

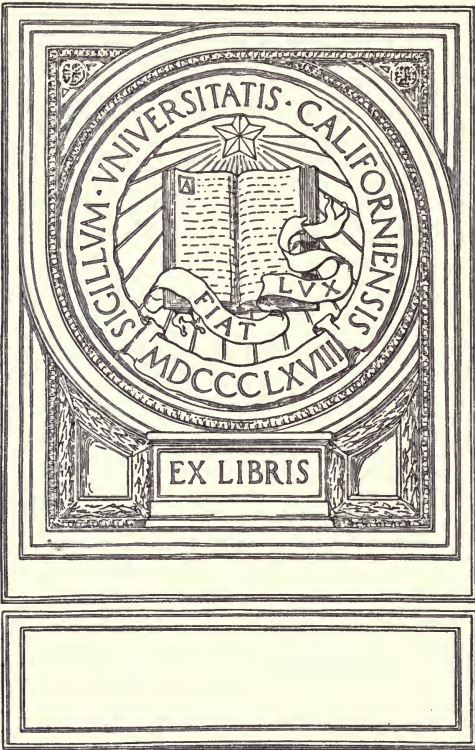
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LECTURE

ON THE

Constitution of Old Pastures and Meadows,

DELIVERED JANUARY 14, 1869.

BY

PROF. WM. H. BREWER.



HARTFORD:

PRESS OF CASE, LOCKWOOD AND BRAINARD.

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NO MORE
ABANDONED

THE LIFE OF

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LECTURE:

Pastures and Meadows, which have not been disturbed by the plow for many years, differ in so many respects from those newly made, and moreover are often so highly valued, that it may be profitable to consider in what this difference consists, and the conditions upon which their superior excellence depends.

We may say that the old ones differ from new ones in at least four important particulars.

- 1st. The texture of the turf.
- 2d. The species of grasses contained.
- 3d. The qualities of the forage, and
- 4th. Their diseases and mishaps.

In these particulars the differences are the most obvious, but in the lesser details, many others might be enumerated.

A true *turf* or *sod* belongs only to temperate or cool and moist climates; to regions where more or less snow falls in the winter, and where the drouths of summer are not too frequent nor excessive. Botanists are acquainted with many thousands of species of grasses, I know not how many, but more than 4000 species have been described, classed in some 300 genera, constituting a well-marked natural order or family of plants, which order stands first in importance to man. It includes all our cereal grains as well as those plants known more familiarly as *grasses*. They are found in all climates, and in all parts of the world. But only those belonging to the temperate and cool parts of the earth form a true sod; and furthermore, only a small proportion of those belonging to any one region, even if not too hot, has this habit. Nearly 200 species of this family are enumerated by Botanists, growing in our Northern States, including all the cultivated cereal grains grown here, but of this number, perhaps not more than 30 or 40 species at most, form any con-

siderable element in our pastures, a vastly less number generally constituting the sod or turf of any one section.

It would be foreign to my present purpose to speak of the grasses of the tropics, some of which grow to an enormous size, and are called bamboos, or the rank grasses of warm climates, some of which are much valued, nor even of those species found even here, which grow in a more solitary way, not making a sod.

It will be seen that the matter of sod or turf depends principally upon climate, no *hot* climate produces it, and no region subjected to excessive periodical droughts produces it. Nutritious grasses may grow there, but they do not form a sod, as we use that word. Perennial grasses may occur there of great value, like the various "bunch grasses" of the Pacific States, or the "Kangaroo grass" of Australia.

Over this matter of climate we have no control, and the finest turf, and the richest pastures of the world are where the climate is mild, the soil not too poor, the summers not too hot, and with some considerable rain during the summer months. The British Islands with their mild winters, their cool, moist summers are noted throughout the world for the excellency and beauty of their pastures. It is the turf of Ireland, with its moist, but mild climate, and its moist soil, which makes it the *Emerald Isle*. The rich low lands of Holland and Belgium are equally celebrated for the quality of their old pastures, and there the rains of summer are abundant.

Many mountain regions, rainy, because mountainous, are celebrated for their pastures; for example, the Alps of Central Europe, where the summers are cool, and the rains are copious and frequent. Switzerland is especially noted for its pastures, in fact the very word *Alps* meant originally an upland pasture, and not merely a high mountain, as we now use it. The upland pastures of Switzerland constitute such a marked feature of the country that they have given their name to the mountains themselves. I shall speak of them again.

It is then in such or similar climates where we have the richest pastures, that the grasses form a turf, and where this

turf is made up of species of grasses that are not individually of large size, of fine grasses rather than rank ones. I have considered the distribution of grasses as determined by the climate, but Science and Agriculture point to another element almost as important; the civilization, industry, traffic, and agricultural systems of the people, and often to historical events. Man carries the grasses of one continent to another, he protects some, he changes all by cultivation. He adapts the soil to them, and them to the soil. If the soil be too wet he drains it, if too dry he irrigates it, if too poor he manures it, and by cultivation he produces new varieties of grasses better suited to his uses.

Let us now consider the changes that take place in the gradual growth of a new pasture into an old one, and to make the case more plain, let us begin with a piece of land newly cleared from the forest, and without grasses, and suppose we do not seed it; for this is what actually took place in the Old World, where their pastures began long before the art of seeding to grass was practiced. In fact, seeding down pastures or meadows artificially is quite a modern phase of agriculture, one that has grown up almost entirely within about a hundred years. Strange it seems to us, but such is the fact.

Well, let us return to our newly cleared land, which, if hill or rolling land, is generally quite poor in vegetable matter, although it may be rich in the mineral ingredients necessary to fertility. The ground will not remain bare. Weeds, and wild and poor grasses will soon come in, and partially occupy it. The first grasses are wild and usually poor, because tough, wiry species can best fight their way and hold their own in the struggle with the weeds, and can best resist extermination by unwholesome conditions. A botanist carefully looking over the soil might find quite a variety of species, but the farmer would pronounce them poor ones. He would say that the soil was "unsubdued," and the grass tough and wiry. As I have said, the soil might naturally be good, but there would be but little vegetable matter just at the surface or near it, and that is where the grasses need it most.

Now, suppose the owner keeps this land for pasture, waging a war against the weeds and encouraging the growth of more desirable species of grasses. Cattle eat off the herbage and leave their droppings upon the surface, much of foliage dies each year, decays, and is mingled with the mere surface soil, and slowly but surely the vegetable matter increases there. The annual crop is drawn largely from the air, and that which is left on the ground does not go back to its original elements quickly, and thus it is that the vegetable matter increases, and especially at and near the surface. But the mineral elements in the soil are also changing, partly from the effects of the air, moisture, heat and cold, and partly from the action of the vegetation itself, one crop of which gets some into a soluble condition which was before unavailable, and as the plant decays, this mineral portion is in fit condition to be used by the next growth.

A change in the texture of the turf goes along with these, the roots gradually form a firmer mat in the soil, the foliage a denser growth above it. The number of individual plants on a given space increases. At first the separate plants were scattered and covered but a small portion of the soil, but they gradually occupy more and more of the soil, and the bare spaces grow fewer and smaller. But this is accompanied by still another change, that of the species themselves. Those species that find the best conditions of their growth, get possession, and gradually crowd out those that are not quite so completely at home under the same conditions. As the soil has been changing, the species growing upon it have been changing. I do not mean that one species is changing into another, but that one supplants or runs out another. The wiry and tough grasses we began with, have been yearly growing less as the soil became richer and the better species had a chance to thrive, for these better kinds will run out the poorer, if the soil is right and they are encouraged.

There has been a change of species, and also a larger number of kinds has come in, because *the soil will support a mixture of species better than any one of them alone*. This is a rule in nature, as well as in farming. Our forests consist of

many kinds of trees and bushes intermingled. Any piece of land left to itself will soon be clothed with a vegetation consisting of many kinds, and you all know that if we wish to grow any one species exclusively, on a given piece of ground, we must take especial pains to keep the others off. We fight weeds, we cut, pull, hoe, plow and wage war generally against them, and yet they will get in, despite all this warfare. Furthermore, if we grow any one kind in successive crops, for example, successive crops of wheat, or corn, or tobacco, or any *one* crop year after year, the soil is sooner exhausted than if we pursue a rotation. So with any pasture, only there the struggle is (or at least should be) between different kinds of grasses; and on any soil two or more plants of different kinds close together will grow with more vigor than the same number of individuals of different kinds. On a given square yard, for example, a greater weight can be grown if there are several species mingled, than if there is but one, and moreover this mixed forage is more eagerly eaten by stock, and is also more nutritious.

Now in an old pasture, the turf is made up of a variety of species, closely intermingled, and this variety makes better forage than any one kind would. If you have never tried it, you will be surprised if you closely examine an old sod, to see how many species go to make it. The nicest turfs have generally quite a variety, and if you do not find such a variety, then it is well to try to produce it, by sowing a variety of seeds, and by manuring and other means, strive to coax them in.

In pastures newly seeded, we commonly see but one or two kinds of grass-seed sown. Observing and thrifty farmers often use three or four, but seldom more, yet in an especially good *old* pasture, we often find two or three times the latter number, some springing up earlier in the Spring, others holding on later in the Fall, and all striving together for room during the Summer. This number of species is an important element among the causes of the firmer turf of such old pastures. If we closely examine a new pasture, even if well seeded with one or two kinds of grass, we will find the ground by no means all covered. There are bare spots between the

bunches of grass. Even on lands that at first sight seem well seeded, these bare portions really occupy as much of the surface as the grass itself, they are partly covered by the overhanging blades, but are nevertheless unoccupied land.

Now, from what I have said, you will see that these unoccupied spots will support a second species better than more plants of the first, because one will take from the soil what the other rejects. But even after a second, and a third kind are growing, there are still bare places that may be used by still another kind, and these *do* at last get in there, until at length the ground is entirely covered.

Now, all of these changes have been going on together, each one constituting a part of the difference between an old and a new pasture.

Since this meeting of our Board began, I have heard several of the members telling their experience or observation on this subject—how some pasture-plot, spared from the plow for many years, has kept on improving, how it has furnished more and more forage, how their stock liked the grass better and better, and how they thrived upon it, and how nutritious the grass was, as shown by the flesh or milk produced. I have in my mind many such cases, even with farmers who devote the most of their land to a rotation.

I do not wish to lose sight of the fact of the *variety of grasses* being an important element in the excellence of such pastures, nor that other fact, that a variety seems more nutritious than a forage of one species exclusively, and is more eagerly sought by cattle, and that we get this variety more commonly in old than in new pastures. So much is susceptible of proof. Furthermore, I believe that a given species of grass gradually becomes better in such an old pasture (if the soil has been kept up,) that it will produce better flesh, milk, butter, and cheese. I say, I *believe* this, but I cannot assert it, because I can offer no positive proofs. But if there are no conclusive proofs of it, there are many things that indicate it. There is the almost universal experience of the increased richness of such pastures, at least for many years. Grass may be improved in quality as well as fruit or grain, and

there are cases somewhat analagous, where the best kinds of certain other products are grown on old rather than new lands. Let me cite some examples.

The most noted wines come from old vineyards, on lands long tilled. New vineyards often produce larger crops, but wines of the richest flavor, those which bring the highest price in the market, come from *old* vineyards where the soil and the vine it supports seem to be so especially adapted to each other that the best wine is the result. Take the same variety of grapes and plant it somewhere else, and it takes years before the best results are produced, and when produced it is unlike that of the original vineyard. It may be as good, but it is not the same thing. A part of this change is due to the different soil, but it is equally certain that a part is due to the change in the vine itself, it adapts itself to the new conditions, and is more or less changed by the process. Go to any wine cellar, look at the various brands and enquire the prices, and you will see how striking is the proof of the fact stated. It is the same with Tobacco. A few years ago, I made a long investigation of some matters relating to tobacco-growing, and was surprised to find how universal was this same rule. This crop is notoriously exhausting to the soil, and hence flourishes with peculiar vigor on new and virgin soils, and has been largely grown on such new soils, which often produce very large crops, but rarely or never of the best quality. The regions most noted for the excellence of the tobacco grown almost universally, are regions long cultivated, and where the varieties grown have originated on or become adapted to those soils. The Connecticut valley, in our own State, the old soils of Virginia and Cuba, settled and cultivated for one to four centuries, are well known examples. And the same facts may be seen in the choice brands of the old world, of Alsace, of Turkey, Greece, Persia, and even China. In fact, I know of no brands of tobacco celebrated for their excellence which do not grow upon old lands, where special varieties have by long cultivation become peculiarly adapted to the soil, climate and other local conditions of their regions.

We find similar facts with pastures. It is true that large

quantities of flesh or milk may be obtained from new pastures, and perhaps even more from land cropped for soiling cattle, but I know of no region especially celebrated for the *excellence* of its butter, cheese, or even flesh (especially of mutton), where the animals are not largely fed from *old* pastures. When you find a farmer whose butter or cheese is celebrated in the markets for their especial excellence, you will find that his pastures are largely of this kind. The dairy region of Eastern New York is a good example in our own country. In Europe, the famous Swiss cheese is produced mostly from pastures that have never felt the plow, and the old pastures of England and Holland are similarly celebrated.

I know not how long a time is needed by a pasture to acquire its greatest excellence, doubtless it is not a definite period, but a time varying with the climate, soil, uses and treatment. I heard a farmer in England say that it took forty or fifty years to get a *good* pasture, according to his standard, but a hundred years was better, and he spoke with special enthusiasm of some that were three or four times as old as that,—but this is longer than *we* wish to wait.

A few years ago I spent two years in Europe, and visited some of the most noted Agricultural regions there. I went directly from a comparatively new section of our own country where the land had been mostly cleared from the forest in a single generation, and moreover it was a grain growing region, the fertile farms of Western New York. Nothing in the Old World struck me more forcibly than the character of the turf. Neither the ruined castles, nor grand cathedrals, nor works of art made a more vivid impression than the old lawns and pastures, with their wonderfully green surface like velvet, their firmly-knit texture like old fulled cloth, the variety of species that enter into their composition, their nutritive value and the quality of their forage, and the excellence of the butter, cheese, and flesh produced.

The mountain pastures of Switzerland, never disturbed by plow or spade since the country emerged from barbarism, are types of one class. For centuries the better kinds of grass have been fostered, a surface application of rotted manure,

added as often as it can be had, the hay seed from the mangers often sown on so that should there be little gaps unoccupied they may be seeded, until now we find the fine texture spoken of. Sometimes such pastures seem to the western farmer poor compared with the ranker herbage of his newly seeded fields at home, but if we compare by the results produced rather than by the height of the grass, their true value will be seen. In his own newer pastures the grass may be higher but it does not so completely cover the ground, there are not so many blades or leaves, nor is there that variety of kinds which makes a more nutritious as well as more palatable forage, and which produces the richest results. On the low and fertile lands of Holland, we may have a more abundant produce, but the excellency depends upon the same features.

I have alluded several times to the final occupation of the soil by those plants just suited to its chemical and mechanical composition. Here we have an important hint for the improvement of pastures. If the desired kinds of grass do not grow well, it is because the soil is not right (always assuming that the climate is good), that is, the soil and plants are not well adapted to each other. We all know that if we wish an especially fine turf for a lawn, we must "sod" it with the old sod of the vicinity, we take the sod from some spot where for years the grasses and the soil have been adapting themselves to each other. If ever we change the character of the soil we change the character of the grasses produced.

I saw, in England, a most instructive illustration of this. A beautiful lawn, adjoining an old mansion, had lain undisturbed by plow or spade for at least 400 years, and possibly longer, and for centuries had been carefully attended. It seemed even and firm as velvet, and was a beautiful sample of such an old turf. A portion of this was taken for experiment, and was staked out into small plots, and on each of these portions some kind of manure was applied. On one compost was used, on another guano, another was manured with crushed bones, or super-phosphate, or nitrates, or salts of ammonia, or mixtures of several kinds, and so on for quite

a series. This treatment had been continued for only three years (if I recollect aright) when I saw it, and although there had been no application of grass seed, yet these plots differed much from the original lawn, and from each other *in the species which were conspicuously prominent*. Grasses not before seen in the lawn at all were flourishing luxuriantly on some of the plots. Before this treatment, other species were better fitted for the soil and hence crowded these out, but with the change in the composition of the soil, these other species better adapted to the new conditions had sufficient vigor to choke out the old ones. Perhaps every one of you is familiar with facts illustrating the same thing, but shown in another way, for the fact is not a new one. Some of the oldest agricultural books in our language say, that one effect of lime applied to land is to "bring in" white clover.

I have dwelt so fully on the number of species in good old pastures, that it doubtless occurs to you that the result might be speedily obtained by sowing at once this large variety of grass seeds, mixed as we wish the plants mixed. This is true, but yet it takes time, for the reason that it takes many years for the firmest texture to be produced, or for the soil to have the proper covering and composition near the surface, or for the nice balance to be reached between the soil and plant so that each square foot or yard of ground is fully stocked with just that variety or species which it grows best. There is such a balance which will ultimately be reached, man can assist Nature in finding it, but he cannot accomplish it without time.

I will not attempt to discuss the relative amounts of forage that may be produced on a given area of old pasture compared with the same area frequently seeded or tilled to crops for soiling, such a discussion is foreign to my present purpose. It cannot be denied that large quantities can be so produced, and that for certain purposes these newer crops may be more profitable, that they may produce larger quantities of milk or even of flesh. But all lands cannot be so used. Every country has large areas that can be more profitably employed in pasture than in any other way, and it is desirable

that in such cases the nature of old pastures as compared with new ones should be well understood if we would turn such land to the most profitable account, and especially if we consider the quality of the butter, cheese, or meat we wish to produce.

Having said so much in favor of age, now let it not be inferred that a pasture is necessarily good because it is old. You have all seen lands kept to pasture year after year, and remain in unmitigated poverty, and perhaps you have seen several varieties of such, which only resemble each other in that they are poor, for their poverty may depend upon a variety of causes. No amount of manure will bring up a pasture that is too wet for healthy grass, that one needs draining. Hill pastures often remain poverty stricken for an unlimited period, from a variety of causes. Sometimes the soil is too poor in organic matter, the grasses grow so sparsely as to hardly merit the name of sod, and the rains wash down to the vallies much of the very material that the pasture needs. In the treatment of pastures as in other matters pertaining to agriculture, no empirical but golden rule can be given to apply to all cases, no universal panacea which shall prove efficacious in all cases, and mitigate all the forms of poverty. The key, however, lies in the rule stated that the most nutritious grasses need a moist but not too wet soil, and on tolerably fertile, and if we have not these conditions we must try to produce them. In the poor soil pastures named, where the soil is too poor in vegetable matter, this may be at first improved by judicious applications of rotted barn yard manure, and as the sod gets better, then this will increase from natural sources. It is drawn from the air faster than it will decay, while the soil remained poor the reverse was the case, it might decay or wash away even faster than it was gathered from the air. It seems in this that the same rule applies that is so often quoted in spiritual matters, "to them which have shall be given more abundantly, and from them which have not shall be taken away even that which they have."

This accumulating richness may be derived from more than one source. It may be drawn directly from the air, or

sometimes stock which have the range of both high and low lands will feed on the latter and lie on the drier places, leaving their droppings there to enrich the poorer hills. Farmers too often apply all their barn yard manure to their grain crops, while the permanent pasture lot is expected to yield its produce year after year without care or manure, to give and keep giving but never receive. The indignant soil will resent such treatment, we can no more expect to forever feed from a pasture without manure than we can expect to forever crop the soil with grain without manure and not impoverish it.

I have seen some pastures greatly benefited by wood ashes, others by gypsum, others by lime, others (especially very old ones), by pulverised bones, and many by rotted barn yard manure. The resources of the farmer must decide what is most profitable to use. On the Swiss pastures I spoke of, barn yard manure is composted during the summer, and applied in the fall. You will see the manure carefully piled up during the summer into a cubical pile, its sides kept in shape by straw being laid in, much as we see the "cheese" laid up in a cider press, then a foot of earth thrown over the top to absorb any escaping gases, and during the summer the refuse house slops are added to the pile, often a few squashes or other vines are grown in the soil on the top of this manure heap, it answering as a sort of hot bed in the higher and cooler places of the upper Alps. This manure is applied, as stated, in the fall, and in the early spring the hay seed that accumulates in the mangers during the winter, is strewed on to keep up the seeding, and take the place of any plants that may have been killed by the rigorous winter. These means prevent the exhaustion of the soil, keep the surface well seeded, and ensure a good turf. Their very nutritious character, I have sufficiently spoken of. The various kinds of soil, the varieties of climate which are produced by differences of exposure or elevation of course modify the character of the pastures, and we have as a result a variety of product. There are many varieties of Swiss cheese depending perhaps more upon these conditions of the pastures than on the different modes of manufacture.

We have an interesting illustration of the exhaustion of pastures in certain of the dairy districts of England, where cheese has been made for centuries, and where animals have been grown on the land and sold. In the course of time these drained off the phosphates, the pastures became poor, the cheese and flesh produced deteriorated in quality and the animals became less healthy. Chemistry suggested the remedy, and the application of bone dust restored them to excellence. I have spoken of an increase in the vegetable matter as taking place. But this may be otherwise from bad management even on tolerably fertile land. I am acquainted with a district through which, in former years, many droves of cattle were driven on their way from the western States to the eastern markets. This was before they were so generally transported by railroads. Several hundred would be driven together twelve to eighteen miles per day, and then turned hungry into the pastures along the way over night to fill themselves, and the next morning carry it off in their full stomachs and leave it along the high way during the day's drive, and be hungry for another man's pasture the next evening. It is needless to say that this was a most exhaustive process, and the meagre sum the farmer derived poorly repaid him for the loss his land sustained.

We hear much of pastures "running out." They will run out unless cared for. The soil may be as effectually exhausted by this process as by cropping, only it is perhaps a longer time in taking place. Manure of some kind must be supplied, or in time the soil must be impoverished. Sometimes low lands receive the wash from the hills which keeps up their fertility, at others occasional overflows from streams supply the place of manure, and again, artificial irrigation supplies it in others, but all of these are exceptional cases, the great majority need manure.

The kind of stock pastured should modify the treatment. Sheep feed closer than horses, and horses closer than cattle. Sheep, moreover, feed more evenly, and it needs a more fertile soil to fatten cattle than sheep, as every farmer knows. A too common mistake of farmers (especially of the careless

kind) is to feed off too closely early in the spring or late in the fall. In the one case, the growth for the summer is directly retarded, in the other the slight protection the roots need in winter is eaten off, and our severe winters kill some of the roots. Worse than either is to let sheep stray over them in winter when the ground is bare, or the very earliest days of spring, when they gnaw down so very closely that the bud or growing point, at the crown of the root, is eaten off, and that shoot is effectually prevented from growing at all. Thriftless farmers little realize how much a pasture may be injured in this way.

Weeds may infest a pasture, and how troublesome they are depends upon the kind of soil, the kind of weeds, and the particular locality. The only remedy for this is to wage a war of extermination against them by all means within our control, cut them down, dig them up, pull them out, any way to squelch them, but always strive to choke them out with grass.

But there are mishaps that old pastures are subject to for which I can suggest no remedy. At times diseases of the grasses occur. Perhaps the most common cause of these is parasitic fungi, and these in turn are closely dependant on the weather. They may merely diminish the amount of forage; or they may render it actually injurious to the cattle which eat it. Several diseases of stock are attributed to this cause. The wide spread belief that abortion of cows is caused by fungi is an illustration, but whether this latter disease has this cause or not, it is certain that there are diseases that may be traced to this source, and how to remedy the evil I do not know.

Then again, worms and other insects often get in, and cause great damage, the precise nature of which depends upon the kind of offending insect. And for this malady I can suggest no cure. Sometimes lime, sometimes wood ashes, sometimes other things may help get rid of them, but often a remedy is very hard to find.

I have confined myself mostly to pastures rather than meadows, but this lecture was announced to treat of both.

Now, so far as the constitution of old meadows differs from that of those newly seeded, we find that the differences are precisely similar to those of pastures. The same series of changes takes place but other species of grasses may figure in the change. But they too need much manuring unless the fertility is kept up by irrigation, either natural or artificial. Hay is an exhausting crop, because we take so much from the soil.

Some considerations upon the subject of pasturage in general may be of interest here. Many of our farmers, but more particularly in the fertile Western States, are apt to lose sight of the real value of pasturage, in their more exclusive grain raising habits. The following remarks by Boussingault, on pasturage in general, are worthy of thought: "In those countries, the nature of whose climate is favorable to pasturage, the rearing of cattle presents immense advantages, but the animals can be best fattened in those that are most fertile. The pasture that suffices for the growth and keep of a bullock, will not always bring the animal into condition for the butcher. Those countries where the climate is moist, and long drouths rarely felt, where neither summer heats nor winter colds are excessive, the conditions in fact which are met with in the beautiful pasture lands of England in especial, are those that prove most favorable to the rearing and feeding of cattle. The pasture lands of Normandy and Brittany in France, of Switzerland, Holland, and several provinces watered by the Rhine, are also remarkable for their luxuriant herbage. In such situations and with such advantages the grand object of the farmer is the production and fattening of cattle."

"Wherever it has been possible to lay down extensive and productive meadows, it is now beginning to be clearly understood that the introduction of even the best system of rotation were to make a false application of agricultural science. In my opinion, there is no system of rotation, however well conceived and carried out, which will stand comparison in point of productiveness, with a natural meadow, favorably situated and properly attended to. The reason of this is obvious and follows from the very principles which we have laid down

in treating of rotations. The whole object in the best systems of husbandry, is to make the earth produce the largest possibility of organic matter in a given time. But in such a system we are limited by the climate, inasmuch as we are obliged so to arrange matters that our crops shall always attain to complete maturity ; the consequence of which is, that with all our pains the soil remains unproductive during a certain number of weeks or months towards the end of autumn and in early spring, and through the whole of winter. But upon meadow lands, vegetation is incessant, the winter even does not completely interrupt it, and in early spring, it proceeds when the mean temperature is but little above the freezing point of water, and it never ceases until checked again by the severer cold of winter. Therefore, a given surface of meadow land must necessarily produce a larger quantity of forage than land laid out in any other way. It is true that the forage thus obtained will not, like the cereal grains, answer immediately for the support of man ; but it nevertheless concurs powerfully in this by producing milk, butter, and cheese, and in breeding and fattening cattle. Let there be added to all these advantages of what may be called a permanent vegetation, that the cost of keeping it in order is infinitely less, and that there is vastly less risk to run from the failure of crops, and the vast advantages of meadow or pasture land will meet us with all their force."

You will remember that this applies more particularly to the milder and moister climate of Europe, but the principle applies also here. We have great areas that cannot be profitably cropped, which can be profitably put down to pasture. Many hilly portions of this State, now nearly worthless, might be made to yield abundantly of good mutton, if got into good permanent pasture. And the beneficial results upon the country at large as well as upon the individual would be manifold.

We are wont to deplore the evil results following the stripping of our hills of their original forest clothing, and evils have followed this ; but this would be greatly mitigated if the same hills were again clothed in pasture ; not only would

the individual owner be benefitted but the country at large be richer.

I have been particularly impressed with this in reading the work of Moll and Gayot on cattle, in which they consider incidentally the relations which cattle growing bears to other departments of agriculture. To follow out their idea, let us contrast the conditions of the countries and people of Southern Europe with those of Northern Europe, or better the region about the Mediterranean with that about the North sea. The countries adjacent the Mediterranean offer as a striking example. These countries, once the home of a high civilization, and swarming with a dense population, having countless villages and rich cities, are now all more or less despoiled of their ancient grandeur and wealth. Spain, South France, Sicily, Italy, Greece, Syria, &c., countries of Europe, Asia, and Africa, having nothing else in common, separated by different races, different religions, different civilizations are represented, but all have gone down alike, and neither political revolutions, nor bad government, nor mahomedan invasion can explain this. And how explain one single exception to this, in this waste there is one country which in spite of revolutions, of brutalizing despotism, of war, and misrule, has continued to be a rich and populous people, and continued to be the granary of a part of Europe?—we mean *Egypt*. Why has this continued fertile while all the rest have become sterile? You are well acquainted with the explanation; the overflows of the Nile have kept up the fertility undiminished since the days of the Pharaohs. But the agriculture of Egypt is almost without cattle. They are but sparingly needed for farm labor. And the people needed no manure on their fields, they have gathered their harvest for scores of centuries, and the ever faithful Nile has returned the elements of fertility which the crops removed. The people always took from the soil but never returned anything. Egypt was the cradle of European civilization and this principle was carried into the agriculture of the colonies about the Mediterranean, extending even to Central Europe, “and to this principle is due the decline of those lands once so prosperous and fertile, that

Roman soil which once produced 100, 150, or even 200 for one, now yields but five, our, or even three. This principle of cropping without manure, a movement slow but irresistible has brought those ancient centers of civilization and wealth to so low a level. If Egypt has escaped this great decadence of fertility, Egypt, which more than any other land has been the theatre of wars, ravaged by armies, incessantly oppressed, and subject to every variety of disturbance, if this land has escaped, we repeat that it is because of its Nile, which has continued to inundate its lands and each year renew its fertility. I know that it is hard for the historian who is searching for the cause of great phases of human progress or decline, to find it in a heap of dung, but there it is if he will but find it. It may be to him a new chapter, but it will be but another example where great events may be traced to what at first appears to be but small causes."

Thus speak the learned French authorities whom I have quoted, and they go on to give the picture of some of the lands in detail, of Sicily, Algeria, Syria, etc., where the hills despoiled of their forests, and not clothed with grass, have been the prey of the storms for twenty or thirty centuries, the climate has been changed, the rains are capricious and violent, at times the soil has been washed from the hills, leaving but their rocky skeletons, the valleys half depopulated by the overflow of gravel from the hills, and the countries, once the types of wealth, now that of desolation and poverty.

Contrast this with Northern Europe, where, to be sure, the climate is more moist, but where pasturage is more of an item. The turf protects the hills from the ravages of the rains, and the rains are not so spasmodic. The keeping of cattle gives us a continual means of manuring, and thus the fertility of the soil has been kept up,—in fact has increased, until the most densely populated regions of the civilized world are found there, and certainly the centres of the greatest wealth.

"Pasturage then, furnishes the only means which we have of preserving indefinitely the fertility of our soil, the keeping of cattle being the only means of furnishing the enormous

amount of manure which is necessary for this end." And they further state, that those portions of France where the condition of agriculture is the poorest, is where there is the least pasturage, and where it is best, is where pastures and the keeping of cattle furnish the means, in fact they consider this so important that they use the strong language that it is "the foundation of national existence and national permanence."

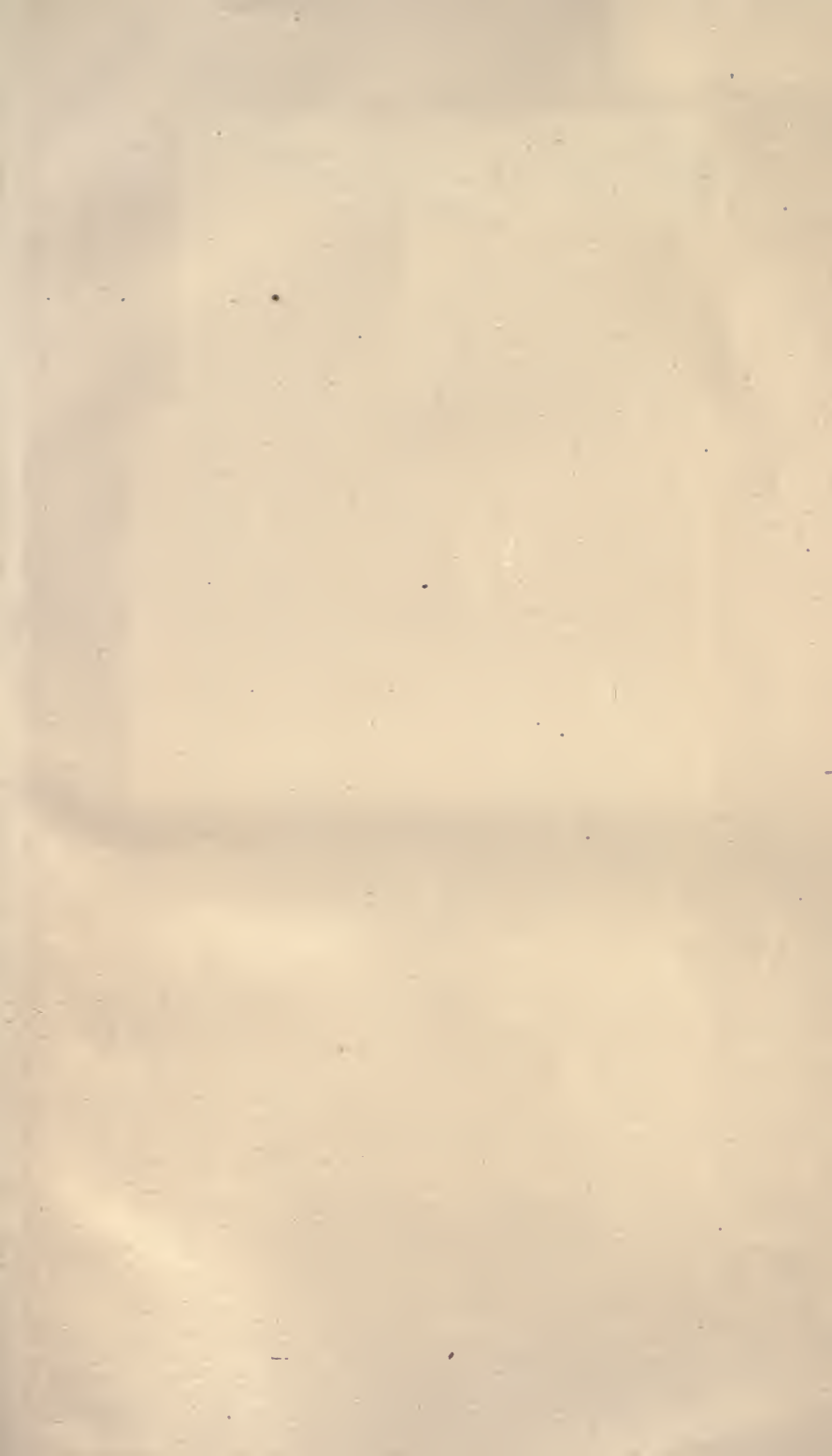
But we need not go to France to see similar facts shown. We may in the same way compare the system of agriculture in our own land, contrasting the North with the South, the one of barnyards, manure, and increasing wealth, the other of waste, exhaustion of soil, conquest of new lands ending in war and poverty. The great differences between the North and South were primarily those of agriculture, and on that foundation grew the rest with all its sad history. The wealth of the North is based on Northern agriculture, and if that wealth is maintained, it must be through the dunghill, and this finds its source in the pastures and meadows of the land.

I will not pursue this train of thought further; each of you can do so in your own mind. And I am convinced that the more it is considered, the more important will seem this matter of permanent pastures, clothing our hills and adorning our valleys, beautifying the landscape, furnishing food for the present generation, and promising permanent wealth and prosperity for the future.

The first part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom. It is shown that the structure of the atom is determined by the laws of quantum mechanics, and that the structure of the atom is determined by the laws of quantum mechanics.

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