned Sir Roderick Murchison read an Essay of Forchhammer of Copenhagen, Upon the Formation of Sulphide of Silicon on the bottom of the sea, in which, amongst other things, the composition of the ashes of some sea-plants was mentioned. When Sir Roderick came to the constituents Chlorine and Iodine (Jod) which in the manus-cript were written in the german ~~character~~ manner, he did not know how to pronounce them, and when he read Chlor and Jod, instead of Chlorine and Iodine, and saw an ironical smile upon the faces of a few english chemists, he said with the amiable self conceit, which so much distinguishes him: "Gentlemen, you must not be sur-=prised at the mistakes which I, perhaps, make, for to confess the truth, I understand nothing of Chemistry". I perceived that he did not understand the subject brought before him, but I wonder-=ed, notwithstanding, at his naïve confession.

Were a Student in Germany or France, on being exam-=ined in Geology, to acknowledge that he knew nothing of Chem-=istry, he would certainly (not competent) obtain the third note. But in England a Gentleman may always confess without de-=gradation, that he is a stranger to Chemistry, for in the english mind the idea of a "Chemist" is scarcely separable from that of a raw apprentice, with dirty hands and apron, who smells of itch-salve, cod liver oil (drops) and worm seed.

England is indebted to a small number of distinguished men, whose merit is recognized all over the world, for the great elevation of Chemical manufactures. The manufacture of bleaching lime is inseparable with the name of Charles Tennant, and before the erection of the Works of James Muspratt in Liverpool, the soda manufacture had scare-=ly any importance in England. (But in 1823 may be dated the commencement of the Soda-ash manufacture in this Country when Mr. James Muspratt erected his Works at Liver-=pool. See Report of the British Asso.n for the Advancement of Science for 1861 page 114.)

Before the year 1817, in which Dr. Thomas Thomson was called to be Professor of Chemistry in the University of Glasgow, there existed no Laboratory in Great Britain, in which a young man could practically instruct himself in Chemistry, and it cannot be doubted that this distinguished man had an essential share in the founding of the Chemical industry in Scotland. But the number of Thomson's Students was always very limited, and when on my journey in England, which brought me frequently in contact with the manufac-=turers of Chemical products, I could perceive how small, on the whole, was the diffusion of Chemical knowledge among the manufacturers.

I found the contrivances of the manufactories, in relation to ap=paratus and economy of labour, at all times worthy of admiration, but the scientific foundation of the management gave evidence, as a rule, of a scarcely credible ignorance. Thus, amongst others, Mr. Macintosh (known by his introduction of water-proof cloth=ing) showed me his Prussiate of Potass, and Prussian Blue works near Glasgow, and I was surprised and deafened on my entrance by a fearful noise which was occasioned by the grind=ing of iron pestles stirring round in the iron pots, the melted mass of animal substances and potass; on closer inquiry Mr. Macintosh said to me with a cunning look: "Here you have something, Professor, which no Theory explains, if my pots scream well, I obtain the most Prussiate of Potass." With the assistance of some Horse Power, he rubbed off from his pots the iron necessary for the formation of the salt! With a handful of iron filings (eisen-feilspäne) he could have ~~easily~~ attained his object much better. For his Prussian Blue he had erected some stairs upon which the light blue precipitate of iron vitriol and Prussian Blue was pumped. In run=ning down ~~they~~ it came in contact with the air, and became dark coloured Prussian Blue. It excited his greatest wonder when I said to him, and showed, that with a few pounds of bleaching powder, he could, in a few moments, make very much more.

In opposition to this, Walter Crum makes an honour=able exception who has won a distinguished rank amongst Chemists by several solid scientific works (I remember only that on the remarkable clay, soluble in water, dis-covered by him.

In the last 20 years, this condition has altered very much for the better, and I do not doubt that this must be as-cribed essentially to the influence (immigration) of the german school, partly by the english Chemists who have been educated in Germany, partly by the founding of a practical institution after the german pattern, in which my friend Sir James Clark had so large a share, and in which Professor W. Hofmann worked so happily. Since the estab=lishment of the College of Chemistry, excellent practical in=stitutions have been originated in London, Manchester, Oxford, Edinburgh, and in many other parts of Great Britain, and in relation to the stand-point of scientific and industrial Chemistry, England is inferior to no other country.

All this has exercised little influence upon Agricul=ture: on my last journey in England, I found the opinion apparently universally diffused, that practical agriculture had to expect no help from Science. Most scientific men,

Playfair, Way, and others, up to my friend Dr. Daubeny had with=
drawn themselves from the Province of Agriculture; it had again
declined to the crudest empiricism. The employment of ar.=
=tificial manures had increased, but, in renouncing Science,
the foundation for farther progress was lost, and many
years must pass before the singular prejudice that scientific
knowledge is useless, or even injurious to the practical man, is
extirpated, and before the new seed of a better understanding, finds
again, in England, the soil suitable for its development.

The dispute instigated by ignorant Practice in England
against Science, was so far, a great gain to the german farmers
as it awoke them to reflection, and whilst they learned to under.=
=stand correctly the doctrines of Science, they were enabled to
submit them to a better trial; the result was that they withdrew
from their blind admiration and imitation of english agri=
=culture, and arrived at the conviction that it is only half
Science that injures; progress is therefore, for ever secured in
Germany.

Husbandry and History.

The methods and aims of Natural Philosophy in our time,
are entirely different from those of earlier times, to-days idea of
"Observation", "Explanation", and "Cause", was, in Bacon of
Verulam's Century, not yet developed (1560 to 1658). In his
work, Sylva Sylvarum, or Natural History, of which the great
Philosopher believed that in it he restored (represented) natural
Phenomena as God and not Man, made them, each explana=
=tion which he gives is, according to our views, without foundation or an empty
invention; most of what Bacon explained, we consider inex=
=plicable, and what we call an "explanation" (definition), was quite un=
=known to him; that unalterably firm, immutable, natural laws
govern not only the heavenly, but also terrestrial natural phenom=
=ena, was not then known; each phenomenon was contem=
=plated for itself, and it was believed that its relation to others
was only discoverable by fancy: a cause was imagined for
the phenomenon, and it was explained, and its relations to
others from within, outwards; each fact, yes, each property
of a body, had its cause, and by this was capable of definition
which really, was only a des-cription or paraphrase of the
occurrence.

Our present Natural Philosophy rests upon the convic=
=tion arrived at, that a connexion in law exists, not only between
two or three, but between all Phenomena in the mineral, ~~plant~~,

vegetable, and animal kingdoms, which, for instance, condition the life on the surface of the Earth, so that none is for itself alone, but always concatenated with one or several others, these again with others, and so all are bound up with each other, without beginning or end, and that the succession of Phenomena, their rise and decay, is like an undulating motion in circulation. We consider Nature as a whole, and all the phenomena connected together like the knots in a net. "To observe" we call, trying to perceive by sense, when a knot in the net moves or alters which of the other knots moves or alters with it; one or the other must move or alter with it. To investigate a phenomena, is to seek out the threads with which a knot in the net is united to two or three others; with two phenomena, which constantly accompany, or follow each other, we search out the bond which unites them. As every natural phenomenon is compound, that is, consists of parts, the first and most important problem for the Natural Philosopher is to try and discover its parts, their nature, and quality, and the proportions (relations) in which they act together (their mass or quantity). We explain facts, not in themselves, but only their relations to one another, and we assign only a determinate value to those whose connexion we know. This connexion we call Law. We explain Phenomena not from within, outwards, but from without, inwards, we search out the conditions and how they act together, what precedes, and what follows, the Phenomenon, what next succeeds and so forth.

In former times Nature was considered simple, which she is not; for us what is simple in Nature is that all her objects are attained in the most direct way, and by the simplest method, and that the means to this end fit into each other like the most perfect wheel-work. In the interaction of single laws we recognise the more complex higher laws, and we know that we make its investigation impossible if, in the place of actual things, we intrude our own thoughts, and restore the connexion by a fancy.

Every child can perceive the movement of a pendulum, or the hand of a watch clock; he who observes the clock long and attentively, sees that the movement of the Pendulum and of the two hands is conformable; with each stroke of the pendulum both hands advance a certain distance in the circle, the large hand a 12 times greater distance than the small hand. The observer sees further, that the weight also moves downwards, that is, falls, and that the pendulum ceases to swing if he prevents the weight from falling on the fingers from advancing; he will, therefore, be aware that a connexion or a relation exists, between the

movement of the Clock weight, the pendulum, and the two hands. The essence of observation lies in the knowledge that a relation or dependence exists between two phenomena.

By opening the clock, and searching out the connexion of the movements of the hands, the pendulum, and the weight, with the interior machinery, the observer becomes fully acquainted with the going of the clock.

The investigation of a phenomenon in nature is not so simple, since we have no machine before us which can be opened and looked into. Sensible observations, therefore, cease at the point which was arrived at with the clock before it was opened; most investigations in natural philosophy are carried on without a perfect knowledge of a process as it is, and as it shapes itself under altered external relations. At this point begins the special work of the Natural Philosopher, and as it is a work of thought it is now called "Reflection". Intellectual observation step into the place of sensible observations; they proceed according to the same rules, by which outward occurrences are inquired into. The material with which the thoughts work is called "Knowledge", and by this is understood in natural Science, acquaintance with the forces of nature and all their laws, and the innumerable phenomena in which they reveal themselves perceptibly to the senses. By reflexion the Natural Philosopher seeks to bring back into connexion with natural laws, the observations made, of the laws he knows that they condition (bedingen) similar phenomena, he makes in his mind a picture of the inner machinery of the phenomena (an hypothesis), and he then tries to ascertain, if the imagined causes or the supposed connexion actually exists or not. It is now his problem, by relations designedly brought about, that is by Experiment, to subject his idea of the process to a severe test, and to convince himself and others of its truth; the experiments of the Natural Philosopher are first touch stones of his ideas, then matters of evidence for others; what his mind has observed, he brings, ~~before others~~ by logically arranged facts to which he has arrived by his experiments, before others who know the laws, which are brought into consideration by the explanation; just as any one who has a correct comprehension of a clock, can make it go, and govern it, so that it goes quicker, or slower, or not at all, so now does he who knows the connexion of actual things, become master of the phenomenon, or the process. For a man who does not know the laws, nor how to judge of the correctness of the ~~evidence~~ arguments, the evidence naturally is nothing, & he frequently considers the explanation as something invented,

which it originally is, but has ceased to be, so soon as it has become the intellectual expression of the mutually interacting (ineinandergreifen) laws of nature. That explanation of the Natural Philosopher which is acknowledged to be correct receives the name of "Theory"; it is incontestible and irrefutable for him who understands it, and only ignorance considers itself, at any time, authorised to contradict it. That the making of experiments is an art which must be learnt like any other skilfulness and dexterity, is a thing self evident.

If I turn the attention of the reader to our present method of Inquiry and Argument, which quite excludes all hypothetical elements, and the play of imagination with which the human spirit formerly contented itself, before bringing forward phenomena and conditions which stand in most intimate connexion with the welfare of States, and the continuance of Nations, and generally with the existence of mankind, it is, in order to remove his mistrust and indifference, and to enable him likewise to subject the views which he has himself formed upon these connexions, to so severe a scrutiny that he may then, perhaps, gain the same standpoint as the Natural Philosopher.

It is so trivial a truth that one scarcely should venture to utter it, that, if men could live on air and water, the ideas of Master and Servant, Prince and People, Friend & Foe, Hatred and Love, Virtue and Vice, Right and Wrong, &c, would not exist, and that States' Common-wealth, social and family life, and that the inter course of mankind, Professions, Industry, Art and Science, in short, all that makes man what he is, are conditional upon man having a stomach, and being subject to a law of nature which constrains him to take daily for his continued existence, a certain quantity of food, which his strength and skill must obtain from the earth, since nature of itself does not present them to him, or does not long present them to him, in sufficient quantity.

It is clear that all causes which influence, in any way, disturbing or furthering, this natural law, must exercise a corresponding influence, back, upon all life-relations of mankind; very many of these relations have long been known, and it is only to be wondered at, that precisely the most important of all, is as good as not attended to or valued.

Most men have only an obscure idea upon the source of their first conditions of life; just as the sun rises and sets, and the seasons return with the revolution of the Earth, so, men think, that harvests also return, and as they have continued already, so many hundreds, yes, thousands of

years without interruption, therefore Nature must be careful that man shall not perish and starve for want of the means of his subsistance.

The All-Good Creator has, in the wisest manner taken care of this, and His Almighty Hand has written the directions which man must follow in a great book, which is Nature, and in Reason he has lent to him a part of Himself, and endowed him with the ability to read his book and to comprehend His management of the world; thus He has made man the lord of his destiny, and placed in his hands his own prosperity & continued existence.

No Law of Nature cares for man, for it is his servant, and the servant serves the master, but does not take care of him.

We know with the greatest precision the conditions, relating to the soil, of the maintenance and increase of the human race, and also know that they are only most sparingly diffused in the most fruitful soil, and the store suffices only for a span of time.

In the series range of organised Beings, every animal stands opposed to every other, which preserves its extension within the pre-=scribed limits, so that all find their measure of food, and none dispossesses another. The title to life and perpetuation is grant-=ed to every race of animals by a law of Nature. In a similar manner the law of Nature affects mankind, if they, instead of governing it, are, like animals, governed by it. In the series the last creature, man, stands opposed only to mankind, and every disproportion between the store of food and the necessities of the people, obliges them to lessen their numbers, in order to restore the balance, because one destroys the other, and man, the image of God, only differs from rats in this, that the want of food does not drive him everywhere to devour his fellow. He who has no longer a place at the table of Society, does not give himself up, without farther effort, to starve of hunger. At the least he becomes thief or murderer, or he wanders in coun-=tries and becomes a Conqueror. Every leaf in the world's history shows the horrible effect of this dreadful law, in the stream of blood where-with man must water the earth which he did not understand how to keep fertile.

In the great total, it is at last tolerably equal, whether a nation, in a country whose fertility constantly diminishes, perishes of hunger & dies out by degrees, or whether it, if it be the stronger, forcibly compels another weaker nation in a fruit-=ful country, to die out and make place for it. All great migra-=tions of populations are from countries become sterile to those more fertile.

Before the Roman People enter into History, and long before the founding of the City of Rome, Italy already presents the picture of the most cultivated country in Europe; the re= =mains of their enormous works, which still excite our wonder, testify of this condition in the Country of the old Latins, and all sources of information lead to the conclusion of a surpris= =ingly prosperous condition of the old Latin. It may with certainty be affirmed (so says Schlosser in his History of the World, vol 3. p. 140), that this country was, at no other time, more thickly populated, and never offered a finer prospect of universal wealth ~~that at any other period~~ than during some centuries pre= =ceding the Historical Period. Even, when later the mighty people of Rome had accumulated the treasures of the richest Countries in Latium, the condition of this country was not, in the most remote degree, comparable with the prim= =itive time. At the time of the Roman greatness, Latium exhibited merely the wealth of a few small families, but in the earlier times, it showed a great prosperity spread over the whole country and all its inhabitants. Where now the Pontine Mar= =shes cover a wide tract of land, serving only for the breeding of cattle, and infecting the air, were then situated not less than 23 populous towns; the industry of the Latins had thus known how to transform this marshland into fertile cultu= =vated land, as the Etrus-cans first made habitable the mo= =rasses of Lombardy by their canals and dikes. The number of large and small latin towns cited by the roman histor= =ians in their writings, allows us to infer an unusually robust population crowded together upon a small space, and upon a soil of the greatest fertility, which must have been cultivated like a garden in order to yield the food necessary for the support of the people. (Schlosser. 141.) The territory of the Samnites was in an equally high state of cultivation, including whole ranges of the Apennines, from the limits of Etruria to the extreme South of Italy; the whole district of Monte Ma= =tese, which is covered with snow for a part of the year, and has never been cultivated since the time of the Samnites, was then, by the industry of a happy and hardy people, converted partly into arable, partly into meadow land, and populated in an incredible manner. Only very few tracts of land were unserviceable throughout the whole mountain ranges of the Samnites. The religion of the country was closely con= =nected with ~~the~~ Agriculture and rearing of cattle, and the nation= =al festivities related to these. Particular Priests (fratres arva= =les) formed the Brotherhood of Husbandry, and occupied them= =selves with it, not, perhaps, merely in relation to the worship,

but in a scientific aspect. The whole arrangement of the religious ceremonies, and all popular festivals, tended to the keep up the improvement of the country under magisterial inspection, and to spur the interest of the husbandman by religious duties. On account of their influence upon the climate, the Forests, amongst the Sammites, were under public inspection.

What a state then — and how is it now! Instead of a garden of roses, and luxuriant corn fields, the temples of Paestum (?) are now surrounded with o-canty grass and thistle bearing wastes!

The ignorant man, accustomed to attribute the increase of population to Peace, and its decrease to War, and desolating diseases, explains the condition of these Countries after his own fashion. He knows how clever this or that King was in Great Battles, and how eager, for glory, he was to have very many instruments of warfare, & what laurels this or that ~~Lord of the soil~~ General gained by a similar talent; he calls this his history; but the history of the clod of earth which had the closest connexion with his life, he does not know. Peace did not nourish, nor did ~~Peace~~ war destroy the populations, both conditions exercised only a passing influence upon them. What holds together or drives asunder human society, or causes Nations and States to dis-appear or become mighty, is always, & at all times has been, the soil upon which the man builds his ~~cottage~~ hut. Not the fertility of the land, but the continuance of it lies in the hand of men.

Long before the recorded founding of the City of Rome, the Greeks in old Greece, and upon the Coasts of Lesser Asia, had appeared in the circulation of cultivation and civilization, & before the Roman Power comprehended the whole known world, had shown all the characters of decline in fertility of an exhausted soil. Already 700 years before the birth of Christ, this diminution may be recognised in the enormous emigrations of the Greeks to the coasts of the Black and Mediterranean Seas, and in the progressive depopulation and desolation of the Country.

In the Battle of Platäa (479 B.C.) the Spartan State could still supply 8000 warriors for the campaign against the Persians, a hundred years later, according to Aristotle (Polyb. II. 6. 11. 12.) the same State did not number a thousand men capable for war; a hundred and fifty years later Strabo laments that of the hundred Laconien towns in his time, besides Sparta, scarcely thirty were remaining. A hundred years after Strabo, Plutarch (Mor. p. 413.) painted the sad desolation of Greece and the old World. But the Roman State also experienced the same fate. In his agricultural records, Cato speaks (B.C. 230)

not yet of the diminished fertility of the roman fields, but of the best means of depriving them of it. Three hundred years after Cato, Columella says in his preface to his 12 books on Husband=ry:

"The Great of the State indulge themselves in deploring, now the unfruitfulness of the fields, and then the inconstancy of the weather, which for a long period of time has been injurious to the crops; others think that the soil has become exhausted or spent by the too great fertility of former times. But, he con=tinues, no man of sense will allow himself to be persuaded, that the Earth, as we men, grows old, the infertility proceeds much more from our treatment, because we leave husbandry to the unreasoning discretion of ~~of~~ incapable servants."

The simple fact, that already in the time of Nero, there were books written upon Agriculture, is, of itself, characteristic of its decline, but we recognise still safer evidence in the decrease of population from the time of the last Punic war, upon which the war of the Italians, the Civil War between Marius and Sulla, could only be said to have had a passing influence, even on the supposition that both occurrences had snatched away half a million of men, five times more than the amount of Appian and Diodor's estimate, ~~when~~ if the soil had not lost its former power of production.

We know from recent French history, how passing the effect is of the bloodiest wars, upon the state of the popula=tion in Countries where the soil is not yet exhausted of its fertility. In the war time from 1793 to 1815, France lost over three millions of grown men; the Civil War of La Ven=dée cost upwards of a million of men; a few years after 1815, the population had become greater than 23 years previously, for the Revolution had brought under the plough many hun=dred thousand hectares of fruitful soil, belonging to the dead persons and thus increased the conditions for the repro=duction of men. The census which was stopped under Julius Caesar (B.C. 46) indubitably established the fact of the declin=ing population, and the external reason of it was not con=cealed from this great man; but his agricultural laws, by which he distributed the State's land on the Campagna among 20,000 poor citizens who had three or more children, could not again invest the exhausted land with its lost fertility; the object was not attained.

Under Augustus the wound of men fit for service in war, was extraordinarily so great, that the chief city and its province was put in fear and terror by the destruction of a small corps of the Army under Varus in the Teutonic (Teutoberger)

Forest. Rome could no longer supply its contingent to two Legions, there were no longer volunteers for war service, and it required the most severe compulsory measures to get together a small army. Livy (VI. 12.) speaks of the great desolation of the interior of Italy, and says of the country of the ancient warlike nation: "now slaves must take care that it become not wholly desolate, scarcely that a small seminary of soldiers can be maintained there."

The piratical war, whose fortunate termination (B.C. 79) founded the power of Pompey, indicated in what degree Rome was dependent upon the importation of foreign corn, and if, as Mommsen mentions (in his Roman History vol III. p. 492) the inhabitants of Rome were, already before Julius Caesar, constantly in the presence of a dearth, and not seldom really felt the pressure of hunger, the evidence brought together by these facts shows that Italian husbandry was only exceptionably able to satisfy, in this respect, the requirements of the City and the Army.

By the brutal plundering of vanquished countries Rome had, before Augustus accumulated extraordinary wealth, which under him, was still further increased by the enormous contribution of the Provinces in favour of the world's city; a part of this was received back by the country and Towns in the building of great Public Baths, Bridges, High-ways and Aqueducts, but the most active enhancement of commercial intercourse and of industry did not restore to the Roman fields the conditions necessary for the permanence of the human race which they perpetually without interruption were losing.

Whilst, outwardly, the Roman State presented every appearance of prosperity and the most luxuriant affluence of power, the evil worm was already busy destroying its march of life, and it began the same work two hundred years ago in the European States.

How many men of insight, power and good will governed Rome in the first century of the Empire! But what could the might of the mightiest, which in its presumption made itself to be honoured as a God and exalted itself as more ancient than the Gods; what could the wisdom of the Philosopher, the deepest acquaintance with jurisprudence, what could the valour of the ablest generals, the most formidable and best trained armies effect against the action of a law of Nature! All that was great and strong sank to littleness and weakness, and lost at length even so much as the glitter of its ancient splendour!

While civilization and intellectual cultivation gained extension, and Arts and Professions received unusual advancement, and all which ministered to the objects of outward life appeared to be in constant progress, and a new religion should replenish the old world with new life Courage, all this only accelerated the ruin.

Free and independent of all, is the husbandman, whose field is not larger than he and his children can cultivate with their own hands, and fertile enough to bear his share of State Taxes, and to give a sufficient subsistence to his family and a certain wealth; to him his children are a blessing.

If in consequence of the exhaustion and impoverishment of his land the free peasant disappears, then, with him expires the real civism and the love of the Fatherland, for in the Peasant is maintained the religious feeling and the affection for the place upon which he was born, and for the land which he tends; he knows, better than others, how to value the heavenly gifts, animating sunshine, & fertilising rain, and without them how helpless is he? his small farm which supports him cannot be sold, he has a sure scale for its value, not for that of money; he is the last in the land who lays down arms in its defence against the conquering enemy, the last who retains loyalty to his hereditary Prince when all others forget it.

But while he, in his ignorance, slights and violates the laws of Nature, he meets with the punishment due to his actions; his cares and toils, his industry in the cultivation of his land, only accelerate its exhaustion. For him the inevitable time arrives when he can no longer obtain sufficient to maintain his family, from the soil, exhausted by a system of robbery (raubbau). He does not know the reason of its impoverishment, and ascribes the diminution of his crops to a number of other causes, never to the right one; he hopes for better years, and begins to meet his most pressing necessities by debts; at last the tax gatherer compels him to sell his growing corn, and after a few generations his property falls into the hands of his creditors. A large estate arises from many small Peasant holdings. The great landlord drives away the family of the peasant, and retains only the working hands, he does not obtain more products than before, but he exports very much more than the peasant, who consumed the greatest part of the produce for the maintenance of his household and cattle.

The war of the Roman legislature against the action of this natural law, which for centuries was continually renewed,

is exceedingly instructive and remarkable.

The Lawgiver who has no idea of natural laws, assumes the given conditions and soil relations as perpetual and unalterable which they are not, and sees the reason of the diminution of the population and of the producing power of the land, in the people, who, according to their nature, do not alter in their in-stincts to preserve and propagate themselves; while he, by his laws, tries to determine the actions of men, he believes that his orders are powerful enough to preserve or restore conditions which are beyond recovery; a peasant can be taken from the plough and be made a soldier by a law, but no compulsion is able to turn the citizen or soldier into the peasant or ploughboy whose work is the most difficult of all; he must the week long rise with the sun, and work sixteen hours a day; he must know today what he shall do tomorrow, each day something different; weather and seasons do not wait for him; he grows into his work and does not learn it, as dexterity is acquired in a handi-craft or art.

Neither the violent appropriation of land under Cains Gracchus, nor the efforts of Julius Caesar or Augustus to restore the disturbed relation between the requirements of the popula-tion, and the producing power of the soil, or between hunger and the fields which could no longer appease it, had the least result, and necessity scarcely allowed the ruler any other ex-pedient for supplying the scarcity of corn than the plunder-ing of the provinces.

The giving of corn to the poor roman citizens from the public granaries, had already begun under Scipio (196 B.C.). Under Cains Gracchus each self announced citizen had given to him monthly 5 modii of wheat (= annually to 10 prussian bushels = 15 bushels = 2½ bavarian bushes = 5½ hectoliter = to 830 zoll. pfunde); under Julius Caesar the number of the re-cipients amounted to 350,000, under Augustus and the later Emperors to 200,000. The corn delivered out by the State, ac-cording to this, amounted yearly from 1½ to 2½ millions of cwts. (centner.) This, evidently, satisfied only a portion of the requirements of the Latinum People and of the Army, for the capitalists of Rome carried on, at the same time, a flourishing & profitable trade in corn. The most corn was furnished by ~~the~~ the Province of Asia, the countries on the African coast, Sicily and Sardinia. Rome received from Sicily, a tenth part of all the corn grown upon the Island, the same also from Sardinia; already under Gracchus the Province of Asia had been declared ~~State~~ land, and it can be conjectured what an influence must have been exercised upon the quality nature of the soil

of these countries, by such a system of plundering continued many hundreds of years, and that at last the exportation of corn to Rome could be maintained only by the destruction of the free population, and the introduction of ~~the~~ day-plot-tillage (? plantagenbau.) on the largest scale by means of an army of slaves.

Under the later Emperors, not only the population of Rome but half Italy, lived on foreign produce.

Their food, their daily bread, was dependent on the will and the favour of the Ruler, and its existence was endanger-ed by every stoppage in the enormous machinery of Govern-ment which consumed the working strength of the inhabi-tants of the rest of the world for their maintenance. By means of this dependence upon the State, the people of Rome in place of the feeling of self reliance & power which labour produces, became self-seeking, cringing, weak & debased slaves & acquired all the vices of moral degeneracy.

By the time of Dio-cletian, three hundred years after Augustus, the free peas-antry had quite dis-appeared, and their place was occupied by the colonists (? colonen) or bonds-men, peasants belonging to the estates (farms) and thereby was completed the thous-and years process, and in the next century began the death of the gigantic body and its inter-nal decay (faulniss) and as this furnishes the soil in which worms and creeping things increase, so the over-grown mil-itary State consumes the residue of its healthy and produc-tive juices and completes the destruction of its self dissolving members. As rats leave a sinking ship, so at length Con-stantine forsook the ruined land, in order to pursue the same process of des-truction in another part of the world.

As a chief cause of the want of population in Greece, Polybius had already (Ex. Vat. de Sentent. Lib. 37) pointed out the avoidance of marriage, and the unfruit-fulness of the marriages, phenomena which, in the same form, made their appearance in the Roman Empire, and which Augustus with all the means at his command, although unsuccessfully, sought to combat; and here we see how power-less the law-giver is for the removal of the evils in the State, whose character he perceives without knowing their real cause.

Amongst all the laws of Nature, none is, in all classes of animals, so related to their increase, and so intelligible to the understanding as the law that the individual multiplies him-self in the same proportion as the conditions of multiplication increase. National economy has proved this law also for man-kind, and given it expression in the fact, that the number of marriages and of children is dependent, in a determined

relation, upon the price of corn; they increase in years of plenty, and decrease when bread and the necessaries of life rise in price.

In Spain we see accomplished a perfectly similar process. Under the sway of the Emperors, Spain, the native country of Trajan, Hadrian, Marcus Aurelius, belonged to the richest and most flourishing countries of the world.

Livy and Strabo tell of the fertility of Hispania and of the hundred-fold crops of Andalusia; in each new campaign, reports Livy, new arms were found, new riches, for no war had ever wasted this territory.

Under Abd Errahman III (912 to 961) mahommedan Spain (the present provinces of Arragon, Valencia, New Castile, Murcia, Estremadura, Andalusia, and Granada, with the southern half of Portugal) had from 25 to 30 millions of inhabitants; at that time it was still the most populous Kingdom of Europe. Terragonia, under the Romans the second City of the Empire, had over a million, under Abd Errahman III still 350,000 inhabitants, now 15,000!

The city of Granada alone could send 50,000 warriors into the field, and if we may give any credit to the reports of the arabic authors respecting Cordova, this city, with its twice one hundred and twelve thousand houses and six hundred mosques, was, in extent, not much inferior to the city of London at the beginning of this century.

Six hundred years after Abd Errahman, Herrara, in his book upon Spanish agriculture, which appeared in the year of Philip II^d's death (1598), asked: "what can be the reason that in these days the insufficiency of the necessaries of life makes itself felt throughout the whole country, and that now during Peace, a pound of meat costs as much, as a whole sheep formerly in the time of war? Over population cannot be the reason, for where formerly a thousand Moors had active hands, five hundred Christian scarcely find their subsistence now. Nor can the importation of gold from India be the cause. Is it then the Earth "asks he farther" which rests? But the Earth requires no other rest than the sleep of winter, and since the age of man the winter rain has never failed to revive it and furnish it with strength for the quickening of the young seeds. But what then is the reason that the Earth will no longer entirely nourish us?" — "The mule is the reason", thinks Herrara "the mule came into use in the middle of the 13th Century, and from this time may be dated the desolation of Spain, it does not possess the strength to plough deep enough!!"

The enactments of the Catholic Kings give a picture of the gradual exhaustion of the Spanish soil. Already in

the twelfth century King Alonzo Onzeno and Pedro the Cruel of Castile, had issued decrees for the preservation of the meadows and pastures, and the Emperor Charles V commanded that the meadows recently ploughed up for arable land, should again be laid down for meadows!

Now, in Catalonia, a crop of field produce is obtained from the land once in two years, in Andalusia once in three years! (see Pictures from Spain by Freiherrn von Thienen-Adlerflycht. Berlin. Duncker. 1861.)

The long war between the Christians and the Moors is naturally easily understood, it was the struggle of two nations for daily bread. The increase of the christian population in the less fruitful parts of the country occasioned a famine; opposed to them was another which, on account of their religious belief, so they thought, had no right to their existence, and which still had full granaries of corn. Reason enough for the extirpation of this Godless race. One or two centuries after the expulsion of the Moors, the corn chambers were again empty; the sources which had replenished them were exhausted, and the treasures of the New World, the stream of gold and silver which flowed to Spain, did not suffice to procure the necessary food for the increased population; the resources of the nation were finally exhausted in wars to enlarge the territory which could supply them with food.

Not negligent husbandry, but the destruction of the fertility of the land by a robbery of its constituents (Raubbau. rob-culture*) occasioned the fall of the universal empire both of Rome & Spain. Like causes produced the same effects in both countries.

The system of robbery in Agriculture (rob-culture) which desolates and depopulates countries may be described in a few words.

In the beginning, or upon a virgin soil, the husbandman cultivates corn after corn. * when # the crops diminish, he

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* The hunter and wandering Shepherd naturally precede the husbandman, and the influence of husbandry upon the cultivation and civilization of peoples & lands, is intimated in the following manner, in our oldest historical book the Bible, Gen. 4th chapter:— Agriculture takes his pastures from the wandering Shepherd, & drives him away (Cain the husbandman killed Abel the Shepherd), the children of the husbandman (Cain's posterity) wander no more and build substantial habitations (and Adah bore Jabal from whom come those who live in houses & rear cattle), from husbandry spring the arts of of Peace (and his brother was called Jubal from whom come those playing on the Harp & Fife) as well as Crafts & industry (Zillah bore Tubal-Cain, the master in all brass & iron work). Husbandry is the business of man, & according to the divine command, shall be everywhere & have no home. (Cain had no wife & did not die).

he wanders to another place. The increase of population sets, by degrees, a limit to these wanderings; he cultivates the same surface, allowing it alternately to lie fallow. The crops continually diminish, and the husbandman, in order to restore them, now employs the manure which is furnished him by natural meadows. (Dreifelder wirthschaft. Three-course rotation.)

But as this compensation does not suffice for a continuance, it is succeeded by the production of manure upon the land itself by means of the cultivation of Fodder plants. (wechselwirthschaft); the subsoil is used for the growth of fodder plants, in the same way as the manure-giving meadow, at first without interruption, then with the intercalation of fallow years; finally the subsoil is exhausted, the land will grow no more fodder crops; first appears the bean-sickness, then clover,-roots- & potato sickness, and at length husbandry is discontinued; the land no longer feeds men.

This process may be going on for many hundreds of years, in individual cases, for thousands of years, before mankind is made aware of the results of this management, and seeks the assistance of correctives, each of which is an indication of the exhaustion of the land.

The history of agriculture in North America has made us acquainted with innumerable incontestable facts, which prove how, proportionately, short the period is in which crops of corn or commercial products can be obtained without interruption or manuring. Already, after a few generations, the excess of plant-food-stuffs which has been accumulating in the soil for centuries, is exhausted, and profitable crops can no longer be obtained without manure.

In the Lower House of Congress at Washington, the Delegate Morell from Vermont proved by statistics, that in the States of Connecticut, Massachusetts, Rhode Island, New Hampshire, Maine and Vermont, taken together, the wheat-crops in ten years (from 1840 to 1850) had diminished in comparison with an earlier period, one half and the Potato crops one third; in Tennessee, Kentucky, Georgia, & Alabama, as well as in the state of New York the corn-crops had diminished one half. The average crop of wheat in Virginia and North Carolina, amounted in the year 1850 to only seven bushels, in Alabama to only five bushels per acre. Upon the new soils of Texas and Arkansas an average of 700 to 750 lbs of cotton is obtained per acre, and on the old fields in South Carolina only half as much.

"In a journey through the country" says the Deputy Clay of Alabama "one meets with numerous Farm Houses, once the

"homes of intelligent and industrious freemen. Now they are
"empty, deserted and ruinous; we there meet with fields once
"fruitful, now overgrown with weeds. Moss grows on the walls
"of those once cheerful places, and the whole estate which formerly
"secured happy homes to a dozen white families, is now in the
"hands of <u>one</u> master. The land which is not yet out of its
"childhood, already carries on its brow the wrinkles & decline
"of age; thus is it in Alabama, Virginia and the Carolinas."

An attentive survey of the condition of the soil every-
-where, in all parts of the world and regions of the Earth, will
show the working of this same great natural law. For, where
formerly mighty empires flourished, and a dense population
obtained food and wealth from the soil, the same land
now does not produce as much fruit as will pay for its
cultivation.

In no science is it better & surer known than in
Chemistry and Physics, that every natural phenomenon is
conditional, not upon one, but upon many causes; to
the most simple chemical phenomenon always belongs <u>three</u>
which must work together in a certain relation when it is
occasioned, and it would, therefore, be quite inadmissible
to ascribe the decline of a Nation <u>exclusively</u> to one single
cause for doubtless a number of others have contributed
their share, but these are the variable factors, whilst the
exhaustion of the soil by a systematic abstraction of its
Constituents (Raubbau, Vob. culture) is the only cause which
is always present & co-operative. The mass of people al-
-ways consider the phenomena of civil & family life, the
condition of the population, to be dependent only upon
one thing, and bring it forward & do not dispute it, because
they do not see the cause; what they perceive is always
only an effect. The common people ascribe the dearness
of bread or money to an epidemic sickness, a poisoning of
springs; they kill the mole & exterminate the sparrow which
do so little injury and so much good, and in political matters
the views of the Statesman are often very similar to those of
the populace in so far that he unites the political voices &
movements in the people, yes even revolutions, to persons
whose actions, however, are only characteristic of conditions
which he himself, by misapprehension of the requirements
of natural laws, has brought about. Not any political
cause of the decline of a nation influences the soil, or is
able permanently to alter its nature, and the decline of a
Nation is, therefore, only permanent, when it has itself changed
the nature of the Soil.

Just as the husbandman abandons the soil which can no longer nourish him, and seeks new land which is able to support him, so changes and wanders the cultivation and civilization of nations with the condition of the countries. A people originates and develops itself in proportion to the fertility of the soil with whose exhaustion it evidently disappears; only the spiritual attainments possessions, which are the fruits of culture and civilization do not disappear, they only change their place.

The One and the same natural law rules over the rise and decline of Nations. Depriving the soil of its conditions of fertility involves their decline, the maintenance of these conditions insures their continuance, their wealth & their might.

The History of the greatest Empire of the Earth knows nothing of the origin and decay of a people or a nation; from the time when Abraham went into Egypt to our own, we see in China an uninterruptedly (excepting by internal wars) increasing population; in no part of the vast territory has the soil ceased to be fruitful & grateful for the care of the husbandman. The Island Kingdom of Japan, with its mountainous Soil, at the most half capable of being cultivation, with a greater number of inhabitants than Great Britain, produces not only an abundance of food for all its inhabitants, without meadows, without fodder, without importation of Guano, Bone meal and Nitre, but, since its harbours have been opened it exports yearly not inconsiderable quantities of the means of life. (Report to the Minister of Agriculture upon the Japanese Agriculture, by Dr. H. Maron, Member of the East Asiatic Expedition. Page. Appendix G.)

Experience and observation have conducted the Chinese and Japanese Farmer to the only method of culture which is capable of maintaining for ever the fertility of a soil, and of raising its power of production in proportion to the increase of the population, and it is well worthy of the greatest attention that Husbandry in these Countries is chiefly indebted for its perpetually thriving condition to its union with the worship and with strict religious prescriptions. the "God" of the Chinese is, in an especial sense the Plough.

The foundation of Chinese and Japanese agricultural systems is the full return to the soil of all plant foodstuffs abstracted from it in the harvested fruits of the field; the Japanese husbandman knows nothing of the restraint of a succession of crops, and only cultivates that which appears to him to be most useful; the products of his land is the interest of its strength, he never lessens the capital which

brings him in this interest.

European Husbandry, as well as Husbandry in Spain, Italy, Persia, & generally in all the countries which we see fall into desolation and barrenness, is the complete opposite of the japanese; it rests upon the plunder from the soil of its conditions of fertility. The aim of the european Farmer, and the great problem of his art, is to get as much corn and flesh as possible from his land with as little possible expenditure of money in the re-purchase of the exported conditions of his crops.* Among german Farmers, he is considered the most skilful who succeeds in bringing the greatest quantity of corn and meat to market without any purchase of manurial matters. yes, he is proud of his success, and the others praise him, how clever he is, and how well he understands the management of his land. No rational man can sanction the continuance of such management, and believe that this system of plunder will not have the same result in european countries, which it has had in others; if no natural law existed which takes care of mankind, if the maintenance of the fertility of the soil is placed in his hands by the Creator, and man is answerable for all the misery which his actions prepare for his successors, it is a sin against God and the human race if he intentionally & wilfully, because it is some cost and inconvenience to him, uselessly lavishes over himself & withdraws from the circulation of life the conditions which he knows have served for the support of his life & that of his children and which are designed by nature to serve for the development of a new and all following generations.

The descriptions given by Schubert and others of Agriculture in the middle and towards the close of the last Century, are a picture of the state of what in which we shall find ourselves, if the predominating error of the inexhaustibility of the soil is not perceived by Farmers, and their management regulated accordingly.

"Excepting bad, sour hay, the Farmer had no other "winter food for his cattle, than some white roots, Carrots, Cabbage

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* The principle of german agriculture is "with the application of "the least quantity of manure to produce the greatest quantity "of those vegetable matters which can be used for the nourishment "and maintenance of the animal organism." See the Elements of the Natural Laws of Husbandry and their importance in Practice" by Dr. J. Wolf. 3d Edition. Otto Wigand. Leipzig. P. 1016.

" and Potatoes, and of these not much, because, of itself,
" nothing would longer grow on the fields. This sparing food
" would be still more sparingly given as the winter lengthened,
" and when it was all used the cattle had to be satisfied with
" barley, oat, or pea straw. On this account milk, butter &
" cheese were bad and scarce. The spring was anxiously
" expected in the hope of obtaining a little corn, and when the
" grass had grown, perhaps, an inch high, the cattle were sent to the
" pasture grounds from which they returned as hungry as
" they went up resembling the lean kine which Pharoah
" saw in his dream". So writes, Johann Christian Schubert, of the state of matters in his time who, on account of his merit in the introduction of Clover culture, was nominated by the Emperor Joseph II Knight of the Clover Field of the Holy Roman Empire.

Perhaps, by that time, the pressure of necessity would have diffused more enlightened views, & the Farmers have been brought to a consciousness of the defects in their management, had not three events prolonged, for another century, the delusion that his their system of plunder was a legitimate practice.

These were, the employment of gypsum in Clover culture, and the importation of Potatoes and Guano.

In England and France husbandry was already passing through its last period in the transition to artificial manuring (?) / Mist-wirthschaft.) The soil, by centuries of the customary three-course-rotations, was already exhausted, and its producing power could be kept up for a time, at the expense of the sub-soil, by the growth of Clover & fodder.

In gypsum, which in most places extraordinarily increased the clover crops, a means was discovered of increasing the amount of manure without manuring, & thus augmenting the corn-crops with this manure. And in Potatoes a species of crop was obtained, by which the exhausted corn land yielded a very much larger amount of food for men and animals, than was the case with any other kind of cultivated plants.

It suffices, in order to estimate the importance of the potato, to refer to the year 1847, in which, in spite of a good corn harvest, the failure of the potato crop occasioned an enormous dearness of all the necessaries of life, and a famine in Spessart (?) Silesia and Ireland.

We may assume, that in France and Germany, a third of the population depends upon the Potato as its chief source

of nourishment, and it does not require a very lively imagination to comprehend the shocking & fearful state which must ensue if the potato crop continually fails on the Farm.

The present population of Europe owes its amount to gypsum and the potato, and there cannot be the least doubt that the european people would have been less in numbers by 20 to 30 millions, had gypsum never been brought into use nor the potato been imported. The importation of the potato was considered in the last Century, as of so much more significance, because, at that time, in consequence of the exhaustion of the field-soil, all certainty was lost in the cultivation of the most important food plants, Peas, and Pulse generally. The Farmer naturally, cultivated no crop, which, with ordinary conditions of weather, he could not be certain would thrive, and yield a safe return. Potatoes came in the place of these nutritive grains, the true representatives of meat for the working population.

The potato plant is able, by means of its long ramified roots, to dig through the soil, like a pig, and will still flourish upon a relatively poor field, which is scarcely able to give remunerative corn-crops; it shares with the straw-crops the store of food-stuffs, augments the supply of farm yard manure for the land, and is the last in the series of vegetable growths, which, when all others cultivated on the surface soil have failed, will continue remunerative.

The ~~important~~ introduction of Potatoes and the application of gypsum, would seem to be true ameliorations of agricultural management, not only because they increased the working soil capital, but because they augmented the revenue of the Farmer. That a time always will come, when the soil must cease to be fertile for potatoes, and when gypsum will have no longer any effect in raising the clover-crops, or that the duration of the crops gained nothing from the field to man, but abstracted more, that they must diminish with their increase, were reflexions impossible for the Farmer of that date; his methods for centuries had been founded on the notion, that soil rather increased than diminished in its power of production by cultivation.

Had he been accustomed to account to himself for the phenomena of Agriculture taken as a whole, he would very soon have perceived that in many places, fields of clover which, ten years before, had been considered inexhaustibly fertile, no longer when manured with gypsum, yielded crops as large as heretofore, and that there must be the same limit to the fertility of

from regular rotation
soil with regard to Clover, as that which had excluded the cul-
=tivation, already so uncertain, of other leguminous plants,
such, for instance, as the Pulses.

Finally, had there not been potatoes, necessity would, ap-
=parently, have compelled the german farmer to reflect upon
the reason why the english farmers set so high a value upon
bones as manure, a value which he was so little able to com-
=prehend that for 70 years he had looked with the most perfect indifference
upon the exportation of millions of cwts. (Centnern) of bones.

The thought, however, lay near enough, that the plunder
of bone-earth from german fields, must be detrimental to them
if the addition of it to the english fields were advantageous. If
english corn and clover crops were improved by it, german corn
and clover crops, deprived of it by England, must fall off.

In the hands of the ignorant practical man, Potatoes &
Gypsum would be the means of stimulating the plunder of the
land, and accelerating its exhaustion.

Another, perhaps the greatest evil, resulting from the
cultivation of the potato, would of itself without it, not have been
apparently felt, or not so very much felt, and this was the di-
=minution of the physical capacity for labour of the popula-
=tion which supported themselves chiefly upon potatoes.

I cannot here go further into this connexion, and
it must suffice to remark, that since the intro-duction of
the potato the mean stature of man has lessened in Germany
and France, so truly indeed, that within the last 70 years the
standard measure for soldiers has been neces-arily lowered.

The bone substance, which the bony skeletons of men
lack in Germany and France need to restore the average height
of former times, has been exported to England in bones, and
has there served to maintain in its original size and strength
the bony skeleton of the english soldier and Labourer.*

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* The celebrated Anatomist & Physiologist Tiedemann, in a post-
=humous work which has been placed at my disposal by the kindness
of his son-in-law Prof. Bis-choff, says:- "An exact investigation upon
"the size of the body gives the safest inferences upon the physical
"nature, the prosperity, and thriving condition of a nation. In
"general, within certain limits, those over the average, speak for
"the thriving state of the average of the organised beings of their
"own species. For man, it is proved that his bodily size lessens
"if his prosperity is prejudiced, be it in physical or social relations.
"An investigation of the bodily size of a people gives an important
"starting point for the determination of their strength. A people is
"depressed in the same degree as its mean size of body diminishes. The

Upon this effect the experiments of Boussingault do not leave the least doubt *; they show that it is impossible to get a pig up to the aver=age size with the fullest feeding with potatoes; he is always smaller than a pig fed in the ordinary manner, and at a certain point he will gain no more flesh. This is a well known thing, and, on that account, the Farmers adds Peas to the Potatoes, which are very much richer in bone earth than the Potatoes. With this addition, relations immediately alter, and the pig continues to grow. The greater contents in blood and flesh producing matters in Peas, in a given volume, than in Potatoes, has, naturally, its share in this increase.

Although, by the introduction of Clover and Potato culture, to=wards the end of the last Century, the amount of food-stuffs serving for the maintenance and increase of the population, was very consider=ably augmented, perhaps, after one or two decades, a failure in pro=

"members of the higher classes attain a finer growth than those of "the lower classes. The cons-cription lists afford a good means "for the investigation of the amount of growth."

By comparison we find, that in all european countries where cons-cription exists, the mean height of full-grown men, & as a whole, their fitness for military service, has diminished since its introduction. Before the Revolution in the year 1789, the minimum stature of an Infantry Regiment in France amounted to 165 Centimeters, in 1818, on the other hand, (law of the 10th March) it was 157 Centimeters; by the law of March 21. 1832 156 Centimeters; on the average in France, above half are rejected on account of a want of size and defects; the mili=tary standard in Saxony was, in the year 1780, 178 Centimeters, it is now 155 Centimeters. In Prussia the military standard is 157 Cen=timeters. According to a statement in the Bavarian Gazette of the 9th of May 1862, by F. Meyer, it appears that in the average of nine years in the Kingdom of Prussia, 716 out of 1000 Cons-cripts were found unfit for military service, 317 on account of their under size, and 399 on account of defects; after this it appears that the great=er number of the Prussian Population are restricted to a potato diet. In Austria the military standard is 160, in Sweden 162 centimeters. In 1858 the City of Berlin could not supply its contingent of sub=stitutes for troops, it wanted 156 men. In Cambridge they have the Custom that the University Students measure & weigh themselves. The averag height of the Students is 176.8 Centimeters.

* A pig 8 months old, 120 lbs in weight, gained 14½ lbs. in weight by Potato-food, in 93 days, a second the same age, weighing 118 lbs, fed with the same food, in 208 days gained 48 lbs in weight. When the Pig is a year old, his weight is only kept up by Potato-food.

A second pig 8 months old, weighing 120 lbs, fed with potatoes, whey, butter-milk and kitchen waste, gained 124 lbs in 97 days. Nine pigs, weighing 1174 lbs, gained, with the same mixed food, 826 lbs in 97 days, each averaging 92 lbs.

=duction would have been observable had population increased according to the laws of natural progression

But exterminating wars following one upon another, limited the number of inhabitants in almost all european countries, and prevented their natural increase; so that, in the war time, a special want or a pressing dearness, did not make itself remarkably felt.

If the wars had not occurred, and the Continental populations had increased in the same ratio from 1790 to 1815 as they do at present, several millions more of human beings would have been living in the famine years of 1816 and 1817, and those who remember that time will not be able to doubt, that, in such a case, many european countries would have experienced horrors which the Middle Ages never knew.

In the following years the relations between production & consumption were reversed; the prices of corn and goods fell in an unusual degree, until, in the middle of the year 30, (der dreissiger Jahre) a sort of balance was restored by the increase of the population. From that time begun the enormous emigration, the final cause of which, amongst many others, is, that the working people do not, in their own country, gain enough by their labour to support themselves.

In spite of the immense emigration, the number of corn, potato, and meat consuming individuals, has increased from 1816 to 1846, 54 per cent in the Kingdom of Prussia, very nearly as much in Saxony, 27 and 26 per cent in Austria and Bavaria, and in like proportions in other countries. Doubtless a portion of their wants are supplied by a large area of land now taken into cultivation and yielding crops, which formerly did not repay the husbandman. But let us think of what would have been the condition of this population in Europe, had the accidental circumstance of the introduction and use of Guano since 1841 not occurred, by means of which the production of food upon the exhausted, and, by systems of plunder, still becoming exhausted, soils of europe has been raised?

We may assume that by manuring a field with Guano, for every pound of this stuff, in from 4 to 5 years 5 lbs more of corn or corn value (Wheat, Barley, Oats, Potatoes, Clover) will be obtained from the land than the same land would have yielded without it.

The Duke of Argyll mentioned in his Speech at the Opening of the British Association in Glasgow in 1855, that from 1841 to the year 1855 upwards of 1,500,000 tons or 30 millions of cwts (centner) of Peruvian Guano had been imported into Great Britain, and that we should not exceed the right estimate if we said that in that period, a total of 2 millions of tons or 40 millions of cwts had been imported into Europe. (In the year 1841 2881 tons were imported into England, 286,000 tons in 1859.) From this we may reckon that with the help of Guano, in a period of 15 years, 200 million cwts (centner) of corn and corn-value more have been produced upon

than the
European soil, restricted to its customary manure, could have yielded. This supply of manurial matter, synonymous to an importation of Corn and Cattle, is sufficient to feed perfectly 26 3/4 ~~of~~ millions of human beings for one year, or 1,800,000 annually for 15 years. In this calculation the years from 1855 to 1862 are not included, in which the importation of Guano amounted, at the least, to as much as in the 15 years previously.

Admiral Moresby who was stationed on the Coast of Peru, reported to the English Government in the year 1853, that according to his measurement and including the Chinchas Islands, the store of Guano at that time could be rated at 8,600,000 tons, or 172 millions of cwts. Since that time (according to Pusey) 3 millions of cwts (150,000 tons) have annually been imported by England alone, and in regard to the number of tons imported by the United States from the Chinchas Islands, which evade (ueber-treffen) the British Ships, Admiral Moresby declares "that by a moderate calculation of the exports, the islands will, in 8 or 9 years, be exhausted "of the good sorts of Guano saleable in the English market". "It is "true", says Pusey "that according to the statements of the Peruvian "Government, the north and south districts still contain 8 millions "tons of Guano, but if we take into calculation the airy wideness "of Spanish arithmetic, it is to be feared that these other districts "will not be able for many more years to yield what we require".

"The Guano trade is a monopoly of the Government, and "we have been told that in this free Republic Don Domingo Elias "was, last Summer, sent to the House of Correction at Callao, because he openly maintained that the beds of Guano would "be consumed in 9 or 10 years".

This is certainly no proof in support of the opinion that the Peruvian Rulers themselves believe that the provision of Guano will last much longer.

But we will assume that Admiral Moresby himself was mistaken, and that the Store was three times greater than he reckoned it to be in 1853; at the best European Farmers would have the prospect of supplying their requirements for eighteen years. But what will happen then?

The number of the inhabitants of the Zollverein States, including Hanover and Oldenburg, amounted in 1858 to eleven millions more than in the year 1818.

Let us assume the food, daily necessary for the full nourishment of a man, to be two pounds of corn-value, this makes yearly, per head, 7 1/4 cwts of corn-value.

Consequently, in the year 1858, the population of the Zollverein States consumed 80± millions of cwts (Centner) of corn-value more, than in the year 1818, and if the population increas

in the same proportion it will be necessary for the soil of the Zoll-verein States to produce every year 2 millions of cwts of corn-value more than in the previous year, in order to support the growing population; and the question here comes, what prospect have our Farmers of obtaining this extra supply of food, with the materials to which they will be limited, when the importation of manurial matters from foreign countries ceases?

In the last ten years the British and American ships have searched through all seas, and there is no small island, no coast, which has escaped their enquiries after Guano. To live in hope of the discovery of new beds of Guano would be absolute folly.

With regard to the importation of corn from foreign countries (trans-european) we know that no country in the world is in a condition to export corn perpetually, and especially in respect to the United States, it is known how very much the agricultural conditions have altered there, and how they yearly become worse. When Guano was first imported into England, the American Farmers, with a kind of pride, looked down from their rich soil upon the exhausted soil of Europe, and during the last year the consumption of Guano in North America was greater than that of all the European States taken together. We cannot deceive ourselves respecting the state of Agriculture in America. In the year 1850 the Union numbered 23,191,876 inhabitants, in the year 1856 the number was raised to 27,605,527, in six years the population had increased 4,605,527 (3), that is, about the number of the entire population of the Kingdom of Bavaria. In the year 1856 the inhabitants of the Union consumed 33½ Million Cwts (centner) of Corn and Corn value, more, than in the year 1850. If we assume that in the year 1850 this entire quantity more than was required for home Consumption, was produced in North America and exportable to Europe (in 2100 vessels each of 800 tons burthen = 1600 cwts) it is certain that an equal exportation was impossible in 1856.

Naturally, an exportation of corn can only take place from a fertile country with a small population in relation to the soil area. After a series of years the productive power of the soil diminishes; it yields less corn than formerly, and the number of the corn-consuming individuals increases. The consequence of this is that the exportation lessens; very soon the time arrives when it ceases. Still before this time comes there is a breaking up of the Farms. Robbery improves the art of robbery. In this country, after a further series of years, the State of matters is reversed, the small Peasant Farmer is unable to maintain himself upon his Farm, because by the continual decline of the crops of his fields, it is no longer possible to get a livelihood for himself and his family. While formerly 20 acres

were sufficient for this purpose, 40 acres are now required. He sells his land, and wanders forth with the rest of his possessions, or he starves and becomes a Day-Labourer to a great Land-owner. This Proprietor introduces an intensive system of agriculture. He lessens the number of his corn fields and increases the fodder-fields which must yield the manure wanting for his corn fields. In this manner his corn land diminishes more and more continually, and at length his estate becomes a great Cattle pasture. Great areas of land fall into the hands of a small number of Proprietors.

This is the natural course of a system of plunder in agriculture which in no country has been carried on on so large a scale as in North America; but if, which is incredible, there were a constant increase of production in the United States, the whole of the above assumed enormous exportation of corn, would only furnish the populations of Europe with their daily necessary food for about 6 days, and England, France, & the German Confederation, for only two weeks.

According to the Import Statistics of the British Ports, the whole amount of corn brought from North America in late years has not been more than sufficient to feed the population of Great Britain for 5½ days. In the year 1861 the wheat imported was 8,900,000 Quarters *

After these statements, every endeavour to sustain the European People in their delusions respecting their future conditions, appears like a crime.

The increasing deficiency of manure, which no farmer is able to deny, the ever-growing necessity of supplying from foreign sources, the plant food-stuff wanting in the european soils, is surely, an irrefutable evidence of their growing impoverishment.

A combination of contingencies has increased, to such a degree, the number of inhabitants in all european States, in a proportion not corresponding to the {productiveness / producing power} of these countries, and therefore, unnatural, that it can be maintained only, with prescient management, under two suppositions:

1. If, by a miracle, the soil can again obtain the fertility of which it has been deprived by stupidity and ignorance.

2. If beds of manure or guano are discovered of about the extent of the English Coal-Fields.

No sensible man will consider the realisation of these suppositions as either probable or possible.

In a few years the stores of Guano will be exhausted and it will

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* Before the removal of the Duty on Corn, the purchase of corn required from Foreign Countries amounted to 5 million pounds sterling, after the removal of the duty this rose amounted to 19 millions pounds. (Roscher).

then require no scientific, or if you will, no theoretical explanations to prove the existence of the natural law which bids men to be careful to maintain the conditions of life, and how the violation of this law revenges itself. The nations will be compelled, in Self-preservation, in order to restore the balance mutually to murder & destroy each other in incessant and horrible wars, and if, which may God forbid, two years such as 1816 and 1817 should follow each other, those who lived to see it, would behold hundreds of thousands die in the streets; if there were a war, the mother, as in the Thirty Years War, would drag the body of the slain enemy to her house in order to still the hunger of her children with his flesh,* as in Silesia in 1847, people would dig up the bodies of animals dead from disease, in order to prolong their agony with the carrion.

These are not uncertain, obscure wise-sayings, pictures of a diseased imagination, for Science does not prophesy but calculates; not the <u>If</u> but the <u>When</u> is uncertain. If, from a thousand gold pieces, the weight of one piece is filed off each day, the difference of weight, from one day to another, alters very little. It would not escape the notice of the Mint warden with his fine scales; in ordinary traffic no one would, at first, notice it; every ducat is not filed away equally, and if two ducats are compared the difference appears accidental. If this filing off were repeated a thousand times, of the great sum nothing would remain. In this way the modern farmer treats his land. His experience is self-deceit and his opinions on the nature of his soil are inherited lies. He feeds the Cow which gives him milk, with the flesh which he cuts from her ribs, and believes that she will always give him milk.

English Angriculture is an instance of the destructive encroachment upon the circulation of life, on the part of a highly civilized nation.

The importation of bones began in the last quarter of the last Century, and has continued, without interruption, up to the present time. The importation of Guano began in the year 1841; in the year 1859 286,000 tons (or 5,720,000 cwts) were imported; the average importation of bones amounts to from 60 to 70,000 tons. One pound of bones produces in three rotations 10 lbs of corn value; one pound of Guano, in a rotation of 5 years, 5 lbs of corn-value.XX

Without committing any fault, we may assume, that from 1810 to 1860, a period of 50 years, 4 millions of tons or 80 million cwts of Phosphates extracted from bones, have been imported in the form

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* When, in Nördlingen, one of the Besieger's towers was taken and burnt by the Citizens, their famished hungry wives precipitated themselves upon the half burnt bodies of the enemy, and took portions of them to their houses for their children.

XX These figures are taken from Practice, and are far from conveying an expression of the full efficacy of bone-meal and Guano. For 100 lbs of bone-meal contains the quantity of Phosphoric acid in 2,600 lbs of wheat grain, or 5,700 lbs of Clover hay, or 17,000 lbs of Potatoes; 100 lbs of Guano contains the amount of Phosphoric acid in 1,300 lbs of wheat-grain, 2,850 lbs of Clover, or 9,500 lbs of Potatoes.

of corn, pulse, rape and linseed cake, bones, and bone ash, which have produced upon English soil a tenfold quantity, or 800 mil.=lions of cwts (Centner) in corn value, sufficient for the sustenance of 110 millions of men.

If we assume that from 1845 to 1860, that is in 15 years, the english fields have yearly been manured with 100,000 tons, ma.=king a total of 15 millions of tons of Guano, this has produced 7½ millions of tons, or 150 millions of cwts of corn-value, suffi.=cient for the sustenance of 20 millions of men.

It is further clear that if the Phosphate imported since 1810, and the Guano constituents imported since 1845, had remained in circulation upon english soil without any loss, this soil with these, would, in the year 1861, have contained the main conditions for the production of food for 130 millions of men.*

This calculation stands opposed to the alarming fact that Great Britain does not produce annually enough to feed her 29 millions of inhabitants, and the consequence of the intro.=duction of water-closets in most of the english towns is the irrecoverable loss, annually, of the conditions for the reprodu.=tion of food for 3½ millions of men

By far the greater part of the whole prodigious quantity of manure stuff yearly imported by England, flows again in the rivers to the sea, and the products obtained by it are not sufficient to meet the demands of an increasing population.

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* If a solid aliquot part of all the soil constituents carried away in the crops is, annually, for ever lost, the continued proportional importation of manurial matters, carried on so long as it may, is not in a position really to improve the quality of the soil. After a short series of years the soil will remain in a constant, stationary condition. If, yearly, half of the imported manure-constituents dis-appears, the condition is the same as if the annual importation had amount.=ed to double the quantity, as is really the case, and as if, then, from one year to another, all imported manure stuff were lost. If only a third dis-appears every year, the stationary condition is the same as if the yearly importation amounted to threefold the actual quantity. p. 128.

It follows from this, how much manure could be obtained for the land by a little improvement in the sewers and drains (latrines). If England yearly imports an average of 200,000 tons Guano, and 100,000 tons of bones, and if of this only a third is lost, the relation in about 12 years is, as if 600,000 tons of Guano, and 300,000 tons of Bones, were an.=nually imported, that is, the crops of the english fields would rise in just the same proportion, as if they had been manured with a three-fold quantity of these manures.

The evil is, that the same process of self-destruction is going on in all European Countries, if not on the same great scale as in England. In the great Continental States the proper authorities yearly expend large sums, in order to make the conditions for the restoration and maintenance of the fertility of the fields unattainable by the Farmer.

In Bavaria, one of the richest and most fruitful of the countries in Germany, the average crops of the proverbially rich corn countries of the Danube, have, year by year, noticeably diminished, they are now already lower than the average corn crops of the Rhine Palatinate.*

In order to estimate the condition towards which bavarian Husbandry is advancing, it will suffice to mention here, that in last year, the chemical Manufactory at Kenfield near Aibling sent 15,000 cwts. of Bone-meal to Saxony, where, no doubt, its value was better known.

For 25 years this exportation of Phosphates from Bavaria has continually increased, and that which is sent from the Factory at Kenfeld is only a small part of the whole. In the town of Munich alone, above 25,000 cwts. of bones are annually obtained which for the most part go into foreign countries, & I do not believe I should much exceed the right number if I estimate the quantity of bones annually exported from Bavaria at 120,000 cwts. /centner/. This is no large quantity, not more than the district-direction of Bautzen in the Kingdom of Saxony, imported in two years. /According to Dr. Lehmann's estimate./ But with each cwt. of bone-meal an essential condition for the reproduction of 2600 lbs of wheat-grain or corn-wort is withdrawn from the Bavarian soil, and the annual exportation of bones corresponds, accordingly, to a deficiency in a future year of 3 million cwts. of corn. But what is withdrawn from the land in the bones, is again only a small part of that which is

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* The high price and the demand increased in an extraordinary manner the cultivation of tobacco in the Palatinate in the past ten years, in the year 1853 an eighth, in the year 1857 in which tobacco production attained its maximum, as much as a sixth of the whole cultivated surface was planted with tobacco; but how quick was the recoil. In the year 1858 the tobacco ground amounted to only an eighth, in the year 1859 to only a ninth, in the year 1860 to only a tenth of the total surface, and, whilst in 1856 the average profit per day-work amounted to from 8 to 15 cwts., it had fallen in 1860 to 7¼ cwts. That is rather more than 1/8th. From 1856 to 1860 429,000 cwts. of tobacco were produced in the Palatinate, and the soil lost about 80,000 cwts of ash-constituents. Nothing can be more certain, than that the cultivation of tobacco in the Palatinate will be extinguished, like a lamp when the oil is spent, if the palatine farmers do not learn the multiplication table, and with it, to calculate at what price they sell their land in the Tobacco.

lost in the towns by the blamable negligence of the Authorities, and indifference of the inhabitants towards agriculture. During the last hundred years much wealth has been accumulated in Bava=ria, chiefly by the exportation of corn, and what the country has gained in silver and other valuables, it has lost in the value of the soil. It is maintained that Bavaria still produces more than 34½ millions of cwts. of corn-value (the requirement of its population); but careful estimates would show, that the excess is of no amount, in no case can this more-production be of any duration; as soon as the limit is reached, must begin the flowing back of this accumu=lated wealth. The continued prosperity of a country is only possible so long as the source of its prosperity remains inexhaust=ed, and it is a more pressing necessity in Bavaria, as an agricul=tural State, than in any other part of Germany, that the fertility of its soil should remain unimpaired, which, naturally, can only hap=pen, if the conditions of its fertily are not carelessly & uselessly wasted. In these things it is most dangerous to pay attention to the opinions of the Farmers, of whom, scarcely one in a thousand understands his land, and is able to give an account of his management.*

No one knows how much store of plant-food there is in the soil, and only the fool believes it to be inexhaustible. No ones knows how much he has, every one can know how much he spends. From this we must not infer that we are to torment the soil to give more, but that we are to learn good economy. A boy can calculate how much producing-power remains in a field after a hundred years, if we annually extract from it but ½ per cent, but if we provide this ½ per cent every year, the land, after a hun=dred years, and for all time to come, will yield the same high crops of grain.

If we reflect, that in Bavaria only ¼, annually, of the conditions for the production of the stock of grain required yearly by its inhabitants, is lost, this amounts in 100 years to 860 million cwts. (centner) of corn-worth. No country is rich enough, after a certain time, to purchase back the wasted conditions of life, and were it rich enough, there is no market in the world where they can be bought.

It is so much the more difficult to employ the right reme=dy for the chronic sickness which destroys the european people, because as the sick man does not believe in his disease. The people

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* How can he become wise, who guides the plough & whose glory is the Goad with which he drives the Oxen, and who manages their work, and can speak only of Oxen? He must think how he must plough, & early & late must give food to the Cows. (Sirach. ch 39. v. 26, 27.

are in the condition of a consumptive patient, whose glass reflects a picture of health, who interprets his sufferings in the most favourable manner, and only complains of a little fatigue. Just so the farmer complains only of a little weariness in his fields, for the rest nothing is wanting. The consumptive patient thinks a little wine will recruit his strength, which his physician will not allow him to take because it promotes the development of his disease, so thinks the Farmer also, a little Guano will do his land good, and with it he hastens its exhaustion. It is years before an insolvent bad householder declares his Bankruptcy, when he has first made all his friends and relations poor, and put his last silver-spoon in pawn, then he gives out the delusive hope of deliverance.

So the sinking down of the people to a state of fixed poverty and depopulation, is a slow, centuries-long process, but the day is appointed, when in all european countries, the children will learn that they must atone for the sins of their fathers.

No people and no nation upon the earth has maintained itself, who have not, ~~known how~~ to maintain the conditions of their continued existence, and increase; and all countries and regions of the earth in which the soil does not receive back from the hand of man the conditions for the return of the crops, we see fall from a period of thickest population to desolation and barrenness. The hope, with which many comfort themselves, that land in Greece, Ireland, Spain, or Italy, which we know once yielded large crops of Grain, which it does not yield now, could again be restored to permanent fertily by the best husbandry, is perfectly futile. The emigration from Ireland has continued for a hundred years, & the population of Spain or Greece will never again be able to overstep a certain, very narrow limit.

Great Britain robs all countries of the conditions of their fertility; she has already rans-acked the battle-fields of Leipzig, Waterloo, and the Crimea for bones, and consumed the accumulated skeletons of many generations in the Sicilian Catacombs, and still destroys yearly the return, to a future generation of three and a half million men: we may say, that she hangs like a vampire on the throat of Europe, and sucks out its heart's blood, without any necessity and without permanent benefit to herself.

It is impossible to think that such a sinful usurpation in this divinely ordered world should remain unpunished, and, perhaps, earlier than in other countries, the time will come for England, when, with all her wealth in Gold, in Iron and Coal, she will be able to buy back the thousandth part of the conditions of life which, for centuries, she has so criminally squandered.

I know well that nearly all who practise agriculture

cherish the belief that their method is right, and that their fields will never cease to bear fruit, and this has spread among the people the most perfect carelessness and indifference respecting their future, so far as it depends on agriculture. This may have been the case with all nations who owe their decline to their own acts, and no statesmanship will avert the european States from this end, if the Governments and People do not give the due attention to the signs of impoverishment in the soil, and the serious warnings of history and Science.

National Economy and Agriculture.

In his immortal work on the Sources of the Wealth of Nations, Adam Smith says (German Edition by Ascher, p. 169):

"All that increases the production of food in a country, increases
"not only the value of the soil, upon which the improvement
"turns, but at the same time the value of other possessions, by
"occasioning an increased demand for their production. The
"abundance of means, which are in the possession of many
"people in consequence of the improvement in land is the
"great cause of the desire for the precious metals & jewels, as
"for all other objects of convenience and ornament in houses,
"clothing, furniture, and equipage."

"Food forms not only the chief part of the wealth of this
"world, but it is the abundance of food which invests many
"other possessions with their principal value"

"The population of a country is adjusted, not according
"to the number of people it can furnish with house and
"clothing, but according to the number it can feed. If the
"last is present, it is easy to supply the first." (Page 158.)

"And if human regulations had not disturbed the na-
"-tural course of things, in every civil society, the development
"of the wealth and prosperity of the state would have ad-
"-vanced, in a uniform degree, with the improvement of ag-
"-riculture" (Page 373).

"By wars and revolutions those sources of wealth which
"spring only from commerce dry up. That, on the contrary,
"which springs from the firm ground of soil culture, is far
"more enduring." (I, p. 409.)

If I here bring forward these views of Adam Smith upon Agriculture as the source of the wealth of Nations, and the prosperity and increase of populations, it is not because they contain any thing new which has not been known for thousands of years, but because, in his work,

these truths were first proved and brought home to the consciousness. It is so much more to be wondered at, that the Science of National Economy which Adam Smith created nearly a hundred years since, has given scarcely any attention to the closer investigation of the nature, abundance, and permanence of these sources, and has considered the subject as foreign and not belonging to her, but to other Sciences, whilst they are her peculiar foundation, and all the laws of social life are dependent upon her.

Since the means which serve for the support of human life, only support life by their own destruction, the duration of life in a number of individuals is dependent upon their continual reproduction, and their increase is dependent upon the progressive increase of these conditions of life. National Economy assumes, as if it were self-evident, that a field which has yielded fruit, is always, into its original state, by human labour and a certain experienced management, and that thus, if a soil has produced an effect (yielded fruit), no part of it is consumed.

"well tilled soil", thinks Adam Smith, "stands in "relation to the quantity of manure, which, in the greatest "part of an extensive country, the farm itself yields, & "this depends upon the number of the Stock of Cattle."

In Adam Smith's time men had no conception, or a very indeterminate conception of the reason of the fertility of soils, and the opinion prevailed, in the minds of most men at that time, as well as hundreds of years before, that the working man could obtain his field-crops by labour and skill. "In "the vineyard a treasure lies buried, which may be discovered by "digging it over." The metallurgist of the last century believed that his skill produced lead and iron from the lead and iron ore, and that it might discover a process for making silver or gold out of the lead. The physiologist believed that in the live-process of plants and animals, iron, lime, & phosphorous [were] might be engendered, and that the stomach might possess the mysterious power of transforming thistles, vegetables, (cabbages) hay, and grain, into flesh and blood; Starch-flour was called Strength-(Kraft)-flour, Meat-broth was called Strength-broth, and both were considered excellent nourishment.

The Mechanic believed that force (Kraft) originated out of nothing, and that by a clever conjunction of levers and wheels, a machine might be constructed which would work for ever.

"The generative power of the Earth produces field-fruits",

says Adam Smith, "and sowing and ploughing the land
"serves more to its direction than secretial, and the rent to
"the Proprietor is according to the ~~crops~~ produce of this natur-
"-al power which the Tenant has the use of"; something in
the same sense as the proprietor of a waterfall allowing
a Miller to make use of it on consideration of an annual
tax.

The true principles of observation and inquiry were
so little understood and practiced, that what was perceived
and could not be explained, was accepted as self origina-
-ted. As late as the beginning of this Century, even amongst
learned men, the opinion was very general that the earth
had no share in the production of plants.

The german translator of De Saussure's Researchs
on vegetation, Dr. Voigt, says in the year 1804 in the
appendix of this book (page 187) - "I believe I have sufficiently
"convinced my readers of the untenableness of the assertions
"(of De Saussure), for, ~~they~~ he declares that the constituents of ve-
"-getable growths are always taken up from the soil, and
"chemical analysis would not be able otherwise to explain
"how they are contained in the plant." Dr. Voigt assumes
it to be decided, that Potass, Lime may be produced in the ashes
of plants by the chemical process of combustion, and he con-
-firms the following hypothesis upon the origin of these
matters: "I am inclined," he says (p. 62), "to assume with
"Trommsdorf, that the so-called Nitro-gen plays an im-
"-portant part in the process of incineration, and per-
"-haps essentially contributes to the formation of lime &
"particularly of Alkalies, &c." We must bear these ideas
well in our mind, which comes before us now as if they
lay centuries behind us, in order to comprehend how im-
-possible real progress in agriculture was, so long as they
prevailed. All methods were considered good by which
higher crops were obtained from the soil.

In consequence of the development of the natural
Sciences these ideas upon the causes of all things (allergründ-
-lichste (?)) have altered.

The metallurgist of our time knows that his lead-
-ore already contains all the lead, silver and gold, which he
is able to get out of it, and that his art does not produce
but separate.

The Physician believes no longer in the healing
power of his remedies, in remedies which cool or strengthen,
in salves which cure wounds.

The Physiologist knows that the principal con-

=stituents of the blood is present, already ready made, in thistles as well as in cabbages and grain, and that the stomach does not produce, but simply separates and re-moulds.

The mechanic knows that the machine creates no power but only gives out in work, the power with which it has been endowed.

In the same way we know now that the soil is used up (consumed) in exact proportion to the field-fruits it has yielded, which are employed for the life-purposes of human beings.

Whilst the artisan works according to a pattern, the artist according to an idea, the work of the farmer is subordinated to the directions of natural laws, and his problem is precisely that of the chemical manufacturer, which is, that he brings together his efficacious materials (working) in relations most favourable to their producing the results which he aims at, without further help from him.

No man is able to produce soda or soap; these products are the result of chemical forces, and as these only act in the closest proximity, the work of the manufacturer consists in bringing the elements together in the most suitable form, to which end he uses mechanical means, or the heat of his smelting or other furnaces; in this way he removes the resistance which prevents the action of the chemical forces.

In the same way, the farmer can produce no field-fruits, but his work is to enable certain constituents of the air, water and soil, to operate, under the influence of sunlight and heat, upon a special activity which rests in the seed, so that the plant originates from the bud. In all his actions he must consider that the plant is a living organism, which requires light, air, and space, in order to extend its working instruments upwards and downwards, he must remove every thing pernicious or obstructive which would injure the activity of the plant, and must therefore take care that nothing is wanting in the soil in the necessary materials for the erection of this very composite machine, the plant, that it may create and produce much increase.

If the soil does not contain this material, labour is useless, for in itself it does not make the land fertile. The soil is the source of all the goods & valuables which are used by man in his necessaries of life, and the {prosperity / wealth} which accrues to a country by husbandry, may, according to this, be traced back to certain constituents of the soil which are essential to the obtaining of agricultural products.

In two equally great States, under equal relations,

the population and aggregation of human beings, will stand in relation to the contents of these matters in its soil.

The consumers of field-fruits, corn and flesh, waste and destroy, only for the maintenance of their life-functions, only those elements of food which plants obtain from the air, and it is an order of nature that the matters which the soil gives up to the plant, and which men and animals consume in their food, are indestructible; within a very small portion they leave the body again in the form of products of transformation of matter, and retain always and unaffected, their power of re-producing the same quantity of food, if they are given back to the land. To the individual who has consumed them in food, these matters after they have again left the body, are perfectly valueless, and certain pernicious effects (in consequence of putrefaction and decomposition), compel men to remove them from the neighbourhood of their dwellings.

It is, therefore, clear, that the maintenance of the wealth of a country is essentially dependent upon the preservation in the soil of the whole sum of its active matters.

With every bushel of corn the farmer takes from his land the conditions for the production of an equal bushel of corn, and a country which exports yearly a million bushels of corn, loses with it the power in the future of producing an equal value of corn for the sustenance of its inhabitants. The corn-exporting country barters certain soil-valuables for other valuables (gold & silver) which satisfy no human requirement, and for these gives away its power of producing and incessantly accumulating wealth in the future.

It follows from this of itself, that every country must become impoverished by the continual exportation of corn, and also by the needless waste of the accumulated products of the transformation of matter, by the town populations. The loss to the country which a town occasions by the waste of the soil constituents of a million bushels of corn, or corn-values, is quite equal to the loss sustained by the country in the exportation of a million bushels of corn.

It is further apparent that, for every country which has exported corn for a series of years, or in which arrangements do not exist which make it possible to the farmer to obtain again the matters requisite for the continuation of his industry, a time must come when the exportation of corn ceases, and when, by degrees, the requirements of the rising

population compels them, if they do not produce any other valuable commodities with which to barter corn or corn-worth, to send away their accumulated wealth in gold or silver, in order to purchase corn or corn-value, or the wasted conditions of the fertility of their fields in the form of manure or manurial matters. The importation of corn is no certain indication of the infertility of a country, the importation of manure, on the contrary, is always a proof that the crop-producing power of the fields has diminished.

It requires no particular explanation to make it evident, that the cultivation of soil, even by the most complete mechanical contrivances, is insufficient to maintain the crop-yielding capability of the fields. After a series of years the crops fall off even on the most fertile soil, and they can only be restored by manuring. The improvement of the physical qualities and draining the land, strengthens the action of the farm-yard manure, that is, higher crops are produced upon a drained field with the same quantity of manure, or with less manure for a period of time, as high crops as formerly. Conformably to this, the farmer points to the system of rotations (involving home manuring – Stallmistwirthschaft), as well as to the draining of the land, as progress in agriculture, which, considered by themselves, they are not.*

That, ~~cultivation~~ tillage alone, must always, by degrees, be making the soil poorer, and at length must exhaust it, every one sees, we know that by it nothing is given to the land, but that in the crops something is taken from it; but that manuring with self-produced home manure and draining, are equivalent to mechanical tillage, is not so easily understood.

In order to comprehend this, we must bear in mind what is aimed at in mechanical tillage. Not taking into account the conformable mixture of earthy particles, which have afforded food-stuff to the plants of previous crops & have become so much the poorer, in consequence, in comparison with others which still possess their entire contents, tillage does this, it spreads about in the soil, & renders available for the roots of succeeding plants, portions of food-stuffs which were not available before; this happens by means of the chemical action of the atmosphere and water, not by means of the plough and the harrow, these instruments only effect the coming in contact with one another of air & earth particles. For this

* In this and following descriptions, it is self-evident, that that land is understood which contains the conditions which bring about increased crops by tillage, draining, and fallow.

purpose a certain continuance of the action of the atmosphere, or time, is required, in order to bring a given quantity of food-stuff in the soil, into a sufficiently diffused and available condition. By further pulverising and frequent ploughing, the change of air in the interior of the porous earthy particles is promoted, and the surfaces upon which the air should act are renewed and extended, but it is easy to understand, that the increased crops of the field cannot be proportional to the labour expended upon the field, but that they are augmented in a far less proportion.*

A double amount of tillage (arbeit), will not insure the availability (aufnahmsfähig werden) of twice the quantity of particles of food-stuff, which ordinary tillage would do in a given time. The quantity of these matters is not always equally large in all land, and in that in which there is an adequate supply, its conversion into an available effective state is not immediately dependent upon the tillage but upon outward (external) agents, which, like the air, are limited in their oxygen and carbonic acid contents, and which, according to their quantity, must be increased in the same proportion as the tillage, if this last produces a corresponding useful result. The increase in crop which many soils yield by cultivation, stand therefore, rather in relation to the labour, if the duration of the influence of the atmosphere and of water upon the earthy particles, is prolonged. The farmer knows, if he increases his time of labour, that, as a rule, he succeeds in produces an increase of crop, proportional, and often more than proportional, to the labour.

Fallow rests upon the laws of these natural relations of the atmosphere and water to the soil and its cultivation.

If the effect of a determined quantity of labour, therefore, is that a given field, in a year, gives up a greater amount of food-stuffs to the plants growing upon it, than it does without the labour, and that the farmer succeeds in augmenting the effects of the atmosphere upon the field in exact proportion to his labour, a further increase of the crops will be the result of a further combined action of labour & atmosphere upon the field, a result standing, under other equal circum-

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* This law was first propounded by John Stuart Mill in his "Principles of Political Economy," Vol I, p. 17, in the following manner:- "That the produce of land increases ceteris paribus in a diminishing ratio to the increase of the labours employed, is the universal law of agricultural industry:" remarkable enough, since the reason of it was unknown to him.

=stances, in relation to the degree of the action allowed. The influence of Draining upon the rising of the crops, will now be easily understood.

The water, stagnant or in motion, in the soil, pre=vents the contact of the air with the deeper layers of the soil, & obstructs its useful effects upon the earthy particles. Draining not only draws off this water & renders the earthy mass accessible to the air from above, but, what is much more important, it allows the restoration of a feeble, but continual, circula=tion of air, in all the layers of soil, from the drain-pipes upwards.

Since, as we remarked, the ploughing of the field, besides mixing the soil, has for its object the bringing in contact with one another the air and the soil, and by the laying of a subterranean system of pipes the action of the air upon the soil is strengthened, - that is, since, in the under portions of a drained field, a very much greater number of air par=ticles come, in a given time, into reciprocal action with ear=thy particles, it can be understood that a drained field in fallow, receives again in a shorter time than an undrained one, the same qualities favourable for plant growth. The plough brings the earthy particles into motion, and increases their contact with the air particles; drainage effects a movement of the air particles, and increases their contact with the earth particles, so it is true, that the final result of mechanical labour and drainage is one and the same effect upon the field, both reinforce the action of the atmos=phere upon the land.

A drained field gives, with equal cultivation, & under other equal relations, more food-stuff to the plants growing upon it, than one not drained.

The rotation system, involving manuring, (Stall-mist-wirthschaft) with the manure produced upon the farm itself, is, as above remarked, only a peculiar form of labour.

If the Farmer, together with draining, had mechanical ways and means at his command which would enable him to collect the unequally dispersed and scattered plant-food substances in the land, and augment and accumulate them in the surface soil, he would not hesitate to do it. By the cultivation of Fodder plants, the Farmer, as a rule, aims at nothing different; by means of their roots, which in their manifold ramifications penetrate deeply in the earth, they take up the food-substance scattered in the underground layers. A great part of this is accumulated in the leaves and stems of clover, or the root-stocks of turnips (rüben), &

in this last form it is used, finally, as Dung, serves to enrich the surface soil.

By the incorporation of the organic constituents of Farm-yard manure in the soil, there arises a perpetual formation of carbonic acid in the earth itself, in consequence of the decay of the manure, which has the most influential share in the weathering, dissolving and diffusion of the food-substances in the soil, and, by this means, the effects of the plough and the atmosphere are strengthened and accelerated.

Of two equal plots of land, the one whose surface has been enriched with farm-yard-manure at the cost of its deeper layers, yields a greater crop of all fruits which especially draw their food from the upper portion of the soil, than the other; and of two equal fields, manured equally with stable-dung, of which one is drained and the other is not, the first yields a higher crop than the other, because, by means of the air circulation in the drained field the formation of carbonic acid is renewed, and its effect is multiplied. In both cases the higher yield of crop corresponds, self-evidently, to a greater loss of food-stuffs from the field, and all these means only assist the farmer in carrying away a larger portion of the total sum present in the soil; but since no more of it can be taken away in the form of field fruits, than corresponds to the store existing, and the quantity of which is limited, - it will be understood, that the raising of crops by cultivation of the soil, # with which we must here reckon draining & the system of Farm-yard-manuring, can naturally have no permanence. The larger crops are not obtained by enriching the land in food-matters, but they depend upon the art of more quickly impoverishing the land in respect to them.

The increased crops in several countries since the introduction of the system of rotations, & farm-yard-manuring, & drainage, is, accordingly, no sure mark of progress. Progress in a trade or branch of industry, depends, essentially, upon the acquisition of correct ideas, for these influence (conditions) an economy of the powers (Labour & Capital) requisite for producing the results (~~Labour & Capital~~). "Not trade industry, but frugality, is the cause of the increase of capital." (Adam Smith. I. p. 330.) It is true that these improvements procure for the farmer, for a number of years, a far greater income, but what he gains, he buys with the exhaustion of his land. The population has only a passing use of it, for the increase of food which it will yield in a given time, is lost for the future. Naturally, years of continual failure, must follow years of abundance.

In its principles agricultural management is in no way different from any other ordinary industrial management. The

manufacturer knows that his trade capital will not bear continual deduction without bringing his business to an end so it is to be supposed in rational agricultural practice, that the farmer must increase the sum of the active matters in the soil, with which he produces his crops when he wishes to obtain a larger yield.

The Farmer can only carry on his farm & continually secure high crops, by giving to his land in the form of manure, what he has taken from it in field fruits.

By some teachers of practical agriculture in Germany the opinion is propagated and defended, that it is shown by the effects of fallow, that by means of exposure, the sum of efficacious foodstuffs already present in the soil is increased a certain quantity every year, that this quantity may be lost & no care need be taken for its restitution; the land always remains equally rich in effective matters, since Nature will make amends for that which is carried off.

This opinion may be justified, and if the population of a country did not increase, the restitution of the matters taken off the land in the crops, might be delayed, till the time came that the increase of assimilable food-matters in the soil no longer took place in fallow.

This is naturally only a wanton excuse for that system of plunder, which lays ~~an obligation~~ a duty on its successors, which the man himself from want of knowledge does not know how to fulfil, or will not practise from indolence.

The wisest arrangement has given such a form to the food-materials of vegetables in the soil, that they are only capable of being taken up by plants very gradually and slowly, and by means of human labour. Had the whole sum in the soil been fit for nourishment from the beginning, men and animals would have increased in an unlimited degree, and the history of humanity would have had but a short duration. Even in this lies the secret of the continuation of generations, that man, with all his might, cannot rob the earth of her fertility in the shortest time, as, in his folly, he would willingly do!

The yearly increase, by the weathering process, of the amount of effective food-stuffs present in the soil, is appointed to meet the increase of the populations, and it is in direct violation of one of the wisest laws of Nature, if the present generation believes it possesses the right of its destruction. (or, the right to destroy it.)

~~What~~ That which is in circulation belongs to the Present, & is appointed for it; that which the soil conceals in its bosom is not its possession, for this belongs to future races of men.*

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* Moses I (Gen:) chap. 4 - v 12. "When thou tillest the ground, it shall not henceforth (at once?) yield to thee her strength."

In opposition to Science — which can determine how long, if only a small quantity is yearly taken away without compensation, the store, so small in relation to the perpetuity of the human race, of the conditions of life in the most fruitful land will last — Practice asserts that this store will never be exhausted. But knowledge stands directly opposed to this opinion. This opinion is formed on the experience of what it was today, not of what it will be in the future, it can say, that still a great deal of land yields large crops, that still, yet larger crops may be obtained, that the world is wide and that still hundreds of millions of acres of fertile land have not been touched by the hand of man, and only wait his care in order to yield an abundance of fruit. This is all right, and we may assume without hesitation that to the human race generally, the danger of extinction lies so far off that we do not need to trouble ourselves about it. But we treat here of things lying much nearer home, and, indeed, of the precise answer to the question, what will be the state of European Countries if the field-crops become less year by year, or of England if the importation of corn & manure has reached its limit, or the relations of Bavaria and Hungary when the exportation of grain diminishes and finally ceases.

No one can, rationally, cherish the opinion, that Divine Providence has appointed the European Nations, the present upholders of the cultivation & civilization of the world, to a fate similar to that of the old Greeks and Romans, who, after the fulfilment of a certain mission declined, & fell into poverty, rudeness, and barbarism, and that, therefore, the idea has been planted in the minds of the people that the Earth is inexhaustible in its gifts, and that natural laws secure the perpetuation of the human race. But if only a superficial acquaintance with the Natural Sciences convinces every reflecting man that such laws do not exist, we should think, that the reason of the people would insist that all the means at their command should be employed in order to make their future secure, and that they would impose upon themselves the duty of providing themselves, by the most exact testing of facts which Science and History offer, with the fullest explanation of the present management and future condition of husbandry. Such an investigation, extended over entire countries, and not merely over single fields or plots, would very soon show what confidence can be placed in the opinion of the practical man that the land will never cease to yield crops, or in that of the manure dealers and manure makers, that there will never be a deficiency of manure-stuffs in the World.

By these investigations the Farmer will see with perfect certainty, that only one way stands open to him of securing for all future time, the producing power of his land, and this is, that in his

management he keeps the law of restitution strictly in view, and the people, on their side, will become willing to assist the Farmer in preparing this way, which offers him the possibility of attaining his purpose in the best practicable manner.

If the Farmer determines to restore the food of the plants to the fields which he has taken away in the crops, and if he buys back, each year, in the form of manure, what, in the previous year he has exported in produce, his expenditure will be proportionately small & easy to bear.*

Although the decrease of fertility in a field, from which yearly a portion of its available plant-food is taken without compensation, is only small from one year to another, yet, nevertheless, it is certain, that a time comes when the land will no longer repay the labour bestowed upon it; in the same way, if the farmer gives no more to the land than he has taken from it, the the increase of crops by regular restitution can only annually be small, but, after a series of years, he will find by experience, that he has laid up his money in a Savings Bank, which gives him not only high, but continually higher interest. From a certain period his crops must rise in a regular progression, because by exposure to the weathering process, a portion of the foods-tuff existing in the land is yearly made available for plant-growth, whereby the Farmer's working capital is continually enhanced. If he gives this

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*The opinion that the Farmer must restore to his land as much as he has taken from it, must not be interpreted as if I did not consider it as good, or better, if he gives more to it, in case he can. But of this there can be no doubt. Many wealthy farmers do it, but it can only be because the greater number are ignorant and foolish & do not trouble themselves about restitution; if all were restored, no one could buy back more than he exported.

According to statistical statements, the annual (Wheat, Oats, & Barley) Corn crop of Eng-land & Ireland, is estimated at 60 millions of Quarters, or 240 mil: of cwts, or 12 millions of tons. If we reckon in an air-dried cwt: an average of 0.8 per cent of Phosphoric acid (Wheat & Barley 0.9 per cent, Oats 0.8 per cent) there are taken from the English & Irish fields in these products, 1,900,000 cwts of Phos-phoric acid. In order to restore this in the form of Guano, as one cwt. of Guano contains an average of not over 10 or 12 lbs of Phosphoric acid, there must be an annual importation of from 16 to 19 millions of cwts, or from 800,000 to 950,000 tons of Guano. Bone-meal contains an aver-age of 24 per cent of Phosphoric acid, & accordingly, the above mentioned quantity of Phosphoric acid is contained in 400,000 tons of bones. Since 1848 the average annual importation of Guano into England has scarcely exceeded 200,000 tons, that of bones cannot, at the most, be assumed at more than 80,000 tons.

The loss to the land by the cultivation of other products, Roots, Clover, & Fodder plants generally, is not brought into calculation here.

compensation in the right way, the time to come will afford him the comfortable assurance that improvements in the cultivation of his lands, which previously were only instruments in his hands for hastening their destruction, are truly permanent improvements, and his work will prosper.

If the people, on their part, would make themselves better acquainted with simple natural laws, attention to which would insure, for ever, their future welfare, - if they would keep constantly in mind that no practical farmer is in a condition to give the assurance that the producing-power of the land is permanently recoverable without the importation of manurial matters, that if this importation is dependent upon Foreign Countries, the maintaining & increasing of the crops and the food of the growing population are subject to accidental relations which the people themselves do not control, if, finally, exact statistics prove, that, under the most favourable circumstances, the importation of manurial matters from abroad must come to an end in a comparatively short time (for in this respect, half, or an entire century, is a very short time), they will be able to understand, that on the decision respecting the drainage question of Towns, are dependent the maintenance of the prosperity and welfare of States, & the progress of cultivation and civilization.

The tradesman and artisan can, by industry & skill, increase the number of articles they make, or enhance their value; an industrious shoemaker can make double as many shoes in a day as another, or can make better shoes, whose quality enables him to demand a higher price from his customers. The manufacturer, by the extension of his business and the increased production, can, by quantity, make up the deficiency occasioned by a falling off in the price of his goods.

Without employing all these means for the increase of their income, the condition of Farmers on the European Continent who cultivate their own land has, within the last 20 years, extraordinarily improved, & their trade has been very much more profitable (günstiger) than any other. The reason of this is not that the seasons (witterungs-verhältnissen) have been more favourable, it is not that there have been better & larger crops, not that there has been progress in Agriculture in consequence of which Farmers have succeeded in obtaining more products without increasing the cost of production, but much more in the fact, that the price of all agricultural produce has continually advanced in all parts of the Continent. Besides his cost

P. 153 of production (excepting perhaps day wages) or his produce has increased, the farmer sells his corn & meat, his butter, eggs &c, for a fourth, or a half more silver than formerly, whilst the price of

his own requirements, iron, implements generally, colonial and other wares, have not altered, or rather lessened, & in this way his income has increased. The increased prosperity of the agricultural exercises, at present, a favourable counter influence upon all branches of trade & industry & upon Commerce, and thus all the relations in the State appear to be most flourishing.

The multiplication of markets (Absatzgebiete) by the extension & cheapening of ways & means of communication, does not explain the fact that the prices of agricultural produce have risen in all parts of the Continent. A simple balance would have raised the price in one place, & in another proportionately lowered it, nor can we any better account for it on the ground of bad harvests, which have not, indeed, been experienced in any remarkable degree.

The true reason is this, - agricultural production on the whole, has not kept pace with the advance of population; the number of consumers has increased, but not in equal proportion the crops of the fields. The demand is greater, & the provision is smaller than formerly.

It is of the greatest importance that people should not give themselves up to any delusion in respect to this disproportion, which, if it increase, must exert the most injurious influence upon their fortune and their existence. Self-preservation commands them to give the most earnest attention to the conditions which await them. Every reflecting man must arrive at the conviction, when he weighs well all natural relations, that the future of the European States has no solid, broad basis, but that it quivers on the point of a needle.

If the farmer is not able to bring better knowledge into his business, and procure the means necessary for increasing his production, an equilibrium will be established, naturally, at a certain ~~point~~ period, by war, emigration, famine and epidemic diseases, which will deeply affect the welfare of all, and must finally ruin agriculture. All efforts of patriotic men, to give unity to States, and to strengthen their power of resistance against external enemies — all improvements in national life, and what otherwise may be ordained by Governments and Parliaments to enhance the happiness and welfare of the present and future generations — ~~become~~ will, if the foundation of existence, which husbandry is, be not permanently secured, like the self-seeking Creations of wicked rulers, fall into ruin before the irresistible forces, which invest the continually falling drops of water with the power of transforming the hardest rock into dust.*

* Since the same relations to not exist every where, it is difficult to make propositions which suit all places, and to obtain for

agriculture the manurial matters accumulated in towns.

In many places it would be sufficient to carry out strictly existing police regulations, which prescribe the re-establishment of Water-proof sewers (wasser-dichter Latrinen) and forbid the contents of Conveniences to be thrown into the rivers.

In other great cities, especially such as lie near to rivers, underground conduits and drains have existed for centuries, which are constructed on purpose to remove into the rivers from the towns, as noxious, human excrements, which have the most value as manure

The magistrates of these towns have subjected the inhabitants to heavy taxes for the establishment of such regulations, as make almost impossible the collection of these manurial matters, and the next thing that must happen is to make good the fault committed. The State must take care to put a stop to the foolish waste of these matters wherever it occurs, and to take precautions for rendering its recovery possible. A knowledge and persuasion of the necessity of restitution, and a good will to do it, will first bear good fruit when the ability is given to the farmer to provide himself with the manure he requires, at a price which enables him to employ it. Its collection and transport in a portable form, will then be matters of private industry, about which the State will have no further need to trouble itself.

Evidently, arrangements of this kind will, in many places, cost large sums, which will seem discouraging enough considering that they are for the benefit of a future, but this expense must be incurred once and the prolongation of the present condition produces an irrecoverable & continually growing loss of national power, & in the same degree as this lessens, the difficulties increase of coming to the aid of agriculture at a future time. The sacrifices which the population must make for this purpose, would be proportionately distributed over a series of years, & would surely be very much less than those which Holland made in order to maintain her dykes which defended the Country from ruin by the inroads of the sea. The difference between this & the dangers which menace the people, and agriculture, is only one of proximity. That which is at a distance, appears, both to the bodily & mental vision, as smaller than it actually is; but we must take into consideration that a danger does not cease to exist because it is a long way off, & that if it daily approaches nearer, & besides this, grows in size as its distance lessens, there is reason enough, for taking pre-

=cautious to avert it as early as possible. A small part of the enormous sums which have been spent during the last half century, for Commerce, for extension & improve=ment of ways & means of inter-communication, in Railways, canals, bridges and roads, would, properly em=ployed, be sufficient in a few years, to remove the hin=drances, not placed by nature, but by the folly and ig=norance of men, which Private enterprise interposes to the recovery & use of these substances.

M. Gilbert.
Harpenden.
June 15. 1863.
