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1912

Farming

with

Green Manure

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GREEN MANURES

BY
C. HARLAN, M. D.

SEVENTH EDITION
REVISED AND ENLARGED BY AN AGRONOMIST OF THE
AGRICULTURAL DEPARTMENT OF THE U. S. GOVERNMENT

Published by
DELORE PUBLISHING COMPANY

WILMINGTON, DELAWARE

1912

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C. R. CRUMLISH

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F. R. CRUMLISH

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NO. 1

PREFACE

TO FIRST EDITION

In publishing these pages I have two objects in view—the assistance of those who need advice and the instruction of my foreman on “My Farm,” that he may understand the reason why he is required to do certain things. But how should I know any better than he does the laws of vegetable life and the best course to pursue to obtain remunerative crops?

He is supposed to be practically acquainted with the whole art of agriculture. Now, the fact must be plain to every one that no man, in his short life, by his own experience and observation, can become master of this art, because it takes a whole year to try one experiment. From this fact, his progress in knowledge must be very slow indeed.

Well, then, besides the actual trials on the farm to improve his mind, the next best thing to do is to study carefully the recorded experience of other farmers and the writings of the able investigators of the chemistry of plant-life. To do this with profit he should be acquainted, to a certain degree, with every science which has shed any light upon the subject.

Now, the working farmer is generally too much engaged to acquire this knowledge. Well, then, if he will please to lay aside all prejudice against me, we will read for him and report a few of the grand truths which we find scattered through the vast tomes of other times and the periodicals of our own rushing, busy century.

Whether I shall ever receive any thanks for this is a very small matter.

The consciousness of having done good to others will amply repay me for all my trouble.

I sincerely believe that he who tills the soil is helping God to feed the world, for without tillage the earth could not support one-tenth of its present population. Therefore, what I can do in this good and noble cause it is my duty to do. And I may as well confess that to me it is no tiresome labor, because I love the art; and ever have loved it from my boyhood to the present hour.

C. HARLAN, M. D.

PREFACE TO THE SEVENTH EDITION

The cordial reception given to the former editions of this book appear to call for a new edition. The editors have taken advantage of this occasion to have the book completely revised in light of the important scientific discoveries made since the earlier editions were issued. Although more than three decades have passed since the first edition of this book was published yet there is so much of permanent value to the original themes of the book that the subsequent findings of both science and experience have only added greater weight to their importance. The remarkable role which leguminous crops have come to play in assisting in the solution of the great problems of maintaining soil fertility has called for the addition of several of these leguminous crops to the list of those treated within the pages of the former editions. A few crops important at the time the early editions were issued have given way the others found to be more valuable and the discussion of these has been eliminated to make room for a more adequate treatment of the more important crops for green manuring purposes. There have been some modifications in the accepted composition of the different crops as well as in the market values of the various fertilizer constituents. It has therefore been deemed wise to make such changes in these figures as to make them applicable to present day conditions. The illustrations in this book have been secured from various publications of the U. S. Department of Agriculture.

The importance of maintaining an abundant supply of humus in the soil is coming to be recognized more and more as being of prime importance to the up-to-date farmer who would restore and maintain the original fertility of his fields. The principal theme of Doctor Harlan in these pages has been to

point out how this maintenance of fertility can be brought about on the ordinary farm with the least possible outlay of labor and money. The general principles as laid down in the early editions have stood the test of time and experience and it is hoped that this edition will appeal with added force to the farmers of the country who have the permanent interests of their farms at heart.

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FARMING WITH GREEN MANURES.

CHAPTER I.

INTRODUCTION.

THE plowing under of green crops for the purpose of maintaining the fertility of the soil is almost as old as history itself. The ancient nations compelled to live for centuries upon the same land, realized the importance of green manure crops often to fuller degree than do we the inhabitants of our relatively new country. Here the problem of maintaining soil fertility is only beginning to be so serious as to call for the development of the best farm practices with reference to the use of these green manure crops. The subject must ever be a complex one calling for the proper adaptation and combination of green manures with commercial fertilizers and with crops that are to be fed upon the soil and the resulting manure spread back upon the fields. Different farms will require different systems of management. It is the province of the succeeding chapters to point out the special value of turning under green crops for the purpose of soil improvement.

Green manures may benefit the ground upon which they are grown in a number of different ways: (1) by adding vegetable matter or humus to the soil; (2) by utilizing and holding for succeeding crops much soluble plant food which would otherwise escape from the soil; (3) plant food from the lower layers of the soil may be brought nearer the surface where it can be utilized to better advantage; (4) if the green manure crop be a legume there will be a considerable amount of nitrogen added to the soil through the fixation of nitrogen from the air.

There are two classes of green manures; namely, those that merely add humus to the soil together with what plant food materials they may have withdrawn from the soil itself, and those that in addition to the humus they return to the soil, are able to draw nitrogen from the air and thus directly increase the amount of this most valuable element in the soil. This last class is the family of plants known as the legumes. All the deep rooting green manure crops, both legumes and non-legumes are usually able to draw up out of the deeper layers of the sub-soil, plant food which the succeeding shallower rooted crops would otherwise be unable to obtain. Such plants also permit the more feeble rooted plants to send their roots deeper into the soil since the deep feeding roots serve to break up the sub-soil and aerate it properly for the best growth of the roots of the following crop.

The necessity of making some return to the soil to compensate it for the large removals from it in the form of crops is coming to be recognized even in the West where until recent years the soil was so new as to permit continued cropping and still produce satisfactory crops. There are still some sections in the more recently developed areas of the western half of the country where the soil has not yet become materially depleted, but it is only a question of time when all sections will be compelled to make some provision against the depletion of soil fertility. Commercial fertilizers have been used extensively for generations in the east and have the advantage in that they are easily applied. They do not, however, add any humus to the soil and in this respect do not furnish a complete solution of the problem of maintaining the fields in the proper condition.

One other method is to feed the crop on the farm and return the manure to the soil. This is the practice usually adopted on the dairy farms where grain brought in from outside sources increases the value of the manure returned to the ground. There are a number of points in which this method is not of universal application. In the first place, it is usually impossible to keep from losing nearly half of the original value of the manure

by loss of much of the liquid portion, and by the leaching of fertilizing materials and escape of valuable gases into the air. Such farms can be only partially kept up by the use of manure produced from feed produced upon the farm itself. This means that the land from which this extra feed was secured must go without its quota of manure. Such a method is satisfactory for the individual farm, but it is apparent that all farms in the country could not be run in this manner as there would then be no lands from which feed for the extra manure could be obtained. In addition to this lack of universal application the labor incident to the scattering of the manure over the land is extremely great. In the green manure crops we have the scattering already accomplished by nature, and all that remains to do is to turn it under for the hungry soil. A ton of the green plant growth is about equal to a ton of manure as regards its fertilizing value and an ordinary growth of a green manure crop will produce quite as great a tonnage as is usually applied to the soil in the form of barn-yard or stable manure.

The principal disadvantage incident to the use of green manures is that the field cannot be utilized in producing a regular farm crop while it is producing its crop of green manure. Unless either the green manure or the regular crop can be seeded the same season, the use of the land is lost for the entire season. The greatly increased yield of the succeeding crop is the justification of such a practice. It is considered quite as profitable to crop one half the acreage if enough more than double the yield can be secured by this method, to pay for the seed and labor attending the use of the green manure crop. In deciding which green manure crop should be used for a specific purpose a number of points should be taken into consideration. Choice may be made between those that make most of their growth in the fall, winter and early spring and those that grow only in the summer time. The former class has the advantage in that a summer growing cash crop can usually be planted after a winter growing crop has been turned under in the spring. Preference should be given a leguminous crop if it be available as such a crop will in

addition to its other benefits, naturally increase the nitrogen content of the soil. Other points that are of more or less moment are the cost of the seed, the deep or shallow rooting qualities of the plants, their ability to compete with the weeds and the ease with which the crop may be turned under. The supplemental value as pasture or as hay in emergency should also be considered. If pastured and the stock kept continually upon the land the net loss to the land is not great, while if cut for hay there will still be the stubble and roots available for soil improvement purposes. Even weeds are valuable as green manures if plowed under before they mature their seed. Their value is frequently as great as that of a light application of ordinary barnyard manure.

Liming may be necessary to correct any acidity due to the decay of the green crop. This may be best applied before turning under the crop. It may even be applied before seeding the green manure crop, especially if it be a legume needing lime in the soil. The complete results from a green manure crop are not secured until it has completely decayed and assumed soluble form so as to be available to the succeeding crops. This may require two or three years so that the beneficial results from the plowing under of a green manure crop are usually manifest for more than one season. Tillage hastens the decay of organic matter and for this reason it is usually best to follow the green manure crop with some cultivated crop as corn, cotton or tobacco depending upon the locality.

Many of the green manure crops permit of their being left on the fields over winter either in the green state or matured. In either case they perform valuable service as a cover crop, preventing the soil from washing and assisting in holding the snow which might blow off the otherwise windswept fields.

If a complete system of green manuring be installed upon the farm, the doing away with the pasturing of stock, avoids the necessity of inside fences which are the source of a great deal of expense both as to original cost as well as maintenance. Under such a system the soiling of crops for the necessary livestock

would be practiced to a much greater extent than is at present the case. This is, however, in line with the best practice since more than double the number of stock can be maintained on a given acreage where the green feed is cut and fed to the stock than where the cattle are allowed to trample it in pasturing it off for themselves. In fact the intensive farming of a few acres has been repeatedly shown to be quite as profitable as the ordinary treatment of a much greater acreage. The intelligent use of green manures will facilitate any endeavors to further the intensive culture and upbuilding of the farm.

CHAPTER II.

COVERING THE SOIL.

WHEN green crops are raised to improve the land it is not indispensable that they should be ploughed in to accomplish this object. You need not turn them in till you are under the necessity of doing it to prepare the ground for a future crop. But if the green dressing should be Hungarian millet or white mustard, or anything that might seed the ground at an improper time, you can either plough it in or cut it down when in blossom, and it will improve the soil in proportion to its ability to shelter it.

Cuthbert W. Johnson says: "An English farmer inadvertently left for some months a door in his fallow field; for several years after the crops were particularly luxuriant where the door had been lying—so much so that one would have said that some rich manure had been applied to that spot."

Anderson, an eminent Scotch writer, says in his *Economy of Manures*: "Every practical farmer knows or ought to know, for the facts are constantly before his observation, that land can be made exceedingly fertile without manure. He must have noticed that if any portion of the soil has been covered, either accidentally or designedly for some time, by water, stone, plank, logs, chips, brush, rails, corn-stalks, straw, buildings of every description, with hay or straw ricks, leaves or clover—and in fact, that under any and every substance which has covered surface closely—it (the surface soil) invariably becomes exceedingly fertile, and that the degree of this fertility is totally independent of the covering substance."

After reading these remarkable statements of Johnson and Anderson, both men of extensive observation and intelligence, we can more fully credit the experiments of Gurney in England upon his fields of grass.

Green grass covered with straw gave him in one month five thousand eight hundred and seventy pounds per acre. The same kind of grass uncovered produced but two thousand two hundred and seven pounds. No rain fell during this experiment. Another plot gave in one month, when covered, three thousand four hundred and sixty pounds per acre, while the rival lot, not covered, yielded but nine hundred and seventy pounds. Clover that was covered grew six inches, while that uncovered grew but one inch and a half.

And where a certain quantity of stall dung would double the crop of grass the mulch spread on top of the manure would increase the crop six times. He used about one ton and a half of straw per acre.

"Boussingault found upon comparing water obtained by melting two portions of snow—one taken immediately as it fell upon a stone terrace, and the other (from the same fall), after it had lain for thirty-six hours upon the soil of a contiguous garden—that the second contained ten times as much ammonia as the other. It is well known that snow has a most beneficial effect upon soils, and, amongst other causes, Boussingault believes that it may act in preventing ammoniacal emanations from the soil."—*Journal of the Royal Agricultural Society of England*.

Now, we can believe there is much truth in the old proverb, that "Snow is the poor man's manure."

Not having straw nor any barnyard material to top-dress his wheat, he has often noticed that his crop was much better when kind Nature covered it for him.

Does not this investigation of the great chemist reveal to us *one*, if not more, of the deep and far-reaching causes why mulching is so beneficial to the land?

Professor Johnson says: "The ammonia of the soil is constantly in motion or suffering change, and does not accumulate to any great extent. In summer the soil daily absorbs ammonia from the air, receives it by rains and dews, or acquires it by the decay of vegetable and animal matter. Daily, too, ammonia wastes from the soil by volatilization, accompanying the vapor

of water which almost unceasingly escapes into the atmosphere.”
—*How Crops Feed*, p. 247.

This is a revelation of scientific truth which cannot be misunderstood or explained away. Was ever a stern necessity to do anything more clearly demonstrated to the world? We must keep the soil covered to promote and retain its richness. But how often do we strip the ground naked, and then bake it in the ever-burning sun!

Col. Waring, of Ogden Farm, says: “I had read so much about top-dressing that it was determined to try it on this apparently forlorn hope, and the land was all covered before the heavy rains that fell early in May. The result was almost magical. While that portion which had looked so promising as to seem not to need manure did not yield 1000 pounds per acre of poor hay, ox-eyed daisy and red sorrel, this poorer part, solely as an effect of the top-dressing, produced fully 4000 pounds per acre of very fair hay.”

CHAPTER III.

SURFACE MANURING.

NOT many years ago it was the universal custom to plough in manure the very day or hour that it was spread upon the field. Farmers became irritable and had but little to say if anything prevented immediate ploughing after the precious contents of the barnyard were spread broadcast before their eyes. It was a prevalent opinion that nearly all the richness would dry out in a few days if exposed to the weather.

They had often noticed that manure under cover was about twice as good as that which lay out of doors all summer, but they did not discover that the great injury which it had received was owing to the leaching rains, which dissolved and carried off its richest elements, and not to the sunlight which occasionally fell upon it.

When manure is spread it soon becomes dry, and then all chemical changes cease; fermentation is arrested; it will decay no more in that condition. And when the dews settle and the rains descend upon it, it will dissolve, day after day, and a peculiar dark rich coffee will effectually saturate the soil beneath it.

In the *Genesee Farmer* John Johnston says to Joseph Harris: "I am not surprised at your correspondent, Buckeye, being opposed to surface manuring. I would have been so myself had not experience taught me better. I have used manure only as a top-dressing for the last twenty-six years, and I do think one load used that way is worth far more than two ploughed under on our stiff land."

Nearly ten years after this was written he speaks, if possible, with even a stronger faith than ever in defence of his favorite practice.

Harris writes in *Walks and Talks*, No. 112, that "John Johnston, who has a far heavier clay soil than the deacon, says

he has found by actual trial that one load of rotted manure applied as a top-dressing to grass-land in the autumn, and the land ploughed up and planted to corn in the spring, is worth as much as three loads of fresh manure ploughed under."

Major Dickinson, another able and extensive farmer, declares: "I hold that one load of manure on the surface is worth two loads ploughed in."

Charles B. Calvert, a distinguished farmer of Maryland, "is a strong advocate of the application of stable manures *upon the surface*, instead of ploughing them in."—*Cultivator*.

Mr. Bright writes in the *Gardener's Monthly*: "The practice of top-dressing or of surface manuring has long been the favorite method employed by all intelligent gardeners within the circle of my acquaintance. A piece of soil heavily shaded by surface manuring actually decomposes like a manure-heap; that is, it undergoes a sort of putrefaction or chemical change which sets free its chemical constituents, unlocks, as it were its locked-up manurial treasures, and fits its natural elements to become the food of plants. Manure, then, I say, chiefly upon the surface. Do not waste your manures by mixing them deeply with the soil. Surface manuring and mulching are the true doctrines. I am sure of it."

In Todd's *Young Farmer's Manual* I find the following statement: "James M. Garnet, a Virginia farmer, an excellent writer on agriculture, says: 'I began penning my cattle late in the spring, and continued it until frost in pens of the same size, moved at regular intervals of time, and containing the same number of cattle during the whole period. These pens were alternately ploughed and left unploughed until the following spring, when all were planted in corn, immediately followed by wheat. The superiority of both crops on all the pens which had remained unploughed for so many months after the cattle had manured them was just as distinctly marked as if the dividing fences had continued standing; it was too plain even to admit of the slightest doubt.'"

"A near neighbor, a young farmer, had made the same experiment on somewhat different soil the year before, but with results precisely the same. Similar trials I have made and seen made by others with dry straw alternately ploughed in as soon as spread, and left on the surface until the next spring. In every case the last method proved best, so far as the following crop would prove it.

"The same experiment has been made by myself and others of my acquaintance, with manure from the horse-stables and winter farm-pens, consisting of much unrotted corn-offal, and without a solitary exception either seen by me or heard of the surface application after the corn was planted produced most manifestly the best crop.

"Upon these numerous concurrent and undeniable facts my opinion has been founded, that *it is best to apply manure on the surface of the land.*"

An able writer in the *Cultivator* in 1843 says:

"I have seen spots where cattle had been penned at night for a month or two; for *six years* afterward, the vegetation was double on those spots to any other part of the field, although all the manure had been carefully removed and scattered about. Now, nothing but the liquid could have gone into the earth, and yet the rains of six years never washed away the beneficial effects."

On steep slopes, however, when the rains run off too rapidly without sinking into the soil it may be best to turn under the manure. Of two evils choose the lesser. If plowed under too deeply however it will be so deep that the bacteria cannot work upon it to make it available to the succeeding crops.

Now, if the valuable material of the barnyard will not suffer waste when spread upon the open fields, and is better there than anywhere else, then the green crop, whatever it may be, that is raised to improve the land, should be mown down in summer and in autumn, and should be left upon the surface as long as possible—to prevent evaporation, to disintegrate the soil, to retain moisture, to be leached by rains and dews, and finally to enrich the ground by its total decomposition.

CHAPTER IV.

WATER AS A SOLVENT.

THE mineral constituents of the bones of man and animals are but the *ashes* of our daily food.

Every year from the rock and soil these ashes come, decomposed and dissolved by water, carbonic acid and oxygen.

Green manures, by their ability to collect and preserve moisture on the surface and in the soil when cut down or ploughed in, render an immense assistance in the growth of the organic world. Water is the *blood* of vegetation. It carries nourishment from the ground to the stem, to the leaf, to the seed. In its solvent action rocks become the food of man.

When the soil is *dry* no mouldering down to a finer dust, no disintegration of minerals, no decay of any kind, can be discovered; every atom, apparently stationary, seems fixed and firm as adamant.

Travellers tell us that in the dry air of Egypt the old monuments erected thousands of years ago are just as fresh and smooth in outline as if the chisel had finished them but yesterday. But when some of these relics of the past were transported to Paris, in the moist climate of France they soon began to change, and atom by atom to crumble away.

Dr. Youmans says: 'It has been shown by extensive experiments that no species of rock whatever will resist the solvent action of water impregnated with carbonic acid.'—*Atlas of Chemistry*, p. 50.

What an instructive lesson! How valuable to the farmer! Such knowledge, how exceedingly useful!—that in our daily effort to convert the earth upon which we tread into a flourishing vegetation we *can* combine and concentrate the forces of nature by covering the ground, that *moisture* and *carbonic acid* may do a great work for man.

Yes, so vastly important is the benefit that may be derived from mulching with green manures that we not only see it in the augmentation of our crops and the improvement of our tillable soil, but it may be observed in the condition of the forests around us. Those that have a deposit of leaves undisturbed for years about their roots make an annual growth much greater than those which have been robbed of their carpet of dead foliage by the winds or by the hand of man.

"The fallen leaves," says Liebig, "contain such trifling quantities of potash and phosphoric acid in comparison to their mass that it is difficult to account for the injurious consequences arising from the raking up and removal of the fallen leaves in woods."

It is difficult only when we forget the conditions existing in the woods. There the protection of the soil, the perpetual moisture, and the carbonic acid constantly forming, work without ceasing beneath the mulch, crumbling and mouldering the minerals into an impalpable and soluble state, ready to be absorbed by plants or trees.

Liebig admits that "the injury is perhaps rather attributable to the fact that the remains of leaves and plants constitute a lasting source of carbonic acid, which, carried by the rain to the deeper layers, must powerfully contribute to disintegrate and decompose the earthly particles."

These substantial truths should establish the advantage, if not the necessity, of shelter and *moisture* to improve the soil, and also to promote the growth of our crops.

Yet there is no scarcity of water in our favored country.

We have a rainfall of four thousand tons per acre every year. But what becomes of it?

Professor Johnson says: "According to the observations of Dickinson at Abbot's Hill, Hertfordshire, England, and continued through eight years, ninety per cent. of the water falling between April 1st and October 1st evaporates from the surface of the soil, only ten per cent. finding its way into drains laid three and four feet deep."—*How Crops Feed*, p. 197.

This, we presume, is about the amount of evaporation in the United States. Then what a magnificent prospect is here presented!

Mighty rivers are pouring, not down the deep valleys, but upward from our broad fields to the blue sky above us.

Yes, every square mile of territory sends a constant flood, rushing, though invisible, to the vast seas in the viewless air.

Could all the streams from a single State be concentrated into one torrent, it would out roar Niagara as it dashed against the clouds.

But what becomes of the poor little ten per cent. of water that goes sparkling down the ravines to its ocean home? Is it allowed to depart in peace? No; the farmer at great expense cuts channels along the hillside to irrigate the sloping plains, and the results prove that it pays to do it.

All this is done while the ninety per cent. of fluid is passing away without an effort made to save it. We do not need it all—no, not the half of it. We know by covering the land we can retain enough except in the arid sections, for all the wants of vegetation.

To have a vigorous and uninterrupted growth we must have moisture in the soil, and we must retain it there from rain to rain or we will have a partial failure in our crops.

Professor Johnson says: "The great deserts of the world are not sterile because they cannot yield the soil-food required by vegetation, but because they are destitute of water."

He also says: "Poor soils give good crops in seasons of plentiful and well-distributed rain or when skillfully irrigated, but insufficient moisture in the soil is an evil that no supplies of plant-food can neutralize."

The cause of this will be plain on a moment's reflection. Plants can only take up their food in a fluid condition.

Mr. Lawes proved that an acre of wheat in five months and eighteen days evaporated through its leaves three hundred and fifty-five and a quarter tons of water. Now, every drop of this water was more or less instrumental in transporting a little atom

of food from the soil to some part of the plant, and when the deposit was made, being no longer needed, the water passed off through the leaves.

Liebig also teaches this doctrine. He says:

“Though the soil be ever so rich in the elements of food for plants, still the latter will not grow in hot weather if there be a deficiency of moisture in the soil, for the moisture in the soil is the channel through which mineral food has to reach the interior of plants.”

The reader who has not been a careful observer of the changes in nature and the amount of rainfall year after year will be very likely to suppose that drouth is a plague that very seldom visits our much-favored land, and hence he may consider it useless to spend much time in devising means to remedy the evil. But what are the facts?

The *Cultivator* says: “Seasons of drouth of more or less severity are of frequent occurrence in our climate. Weeks, and even months, pass with little or no rain; the scorching glare of the sun drinks up our summer brooks and turns the fields to dust or brick-like clods beneath its influence. The growing crops are shrivelled and dwarfed by the heat.”

This strong picture received an alarming confirmation of its truth in the then new State of Kansas. No rain fell during all the spring nor in the first month of summer, and there was a total failure in the crops of wheat. Dr. Armor, an able farmer in that State, who called on me the same year, said he made no attempt to gather the few grains of wheat which grew on little stems only three inches high, but gave an order when he left home in July to plough up the fields for reseeding in autumn.

Indeed, water is so indispensable in the process of vegetable nutrition that only a fortnight of dry weather apparently checks the vigor and freshness of the green world around us.

Everywhere throughout the irrigated sections of the West there is usually too little water available to furnish all the land with an abundance of moisture. By proper method of retaining and conserving this moisture much less will be needed.

CHAPTER V.

TILLAGE A MANURE.

IN estimating the expense of raising green crops for manure we must not deduct the cost of ploughing and harrowing from the value of the green dressing, because tillage is manure, and often the very best manure which we can apply to many fields, particularly to heavy clays.

Liebig says: "The influence of the mechanical operations of agriculture upon the fertility of a soil, however imperfectly the earthly particles may be mixed by the process, is remarkable, and often borders upon the marvellous."

The truth of this declaration has often been established by the experience of many observing farmers. Here is one case.

Mechi, England's model farmer says, "I knew a farmer, who took a good farm wretchedly out of condition and full of weeds. He fallowed every acre of it, taking care to allow time between each ploughing for the germination of the seeds. The result was a crop of wheat averaging five and a half quarters (forty-four bushels) per acre, and other crops in proportion. He was a wise man."

Now, in connection with this good tillage had he put on the field somebody's "nitrogenized superphosphate of lime," it is very likely all the credit would have been given to it, and we might have had his certificate that forty-four bushels of wheat per acre were actually obtained by using only three hundred pounds on each acrea of this wonderful fertilizer.

With such facts before him, we are not surprised that Mechi says: "Frequent tillage is our best and cheapest manure."

The farm of Joseph Harris has enough of clay in the soil to require frequent ploughing and harrowing to bring out and unlock its highest productive capacity; hence he has discovered

the great benefit of thorough pulverization. He says: "That tillage and manure are one and the same thing is a great truth."

Taking this natural and rational view of the subject, it would be very unjust to any green crop which is intended for manure to charge it with anything but the seed. And this will reduce the expense of this mode of improvement to a very low figure.

Harris also says: "On heavy land we have not yet been able to dispense with summer fallowing."

John Johnston, a noted farmer of New York State, rich as he has made his land, is yet in the habit of summer fallowing more or less every year.

His practice has been to top-dress his cloverland in the fall, and the next spring to plough it up and prepare the land for wheat by ploughing it twice more, with repeated harrowings, rolling, etc. In other words, he manures the land in the fall and then gives it a good old-fashioned summer fallow.

Here, you perceive, are *three ploughings* and enough of harrowing to seed the ground with two green crops and to turn them in when grown without any extra expense. And this tillage is never done all at once. It is said that there should always be six or eight weeks between each ploughing. This method would be very accommodating to nearly all kinds of green manures.

Observe how careful Farmer Johnston is to neglect nothing that will ensure him a large crop of wheat. No wonder he often raises fifty bushels per acre! We see here that the whole of one year is devoted to the preparation of the soil.

He does not confine himself entirely to this mode. Under another heading we will show that he ploughs in clover in June for wheat. And, notwithstanding he makes from five hundred to a thousand tons of the very best manure every year, he does not compel his fields to produce a crop of either grass or grain, to be removed every year. And that is the true philosophy of farming—every other year devoted to the entire restoration of the soil. On light, sandy land much tillage is not required, only

to subdue the weeds, and for this purpose, to assist the plough and hoe, there is nothing to be compared to green crops.

The way these act in the destruction of weeds is not as freely acknowledged as it should be, because not clearly understood.

When a quick-growing crop is put in the ground, all weed seeds that are on or near the surface sprout and make a feeble growth, but do not mature enough to form a blossom or a seed. In this way tens of millions of noxious weeds will germinate and perish beneath the dense shadow of a green crop.

CHAPTER VI.

GREEN MANURES.

ALDERMAN MECCHI says: "I have noticed a very money-getting farmer in my neighborhood who never keeps any live-stock except a couple of cows, and who never buys any feeding-stuffs or manures.

"He keeps his land clean and fertile by ploughing in green crops, which require no hoeing or labor, and only one ploughing. I know he makes money, for he often purchases land. It is the opinion of some knowing hands that this farmer manages to get better profits than his neighbors who adopt the ordinary system."

This testimony comes from one who has no superior as an honorable and upright man and able farmer. Therefore his words are worthy of a most careful study. Look at the full weight and meaning of these expressions:

"A very money-getting farmer. I know he makes money, for he often purchases land."

There is not a farmer in the wide world who would not be glad and happy if his good neighbor could say that about him.

Whence comes this undoubted prosperity? Does he keep thousands of sheep or hundreds of milch-cows of the purest grades? No. Does he sell Essex pigs or choice calves for almost their weight in silver? No, nothing of the kind.

The whole cause of his *certain success* is told in two words—*green manures*.

Well, if one man has accomplished so much in this mode of farming, have we no details of actual experiments on record to confirm such statements? Yes, we have. Here is one of great value, because the facts are clearly given and are undeniable.

"In October, 1819," said the late Dr. Browne of Gorlstone, in Suffolk, "a violent gale of wind drove to this part of the coast an unprecedented quantity of seaweeds. These were eagerly scrambled for, and, from my greater vicinity to the beach, I collected twenty-seven cart-loads—each as much as four horses could draw. I spread mine fresh and wet upon little more than an acre of bean stubble, instantly ploughed it in, and dibbled wheat upon it.

"On the 6th of October I then salted the adjoining land with three bushels per acre, manured it with fifteen loads of farmyard-dung per acre, and dibbled it with wheat on the 15th of November. The result was that the seaweeded portion gave three times the produce of any equal part of the field."—*Farmer's Encyclopædia*, p. 582.

How did it happen that this *green* manure produced *three* times as much wheat as the dung from the barnyard? Certainly the nitrogen in this weed was available. It could not be otherwise. And it is very probable, it was much more so, than that in the yard-manure.

Now comes the interesting question: In what condition does nitrogen exist in seaweed? In the form of albuminoids, there is not a shadow of doubt, just as we find it in clover, in Hungarian grass and in all vegetation. And we have the authority of Boussingault that there is less nitrogen in seaweed than in clover, and we know there are less phosphoric acid and less potash in the former than in the latter plant.

Then would not the same amount of clover or Hungarian grass, with salt, have brought the same result?

And what a vast difference in the cost of these plants! All the doctor could get would only cover a little more than an acre. To obtain any more of it he would have had to buy it. What it would cost in England we do not know. In this country it is about the price of good manure.

Col. Waring says that seaweed costs three to four dollars per cord on the beach. While this price continues, of course it can only be used to advantage by those living near the coast. We

advise every one who can raise a good crop of clover with bone-dust and lime or plaster to depend on it, unless he can get the sea-weed at a much less figure than three dollars per cord.

We feel deeply interested in this experiment of Dr. Browne. We hope it will satisfy all manure-makers that green plants can be converted into plant-food without undergoing the process of digestion in the stomachs of cattle.

And, more than this, it should be noticed that solution and oxidation can take place in full time to furnish all the nourishment required to produce a good crop of wheat.

And that the conversion of vegetable matter into manure in the barnyard is not necessary may be proved by another careful experiment:

“The following I know to be a fact. A person brought up as a farmer in Scotland was sent to an estate in one of the Windward Islands to improve the system of tillage. Not being able to manure a field of six acres that had been much exhausted by frequent cropping, he resolved to give the pigeon-pea a fair trial; he accordingly sowed them so thick that in a few months the ground was effectually covered to the height of six feet. He then cut down this mass of vegetation, and immediately buried the whole under the large banks that are raised in digging cane-holes. His first crop gave him but six hogsheads of sugar. Instead of allowing the canes to shoot up again, as they will, he planted the pigeon-pea and proceeded as before; this second crop yielded twelve hogsheads of sugar, as the benefit of the first decayed bushes was then felt. He tried the peas a third time, and his crop was eighteen hogsheads. Finding the improvement was so wonderful, he resolved on a fourth trial, and the six acres yielded twenty-four hogsheads, which is considered a *first-rate crop*, equal to one hundred bushels of corn in this country.”—*Cultivator*, 1842.

CHAPTER VII.

LEGUMES AS GREEN MANURE.

IT was recognized by the ancients that when plants of the pea or bean family were turned under they gave a greater increase in the succeeding crops than did like quantities of the nonleguminous plants. For centuries the real reason for this increased benefit was not known. It has been only within recent years that this reason has been discovered. Professors Hellriegel and Wilfarch two European scientists showed in 1886 that the true explanation of the remarkable effect of legumes on the fertility of the land is that the plants by means of the bacteria which are able to live in the tubercles on their roots are able to extract the nitrogen from the air and work it up into a form which can be utilized by all classes of plants.

If one will examine the roots of leguminous plants he will doubtless see on many of them small nodules or tubercles. These vary considerably in size depending on the kind of plant being examined. The differences in the size and shape of the tubercles on the roots of the different species is often so marked that it is possible to determine merely by looking at the tubercles what plant they were taken from. Those on the roots of red clover are roundish and quite small being about the size of mustard seed or millet seed. The vetches bear tubercles which are very irregular in shape and size. The cowpea tubercles are nearly round, smooth, and about the size of buckshot.

Thus it will be seen therefore that the presence of these bacteria upon the roots is of prime importance for without them the plant is reduced to the same basis as the non-legumes. It suffers acutely from this condition moreover because it has been in the habit of having an abundant supply of nitrogen to draw upon for its own needs which demand large quantities of this

important element. The high protein content of the plants require the nitrogen if the plant is to make a healthy growth. Nearly every legume has one particular strain of bacteria which can live and thrive upon its roots and ordinarily this strain will not live on the roots of any other kind of legume. The bacteria upon the soy bean is different from those upon the cowpea and neither sort can exist on the other plant. The red clover bacteria is different from the kind growing on the alfalfa roots and cannot be used to inoculate the alfalfa. On the other hand the bacteria found in connection with the sweet clover as well as the bur clover and yellow trefoil can all be used to inoculate alfalfa quite as successfully as when the alfalfa bacteria is utilized.

When a leguminous crop has been grown for years in a section the soil is very likely to contain so many of the proper bacteria that no attention need be given to the securing of inoculation. However, when a legume is new in a locality it is usually necessary to provide in some way for the inoculation. This can be done by treating the seed with pure cultures or with soil from some healthy field of the same crop or from some crop which has bacteria known to be efficient in inoculate the particular crop that is being seeded. If but a small amount of soil be available the seed should be slightly moistened, spread out in a shady place and a few pounds of the soil from the old field sifted over the moist seed. As soon as the seed is stirred and fairly dry it should be seeded without the sun having shone upon it. In case the seed is broadcasted it should be sown immediately in front of the harrow. The seed may also be sown on a cloudy day or in the evening. If ample soil is available it may be drilled in or scattered after the manner of lime or fertilizer. This too must be harrowed in without allowing it to lie in the sun to kill the germs.

When the legumes are well supplied with tubercles the growth of the plant is not only more vigorous but the plant itself is much richer in composition. The Michigan Experiment Station performed an interesting experiment with soy beans where it was found that plants well supplied with tubercles produced

114 pounds of nitrogen per acre while those without tubercles produced only 76 pounds of nitrogen per acre. Cowpeas with tubercles on their roots yielded 139 pounds of nitrogen per acre. as compared with 118 pounds for the non-tubercled plants. The Illinois Experiment station showed that inoculated cowpea plants contained 3.96 per cent. of nitrogen as compared with only 2.22 per cent. for the plants not supplied with tubercles. These figures not only show the value of leguminous green manures but also indicate the great desirability of having them well inoculated with the nitrogen gathering bacteria.

The legume roots are rich in fertilizing elements. Their dry roots contain an average of between eight and nine dollars worth of fertilizer materials per ton.

In regard to length of life and manner of growth the legumes may be divided into three classes or groups. (1) Biennials and perennials such as sweet clover, red clover, alsike clover and alfalfa; (2) Winter annuals, planted in the fall and maturing early the following spring as hairy vetch, crimson clover and bur clover; (3) Summer annuals such as cowpeas and soybeans. From these groups it is usually possible to make a selection of a crop suited both to the climatic conditions and also to the rotation practiced upon the particular farm in question.

CHAPTER VIII.

RED CLOVER AS A GREEN MANURE.

RED Clover is probably the most common green manure crop in the country. It usually lives two years from one seeding when it is plowed under for the purpose of adding humus and nitrogen to the soil. Before it is turned under it is usually pastured to some extent and often one crop of hay and one of seed are secured. When especially large crops of grain are desired it is usually desirable to cut the first crop of the second season early enough so that it may be allowed to lie on the field without smothering the second crop which should be plowed under when it reaches its maximum size. On the poorer soils this is an especially commendable practice and it will be found that on such soils the first crop is not apt to be so heavy that the succeeding crop cannot grow up through it.

One reason for the great favor in which red clover is held is the ease with which it lends itself to the general systems of rotation commonly practiced in the red clover areas of the country. The value of red clover on the farm makes it usually desirable that a considerable proportion of the acreage of the farm be at all times seeded down to this crop. The fact that it can usually be seeded in grain in the spring and thus make its early growth while the land is producing a money crop makes its establishment in a field a comparatively simple matter if there be plenty of humus in the ground. There is no loss of the use of the land for the entire season nor does it call for any special preparation of the ground or application of fertilizers to secure and maintain satisfactory stands upon the ordinary farm. If the soil be somewhat run down and not what might be called a strong soil a three year rotation with clover is best. That is the clover when plowed under is followed with corn which in turn is followed with some

small grain crop in which the new seeding of clover is made in the spring. On the stronger soils one or two additional crops of corn or small grain may intervene between the clover crops. The Illinois Experiment Station showed as a result of one of its lengthy experiments that clover is very efficient in a three year rotation in maintaining the yield of corn. This test ran thirty years and the plot continuously in corn produced an average of

Roots of red clover showing nodules.

only 25 bushels per acre while the plot given over to the production of corn, oats, and clover in a three year rotation produced corn at the average rate of 59 bushels per acre—more than double the yield given where no clover entered into the rotation and not making note of the fact that the soil was fairly fertile to start with and presumably gave reasonably large yields during the first few years of the experiment.

The fertilizing value of the red clover plant is by no means confined to the upper portions or the parts above ground. Experiments have shown that from 30 to 50 % of the fertilizing value of the plants may lie in the roots and stubble which may be plowed under even though the tops be cut and utilized as hay although of course the ground will be made decidedly richer if the entire crop be returned to the soil. In one experiment performed by the Delaware Experiment Station it was found that a single acre of red clover produced 122 pounds of nitrogen, 68 pounds of potash and 28 pounds of phosphoric acid. At present prices for fertilizers clover hay itself contains nearly \$10.00 worth of fertilizer elements per ton. As another illustration of the value of red clover in increasing the yield of succeeding crops an experiment performed by the Ontario Experiment Station may be mentioned. One series of plots was planted to grain alone and a second series to clover mixed with the same kind of grains as were seeded in the first series. When the clover was well grown after the grain harvest all plots were plowed under in October. The following Spring all the plots were seeded to oats. The plots previously in clover for only the one short season yielded at the rate of 50 bushels per acre while the plots that had been seeded to grain alone yielded only 39 bushels per acre. To determine if the effect of the clover extended over more than one season these oat plots were seeded to barley the next season with the result that an average of nearly 38 bushels per acre was obtained from the old clover plots as compared with 29 bushels per acre for the plots which had not had the clover seeded upon them two seasons previous. It was thus clearly shown that the beneficial effect of the plowing under of a crop of green

clover even though it be of only one seasons growth lasts for at least two seasons.

In another experiment one series of plots were seeded to grass alone and another to grass and clover mixed. The grass stubble when turned under gave a yield of oats at the rate of 35 bushels per acre while the plots upon which had been seeded a mixture of grass and clover the yield of oats was 35 bushels per acre after the stubble had been plowed under. In still another experiment in the same series the increase amounted to 28 per cent. in the case of potatoes and to 40 per cent. in the case of fodder corn.

Enough has been said to indicate the remarkable effect of a crop of red clover upon the land. Too much however must not be expected of this crop. While it does add abundant supplies of nitrogen and humus to the soil to enter into the composition of the increased yields yet it does not make any direct addition of ash and phosphoric acid to the soil. These two substances are just as essential to the growth of the plant as is the nitrogen and when the soil becomes depleted in them they must be added in some form of fertilizer. The production of red clover on most farms is too well understood to make an extended discussion of such matters necessary. It will grow on a large variety of soils but those best suited to its growth are the deep clay loams and limestone soils which are suitably drained. If the drainage be poor the consequent heaving of the ground in the spring is apt to lift the clover plants out by the roots. On low damp soils it is best to seed the Alsike clover which is especially adapted to such situations.

Red clover is usually seeded in the early spring although in Western Oregon and Western Washington and in most of the Southern States it is a common practice to seed the clover in the Fall. About 12 pounds of seed is used when the clover is sown alone while if in mixtures about 8 pounds ordinarily suffices. Under favorable conditions and with special care as to getting the seed evenly scattered a good stand of clover alone may be secured by seeding but 8 pounds to the acre. It is ordinarily seeded in

the early spring on a stand of small grain when the ground is honeycombed with the frost. The thawing of the ground in the middle of the day effectually covers the seed.

The utilization of red clover has been materially handicapped during recent years by the fact that the clover for some reason refuses to hold its stand as successfully as it did in former years and in fact is frequently entirely killed out before it has made any material growth. This phenomenon is usually designated as "Clover sickness." The difficulty may however be due to a number of causes any one of which may make the stand kill out. In Europe this clover sickness is thought to be due to the clover being grown too frequently upon the same ground. In this country however it is apparently usually due to the lack of a sufficient amount of humus in the soil. In other words there has not been enough in the way of green manures added to the soil to make them sufficiently retentive of moisture to hold the clover during the drouths which occasionally occur and which prove disastrous to stands of clover upon soils unable to retain a sufficient supply of moisture. Even though the plants do survive they are often in such a non-vigorous condition as to be the easy prey of various plant diseases and insect enemies which they could otherwise be able to resist. This condition can usually be overcome by the addition of humus to the ground in suitable form, often as manure or straw.

The failure of clover to produce as satisfactory stands as formerly should be taken as a warning that something is wrong with the system of farming operations and that it will only be a question of a few years when the other crops will cease to give paying returns. Many of the non-productive farms of the New England States date the beginning of their downfall from the time the soil showed its first inability to longer bring the accustomed stands of clover. This same condition is being met with to an increasing extent further and further west and its seriousness is one which justifies the most careful attention on the part of those interested in the permanent agricultural welfare of the country.

It has been found that the stand is often lost when sown with grain as a nurse crop where as if seeded alone the stand will maintain itself satisfactorily. This is due to the fact that the maturing grains requires a great deal of moisture and this robs the young clover plants leaving the ground about their roots dry and baked when the grain is cut. When seeded alone the young plants have the entire use of the ground and are much better able to make the vigorous growth which will enable them to resist the drouth and such enemies as might otherwise overcome them entirely.

Another means of bringing clover back into the rotation is the seeding of alsike clover instead of the ordinary red variety, or the larger growing Mammoth clover. The alsike clover has been found to be able to grow on soils which are slightly too poor in humus to render them successful in the production of the red clover. The production of alsike should not be kept up indefinitely as it makes a much less vigorous growth but by its use the soil will, with proper treatment soon become able to bring a stand of red clover as successfully as in former years. The Mammoth Clover is of special importance to the farm largely devoted to green manures as the early growth can be clipped or pastured and the main crop left for a heavy seed crop and the straw then returned to the poorer spots on the field for plowing under.

CHAPTER IX.

ALFALFA AS A GREEN MANURE.

ONE ton of green alfalfa contains 1500 pounds of water, 14 pounds of nitrogen, 3 pounds of phosphoric acid, and 10 pounds of Potash, worth \$3.45. A ton of dry alfalfa roots is worth about \$12.50.*

Under certain conditions alfalfa is valuable as a green manure crop. It acts in a manner similar to red clover and other leguminous crops in increasing the yields of the succeeding crops.

The roots add nitrogen directly to the soil in an available form and are also efficient by reason of their deep feeding habit, bringing up from the lower layers of soil a good deal of plant food which would otherwise be out of reach of the shallow rooting crops which follow. The alfalfa hay is so valuable for feeding purposes that it is usually only the stubble that is turned under. The Wyoming Experiment station found that after five years of continuous hay production that the stubble when turned under increased the yield of potatoes to the value of \$16, oats \$16, and wheat \$8 to \$12 per acre. In Colorado and Nebraska the yields of corn and other grain crops is often nearly or quite doubled by the plowing under of a crop of alfalfa.

On the limestone soils of the Southern states it is also efficient as a soil improver as is evidenced by the experience of a planter near Shreveport, Louisiana. A field of alfalfa 11 years old was plowed up and put in cotton. The 18 acres produced 23 bales averaging 575 pounds each. This same field had been in cotton for several years previous to the seeding down with alfalfa and had not produced more than 9 bales in any one season. Another farmer pastured his hogs for two years on an alfalfa field and

*In calculating the values of the various fertilizer elements here and in the succeeding pages the following values have been assigned: nitrogen 20 cents per pound, phosphoric acid 5 cents per pound and potash 5 cents per pound.

then put the land in corn. He secured 45 bushels of corn on this land as compared with only 18 bushels per acre on adjoining land not previously in alfalfa. On similar land another farmer mowed his alfalfa 2 seasons, pastured it one season, and turned it under, securing a yield of 54 bushels of corn per acre.

Alfalfa is raised in practically all parts of the world. This in itself indicates a wide range of adaptability to various climates and conditions. So far as the climate is concerned alfalfa can be produced in every State in the Union. Special care is necessary in the humid states however to provide the proper kind of soil and treatment. It produces as many as 9 cuttings per year below the sea level in Southern California and will make at least two crops at altitudes ranging up to 8000 feet in Colorado. With proper irrigation it produces wonderful crops in the deserts of Arizona which are among the hottest in the world. On the other hand the hardier strains are able to withstand the severe winters of the north central states. It is raised without irrigation in the semi-arid sections of the west where the rainfall may fall as low as 14 inches per year, and also in the Gulf Coast States where the annual precipitation may rise as high as 65 inches. Although the adaptability of alfalfa is very great yet in areas not climatically suited to its best production special care must be taken to provide the right conditions for its successful growth.

The expense incident to establishing an alfalfa field often makes it of doubtful economy to turn under the alfalfa at the end of the first or even the second year, unless with the definite object of increasing the fertility of the soil for some other crop which promises much more profitable returns. In Eastern Colorado the soils are lacking somewhat in fertility as regards producing successive crops of cantaloupes, potatoes or sugar beets indefinitely upon the same land. It is usually impossible to secure more than two successive satisfactory crops of these without the introduction of alfalfa into the rotation for a year or two. When the truck crop is removed the land is seeded to fall wheat which in turn is followed with oats used as a nurse crop for the alfalfa which is seeded with it. The alfalfa makes a moderate

growth the first season and is turned under at the end of the next season to fit the land for two more profitable truck crops.

Where the initial cost of seeding is not too great the returns the first summer after early autumn seeding may be sufficient to make the crop pay for itself and justify one in turning under the stubble and fall growth after three cuttings of hay have been secured. In the Eastern States a stand of alfalfa will often become choked out with weeds by the end of the third season when it is necessary to turn under the crop.

It is not easy to turn down a stand of alfalfa as the roots are large and hard to cut off with the plow. However, in such sections as Eastern Colorado where it is a common practice to turn under vigorous stands of alfalfa, satisfactory methods have been worked out. There it is the usual custom to plow shallow

Plow with an attachment for cutting the alfalfa roots at the outer edge of the succeeding furrow.

in the fall so as to prevent the crowns from having much of the root to draw upon for its growth as a weed the next spring. The following Spring a deep plowing is given the land so that the succeeding truck crops can be deeply cultivated without the alfalfa roots proving troublesome to the cultivator. The plows are sometimes provided with a knife attachment on the landside of the plow to cut the roots near the outer edge of the next furrow where otherwise they would be apt to slide around the side of the plow share. The shallow plowing in the fall also serves to expose the crown to the action of the weather with the result that a far greater percentage of the crowns are winter hilled than would be the case were deep plowing practiced in the fall. Again the deep plowing in the spring effectually buries the crowns with a

small amount of root attached so deeply that the spring growth is unable to reach the surface and prove troublesome to the succeeding crops.

Alfalfa requires a deep, fertile, well drained, heavily limed soil fine on top but compact below. Inoculation is usually present in the western states but must be supplied in the eastern states especially when first establishing it on ones place. Failure to provide for any one of the above requirements especially in the eastern states usually means a failure as in humid sections alfalfa is out of its natural habitat and must be handled exactly right to enable it to make a sufficiently vigorous growth to overcome its many enemies. Alfalfa will not succeed on a poorly drained soil nor on one low in fertility or deficient in lime. With the possible exception of some parts of the limestone sections all soils in the East may be safely considered to require an application of lime for the successful growth of this plant. At least a ton of lime is generally required and often more than this is necessary on the heavier more acid soils. Ground unburned limestone is recommended wherever it can be secured and applied at one half the cost of the burned lime. It requires twice as much per acre and is somewhat slower in its action but it is not thought to have the deleterious effect upon the humus supply in the soil that the burned limestone has. However when applying lime at the time a green manure crop is being plowed under the rapid oxidation of the green plants is usually desirable and then the freshly slaked burned lime is probably the most satisfactory. Well rotted barnyard manure is a very good form of fertilizer for alfalfa as it provides a very favorable medium for the growth of the bacteria upon the roots. In the Middle Atlantic States, Crimson Clover is probably the most satisfactory green manure that can be turned under in preparation for alfalfa. In the irrigated sections of the country spring seeding is the rule but elsewhere early fall seeding is best. In the Northern States late summer seeding is even preferable to early fall seeding as this avoids the weeds of mid summer while the frequent harrowings which should be given the land for six weeks previous to

seeding will effectually destroy most of the weed seeds which rapidly germinate under such conditions. They are thus not a source of danger the following season in the alfalfa field. Inoculation is usually not necessary in the regular alfalfa districts of the Western States but is ordinarily necessary in the East where the humid climate and acid soil are apt to check the natural spread of the bacteria.

The rate of seeding varies greatly in the different sections of the country. In the Eastern States 30 pounds per acre is usually necessary to insure a perfect stand at the hands of the ordinary farmer. In the Mississippi and Ohio river valleys 20 pounds is the ordinary rule. Under irrigation in the west 15 pounds is usually sufficient. In the semi-arid sections where a thin stand is essential from ten to twelve pounds is used while as small a seeding as 5 pounds per acre has proved thick enough for satisfactory results. If weeds threaten to choke out the young alfalfa plants at any time clipping with the cutter bar of the mower set high will destroy most of the weeds without harming the alfalfa which starts new buds from the base of each shoot. In most parts of the Eastern States alfalfa is still in the experimental stage and ones first seeding should be made upon a small scale and if possible several different treatments given separate parts of this experimental tract. In this way the experience which would otherwise require several seasons to procure can be obtained at the end of the first year.

Alfalfa should not be sown on ground that is badly in need of humus as it requires a fairly good soil to make a satisfactory growth. On such soils as are especially low in humus it is better to sow some other legume which will build the soil up until it is in the proper condition for the reception of the alfalfa.

CHAPTER X.

MISCELLANEOUS LEGUMES AS GREEN MANURES.

COWPEAS.

ONE ton of green cowpeas contains about 1700 pounds of water, 12 pounds of nitrogen, 3 pounds of phosphoric acid and nine pounds of potash. The value of these constituents is \$3.00 at the valuation given in the chapter on alfalfa. One ton of the dry roots contains about \$6.00 worth of fertilizing materials. The average yield of the green tops is 6 to 12 tons per acre.

The cowpea is used to a greater extent as a soil improver in the Southern States than is any other crop. It is a native of India but has been grown in this country for nearly one hundred and fifty years. Although it is used extensively yet it is not being seeded any where near as extensively as it should be in light of its wonderful ability to thrive on poor acid soils where it is difficult to grow other legumes but where some legume is very essential. Its growth is so vigorous that it usually chokes out any competing weeds. Inoculation is ordinarily present or at least is readily secured.

The experiments which have been tried out to determine the effect of the cowpeas on the fertility of the land have indicated the great value of this crop as a green manure. On the poorer soils it is best to turn under the entire crop but on the richer soils the hay or at least the seed may be gathered and the remaining portions of the plant returned to the soil.

In an experiment performed at the Arkansas Experiment Station it was shown that one crop of cowpeas turned under gave a yield of 14 bushels of wheat for four successive years thereafter as compared with 10 bushels of wheat per acre on the plots not

having had the peas planted upon them and turned under. The plots originally in cowpeas also showed some beneficial effect for a second series of four years thus making a total of eight years over which the effect of the one crop of cow peas could be seen. Where only the cowpea stubble was plowed under the average yield of wheat for the first four years was a little over twelve and

Cowpea Vine showing pod and flowers.

one half bushels per acre. A comparison was also made as to the value of fertilizers on the same series of plots. It was found that 800 pounds of complete fertilizer per acre produced an average yield of 13 bushels for the four years. The beneficial effect of this fertilizer was all observed in the first two years.

The effect of cowpeas on the yield of a succeeding crop of sorghum was determined by the Alabama Experiment Station. It was shown that 5.66 tons of sorghum hay was produced following cowpea stubble while 5.72 tons per acre was secured when the vines also were turned under. Where sorghum had been turned under the yield of the succeeding crop of sorghum hay was only 3.65 tons per acre. This indicates clearly the value of turning under a leguminous rather than a non-leguminous crop. It was also found that where millet was turned under the yield of oats was only 12.4 bushels per acre as compared with 22.8 bushels where cowpea vines had been plowed under.

The South Carolina Experiment Station found that a ton of dry cowpea roots and stubble contained 27 pounds of nitrogen, 5 pounds of phosphoric acid and 17 pounds of potash, a total value of \$6.50. The entire crop produced fertilizer elements to the value of \$41.82 as compared with \$10.14 for corn and only \$8.55 for oats.

These examples might be multiplied but enough have been cited to show the value of this crop not only as compared with other legumes but also as compared with non-leguminous crops which are sometimes plowed under as green manure.

When cowpeas are being seeded for the purpose of turning under as green manure they should be seeded at the rate of about 60 pounds per acre preferably with a grain drill. When the soil is well warmed as in late spring the seed will germinate very promptly if the ground is moist. Cowpea seed more than two years old is usually practically worthless as it deteriorates very rapidly after the second year.

SOY BEANS.

The soy bean, also called soja bean, came originally from southeastern Asia but has long been much cultivated in China, India, and Japan.

One ton of green soy beans contains 1500 pounds of water, 12 pounds of nitrogen, 3 pounds of phosphoric acid, and 11 pounds of potash valued at \$3.10. One ton of the dry roots contains a little over \$5.00 worth of fertilizing materials.

The average yield of the green tops is about six tons per acre. The soy bean is similar in many respects to the cowpea. It is used to a considerable extent as a soil improver in the Southern States and is also grown as far north as Minnesota, Ontario and New England. The soy beans are thus adapted to a wider range of climate than the cowpeas. They will also succeed better than cowpeas on poorly drained soil as well as under conditions that are too dry for the best production of cowpeas. The seed is usually cheaper than that of cowpeas owing to the fact that the soy bean seed can be readily harvested by machinery. It is usually necessary to cultivate the soy beans inasmuch as they are not as successful as cowpeas in smothering out the weeds which prove troublesome throughout the humid sections of the country.

The Michigan Experiment Station found that inoculated soy beans were able to add 38 pounds of nitrogen to the soil which was secured from the air. The Arkansas Experiment Station used soy beans as green manure and found them to give equally as good results as cowpeas, as determined by following them with such crops as oats, wheat, corn or cotton. With corn after cow pea stubble the same results were secured as after soy bean stubble, while soy bean vines turned under gave better results on the succeeding corn crop than did the cowpea vines. With oats, however, the results were slightly in favor of the cowpeas.

Soy beans are very well adapted to short rotations taking either the entire season for their growth or in case of the early

Typical soy-bean plant.

maturing varieties requiring but a part of a season following some small grain crop. In Tennessee and North Carolina the soy bean may be grown between two regular wheat crops without the loss of the land for a season. In other parts of the South it may be grown between oat crops, especially if the early varieties are sowed.

The soy bean is an annual crop, with an erect habit of growth. The seed is usually best planted in rows 30 to 36 inches apart so that they can be cultivated. The plants should be about two inches apart in the row and when seeded thus a bushel of seed will plant between two and three acres. If sown broadcast a bushel per acre of seed is required. The seed may be sown at any time after the soil has become well warmed in the spring. The seed should be planted about an inch deep and never more than two inches in depth even on sandy soil. The special advantage of the soy beans is their marked ability to add nitrogen to the soil together with the short period of time necessary for their maturity.

CRIMSON CLOVER.

Crimson clover is a native of the region north of the Mediterranean and has long been cultivated both as a green manure crop and as a forage crop in that section.

A ton of green crimson clover contains about 1650 pounds of water, 10 pounds of nitrogen, 3 pounds of phosphoric acid, 7 pounds of potash, valued at approximately \$2.50. One ton of the dry roots contains about \$7.50 worth of fertilizing materials. A normal yield of crimson clover is about six tons of green hay per acre. This crop is especially adapted as a green manure crop and as a cover crop in the Atlantic States from Pennsylvania southward. It is easily recognized by its scarlet or crimson colored blooms. It is usually seeded in August in the North Atlantic States or in September further south either alone or in corn. It is especially valuable in that it may be seeded among an intertilled crop and will make enough growth in the autumn, winter and early spring so that it may be turned under in the

spring following the seeding in time for another crop such as corn or even cotton in the South Atlantic States. It will not succeed on the poorest of soils and a preliminary crop of cowpeas turned under is usually necessary in establishing crimson clover upon a soil very low in humus and fertilizing elements. By the intelligent use of this crop as a green manure, land producing only from five to ten bushels of corn per acre has been increased in fertility so that it will normally produce fifty bushels. This may be accomplished without the loss of the use of the land for corn single season, by seeding in the corn at the last working and turning under the crop the following spring in time for planting the corn. Nearly as good results have been obtained by cutting a crop of hay when the plants come into bloom and then turning under the rather high cut stubble just before planting the corn. At the Delaware Experiment Station sweet potatoes following crimson clover yielded an increase of 18 bushels per acre. This was a gain equal to that on another plot which had received an application of 140 pounds of nitrate of soda. At the Maryland Experiment Station, potatoes, planted on plowed under crimson clover, yielded 72 bushels per acre as compared with 53 bushels on a plot not previously seeded to crimson clover. In the following year the same plots yielded 102 bushels on crimson clover land while that not seeded to crimson clover gave only 68 bushels of potatoes per acre. In an experiment with corn, following crimson clover, the corn yielded 46 bushels while that on land not seeded to crimson clover gave only 39 bushels per acre. Crimson clover also makes an ideal crop to turn under just before seeding alfalfa as it will grow in land slightly too low in humus for the best results for alfalfa and by the larger quantities of humus which it adds to the soil does much toward developing the ideal conditions required by the alfalfa for its most successful growth. Fifteen pounds of seed per acre is usually regarded as sufficient for obtaining a satisfactory stand. If sown in a drought a poor stand often results. It is usually best to wait and seed it between showers after the drought is broken should such a drought occur at the customary seeding time.

SWEET CLOVER.

Sweet clover came originally from southwestern Asia but has been grown for many centuries in the region surrounding the Mediterranean Sea. The yellow species were originally the more common but in this country the white species is much more widely utilized than are the yellow species.

A ton of green sweet clover plants contains about 1600 pounds of water, 12 pounds of nitrogen, 5 pounds of phosphoric acid, 13 pounds of potash. The fertilizing constituents above named possess a value of \$3.30. The yield of green hay of white sweet clover varies from 12 to 18 tons per acre. The special value of sweet clover as a green manure crop lies in the fact that it will grow on many soils which are too poor for the successful growth of other leguminous crops. It is extremely useful in improving the humus content of soils which are almost devoid of this material. Sweet clover may often be noted growing on steep slopes such as railroad cuts or embankments where the conditions are so unfavorable that few or no other plants are able to maintain a foothold. On the limestone hills of Tennessee, Alabama, and Mississippi this crop is very important in that it makes a very luxuriant growth upon these soils which usually refuse to produce a satisfactory crop of any other plant. After a few years in sweet clover, however, these lands prove very fertile and by the use of this plant the value of such lands is often more than doubled. The Experiment Station in Alabama grew sweet clover on reasonably fertile land and then seeded the land to corn, obtaining 28 bushels per acre as compared with 21 bushels per acre where cotton had preceded the corn. This increase in yield was not the only value to be credited to the sweet clover since the first season it produced $2\frac{1}{2}$ tons of hay and the second season $3\frac{1}{3}$ tons of hay which was readily eaten by stock. In another experiment, presumably on poorer soil or under less favorable conditions, corn yielded 23 bushels per acre following sweet clover as compared with only 16 bushels on adjoining land where cotton

had been produced the season previous. An European Experiment Station found that the yield of oats when preceded by sweet clover was increased 17 bushels per acre. A part of this field seeded to potatoes yielded more than double that of and adjoining plot not seeded to sweet clover. The Ohio Experiment Station produced a yield of 27 bushels of corn per acre as compared with 19 bushels on similar land not in sweet clover. Under natural conditions sweet clover drops its seed in the fall and germinates very early the following spring. The first season's growth is about thirty inches in height with a very large development of fleshy roots. The crown buds on these roots develop in the fall and commence growth very early the following spring. This crop can be utilized as early pasture and then turned under for some late spring seeded crop or it can be pastured until July and then allowed to make seed and the straw and high cut stubble returned to the land. When seeded under field conditions it is necessary that the land be very firmly packed as this insures a prompt germination and a much more healthful growth of the plants than is the case on poorly settled ground. Many farmers have been successful by seeding the sweet clover with oats as a nurse crop. If seeded alone it can be pastured the first season without detriment to the plants. It makes a fairly good growth when seeded in late summer but does not make sufficient root growth to make an especially good growth the following season.

BUR CLOVER.

There are two common species of bur clover in the United States, one being the spotted or southern bur clover used in the Southern States and the California bur clover. The California bur clover is very tender and usually winter-kills except in the extreme southern portion of the United States. The spotted bur clover is hardy as far north as Tennessee and North Carolina. Bur clover does best on light, rich soils and may obtain a height of 18 inches, yielding as much as 2 tons of hay per acre

or 6 tons of green matter to be plowed under. It may be grown even on red clover soils. It is also adapted to growth on Bermuda grass sod and this combination gives almost continuous grazing throughout the years as well as furnishing a goodly amount of green manure for plowing under. Bur clover should be sown in late summer or early fall at the rate of 16 pounds of hulled seed per acre or 20 pounds of seed in the bur as it usually is in the case of the spotted bur clover. Bur clover reseeds itself readily and is never troublesome as a weed. It possesses the further advantage in common with sweet clover of being able to inoculate the ground for alfalfa.

JAPAN CLOVER.

Japan clover is an annual legume of value principally in the Southern States where it makes a good growth. In the Middle Atlantic States it usually makes such a low growth as to be adapted only for light pasturing on worn out pastures. It is of special value in the South owing to its ability to come into places of its own accord and improve the nitrogen and humus content of the ground. It possesses the same ability to increase the yield of succeeding crops as do similar other leguminous green manure crops. It produces about five tons of green hay per acre. It should be planted at the rate of ten to fifteen pounds of seed per acre and harrowed in on reasonably well prepared seedbed in late spring after the soil has become well warmed.

VETCHES.

The vetches are mostly natives of Europe and western Asia but have been grown in this country for many years. There are several varieties, the two sorts most generally grown are the common vetch which is used as a summer crop in the Northern States or winter crop in the South and the hairy vetch or sand vetch which can be seeded in the fall even in the north and will survive the winter and be ready to turn under the following spring.

A ton of the green vetch plants contains about 1650 pounds of water, 13 pounds of nitrogen, 3 pounds of phosphoric acid, and about 10 pounds of potash. The above fertilizing constituents possess a value of \$2.25. One ton of dry vetch roots contain over \$10.00 worth of fertilizing materials. The vetches ordinarily yield about six tons of green plants per acre.

Hairy Vetch showing flowers.

Vetches must usually be seeded with some erect growing crop such as a small grain in order that the vines may not lodge or trail along the ground. The hairy vetch is especially valuable owing to its hardiness, its drought resistance, its value as a green manure crop and also as a winter cover crop, keeping the land

from washing when it would otherwise be bare and subject to severe winter erosion. About 40 pounds of hairy vetch or 60 pounds of common vetch are required to seed an acre. When turned under this crop has marked effect on the yield of the succeeding crop and possesses the advantage of being so hardy it can be seeded rather late in the fall and still make enough growth for turning under the following spring in time for the ordinary cultivated crops. A rolling coulter to cut the vines just ahead of the plow facilitates the turning under of the vines.

CANADA FIELD PEAS.

Canada field peas are grown as a summer crop in the extreme northern States and in the mountains of the States farther south. It requires rather cool weather for its best growth and for this reason is used to some extent as winter hay as well as green manure crop in California.

A ton of green Canada field peas contains about 9 pounds of nitrogen, 3 pounds of phosphoric acid, 10 pounds of potash and 1800 pounds of water.

Canada field peas yield about five tons of green hay per acre. The Ontario Experiment Station grew wheat on three different plots upon which green manure crops of Canada field peas, rape and buckwheat had just been plowed under. The yield of wheat following the Canada field peas was 36 bushels as compared with 30 bushels following the rape and 27 bushels following buckwheat.

There are many varieties of field peas among which may be mentioned the French Pigeon, Golden Vine, Prussian Blue and Canadian Beauty. Canada field peas are sown in the early spring in the north or in the autumn in the southern States. They are usually mixed with some small grain crop using about a bushel of peas to a bushel of grain per acre. If the vines are allowed to mature seed it is usually best to pasture them with

hogs until they have eaten up most of the peas and pods as these are usually more valuable for pork production than to turn under as green manure. After the hogs have finished pasturing off the peas the vines may be turned under as green manure.

Canada Pea showing pods.

CHAPTER XI.

GREEN CORN AS A GREEN MANURE AND AS A PROTECTION AND MULCH FOR WHEAT.

WE believe that corn along with legumes will take a high position among green manures when the best way to use it is properly understood. A farmer in Kentucky sowed corn on a field of thirty-seven acres, and the result was so favorable that he says: "Were my only object the rapid improvement of my soil within the shortest space of time, I would not seek further or better means than first sowing down thick with rye, which I would plough under just before the time of ripening, to prevent its seeding the ground, and upon which I would sow one bushel and a half of corn per acre, thus in the same season ploughing under a heavy coat of rye and corn, which in the short space of twelve months will equal, if not surpass, any benefit which can be derived from clover in two years."—*Cultivator*, 1843.

One more vote in favor of corn I wish to record from a good writer and practical farmer.

S. E. Todd says in his *Farmer's Manual*: "Some farmers contend that clover ploughed under is the cheapest manure that can be made. It is a great fertilizer; but I believe that a soil can be renovated sooner and at a less expense with Indian corn than with clover, because a much larger quantity is turned under yearly of corn than of clover. By being expeditious in business when a crop of wheat, oats, or barley is taken off in July, as they are many times, if the soil is ploughed immediately and Indian corn sowed, it will grow large enough in ordinary seasons before the autumnal frosts to plough under. But when clover is raised no other crop can be grown the same season."

These are very high recommendations in favor of green corn. And are they not true? Whatever is undoubtedly beneficial as

food for animals most certainly will be good manure. Why is clover so much better than wheat straw, for animal food? Because it contains more than four times as much nitrogen as the straw. And that is the very reason why it is so much better for manure.

Without nitrogenous food we can have no flesh. Without nitrogen in the soil we can raise but little food that will make flesh. In other words, nitrogen is an absolute monarch who can never be dethroned while life exists upon the globe.

One ton of green corn contains six pounds of nitrogen, two and a quarter pounds of phosphoric acid, eight pounds of potash, and sixteen hundred pounds of water. The above fertilizing material possess a market value of about \$1.75. I find by years of experience that it is better to plough in two crops of corn in one year than one great heavy crop which has grown all the spring and summer.

I have several times turned in from thirty to forty-five tons per acre. The great objection to this mode was pointed out to me by the ploughman. The surface-roots formed such a dense, compact, and tough mass along each furrow that the plough could not cut them, and it became necessary to run under them; hence the ploughing was much deeper than desired.

Two crops in a year, each containing in tops and roots about twenty tons per acre, will manure the land well.

Let us compare these with the contents of the barnyard. At this rate on twenty acres we may have eight hundred tons of green manure. To equal this dressing in nitrogen, phosphoric acid, and potash will require about five hundred tons of stable manure. And that will cost to buy it at least five or six hundred dollars, even if you could find that much for sale anywhere within a reasonable distance of the farm.

Having ploughed in the first crop of corn about the middle of July, what shall we do next? I will tell you my plan, and if it does not meet your full approval do not follow it. Or if doubtful of its value, try it on a small plot and you will lose but little if it fails.

About the first of August, having the land in good condition, put in the corn in furrows six or seven feet apart and seven or eight grains to the foot. Keep the ground mellow and free from weeds with the cultivator while the corn is growing. This you ought to do if there was no crop to work in preparing the land for wheat. Now, when the time comes to sow wheat you will find the sown corn from three to four feet high, according to the quality of the soil and the warmth and wetness of the season. Then sow the seed between the rows and fluke it in.

Now mark the result.

No blasting winds in winter nor in the early spring can injure the wheat. The drifting snows will be retained and help to shelter it. The soil, powdered by freezing and drying into fine dust, will not be blown away. No droughts will check its growth. The ground will always be found moist and mellow beneath the shelter. Even the rows of corn which may only be a foot high will attract the surface-roots of the wheat to banquet in the moist and mouldering dust beneath their dense shade. And when it decays in the warm days of spring, the rains will leach out its soluble elements and saturate the soil with them, and do more good to the ripening wheat than the same amount of green fodder fed to cattle and the residue returned to the field.

To establish these high claims for Indian corn, and the great necessity of shelter for winter wheat, I will quote a few words from John Johnston, the great apostle of agriculture, whom we have already presented as the powerful advocate of surface manuring.

He says: "Wherever the wheat was exposed to the west and north-west it is greatly damaged, and I fear considerable of it is ruined. I have eighteen acres of Soule's wheat, about five of which are sheltered by growing timber from the west and north-west. Those five acres look as promising as any wheat I ever saw; the other part of the field is weak, and I think cannot make a full crop, although much better than much I see around me.

The Maryland wheat of which I wrote you was sown immediately, east of the orchard. So far as the shelter of the orchard extended it looks pretty well; beyond that it is quite feeble. Had my orchard been on as high land as the wheat-field, I have no doubt it would have sheltered all the wheat-field.

"I have thought it would pay to plant quick-growing timber to shelter fields that are exposed to the west or north-west. We have no hard blows from due north or anywhere easterly to injure crops, but often from the west. It was only three years ago that half⁶/₈ of the wheat in the State that was exposed to the north-west and west was killed by a hard frost and hard blow on the eighth of March. I feel quite sure that it would pay to have plantations for shelter wherever winter wheat is the staple crop. A top-dressing of manure, or even straw, would have a tendency to protect it in such seasons as this has been. *This I know.* One inch of straw put on after sowing the wheat would have saved it, I have no doubt; and fine manure would be still better. Where the wheat is sheltered by our rail fences it is safe as far as that shelter extends, though one would not suppose there was much shelter from a rail fence; but it has been enough to protect the wheat on that severe day, the 17th of February."—*Country Gentleman*, vol. 23d.

Probably no man was ever more successful in raising wheat, or ever gave the subject a more patient investigation, than John Johnston; hence these words will be received as instructive truths by all who know his exalted worth.

The wheat-plant has many enemies. The midge, the mildew, and the Hessian fly too often nearly ruin it; but according to the authority of Lewis Bollman of Indiana, "*Freezing out* is perhaps more destructive to the wheat-crop than all other misfortunes to which it is incident."—*Agricultural Report*, 1862.

S. E. Todd says: "In every wheat-field may be seen in spring, plants growing in little hollows sheltered by lumps or banks from the cold wind, but enjoying the benefit of the sun's rays. The difference between the growth of these plants and

others which have not the benefit of shelter is remarkable.”—*Wheat Culturist*, p. 212.

Again he says, on page 226: “The more we can protect the wheat-plants from piercing winds and intense cold, the better crops of grain we may expect to raise.”

In corroboration of these statements we have seen reports of stumps in the Western States saving little patches of wheat all over the field.

Sidney Weller of North Carolina was in the habit of scraping up the pine leaves in the forest and covering his wheat in the fall with much care and trouble. He says: “By four years’ trial I have now found it always benefits the wheat—sometimes increasing the product one-half at least—and even guards the clover against the misfortune of burning out in hot, dry summers.”—*Cultivator*, 1843.

What a contrast between the labor of spreading straw or pine leaves upon a large field, and the ease and rapidity by which you can roll down a luxuriant growth of green corn where it grew!

This method of raising wheat will not prevent you from using stable manure as a top-dressing.

Any time before sowing the wheat, or afterward if you wish to do it, you can drive between the rows of corn and spread the manure from the wagons. You remember that Gurney says that manure does six times more good under a mulch than when not covered with anything.

In the first edition of this work the farmer was advised to roll down *in the fall* the corn which had been planted in drills to protect the wheat. Careful experiments since that time have proved to my satisfaction that this is not necessary, and that it is better to leave the corn standing till spring and then roll it down.

Since the discovery that drilled wheat is seldom injured by freezing, and that careful rolling of light land is another great source of protection, it is only in very exposed situations and in the Northern and Western States that you will have to resort to other means to secure an ample shelter to your fields of grain.

It is very probable when planting corn for this purpose that it would be better to have the rows wide enough apart, that the drill may be used in putting in the wheat. Another point will need more careful experiments to work out the right number of kernels to the foot; that is, how thick to sow the corn. Would it be better to scatter in the furrow fifteen or twenty, or only six or eight, grains to the foot in preparing a shelter and protection for the crop of wheat?

CHAPTER XII.

HUNGARIAN MILLET.

ONE ton of Hungarian millet in blossom contains about seven pounds of nitrogen, two and a half pounds of phosphoric acid, nine pounds of potash, and thirteen hundred and sixty pounds of water. The above fertilizing constituents are worth about two dollars. When the clover-seed which was sown among the wheat has failed to grow, you had better seed the field in the spring with Hungarian grass; that is, if you intend to alternate a green and grain crop in succession.

As soon as all danger is over from frosts sow one bushel per acre of the Hungarian seed when the ground is in good and mellow condition, and then roll it in. As soon as this crop comes in blossom, sow over it a half bushel more of seed per acre. Then with your mowing-machine cut it down and leave it on the ground. Being cut so early, it will sprout up, and with the last sowing you will have two crops growing together, and, being shaded by the first, will be equal to it in weight and value.

These two crops of green manure will make together twenty-five tons per acre, and this will amount on a field of twenty acres to five hundred tons. Then this green dressing will cost the price of the original seed or about ten cents per ton. The ten thousand pounds of nitrogen in it will cost less than one cent per pound.

Let us compare this with barnyard manure. It will take one thousand tons to furnish as much nitrogen as we have in the twenty acres of Hungarian grass. If you can buy the manure and haul it home and spread it for one dollar and fifty cents per ton, it will cost you fifteen hundred dollars.

Peruvian guano contains two hundred and eighty pounds of nitrogen per ton, and at the old price of sixty dollars it would

cost nearly twenty-one hundred and sixty dollars to obtain as much nitrogen in that way as we get for sixty dollars in the twenty acres of Hungarian grass.

Nitrate of soda is another highly-concentrated manure, because it contains three hundred pounds of nitrogen per ton. But I do not know where you can buy the pure article for less than ninety dollars for two thousand pounds; therefore, it will cost you three thousand dollars to get as much nitrogen as we obtain for sixty dollars in twenty acres of green millet. [In 1911 the market price of Nitrate of Soda was about \$50. per ton.—*Ed.*]

After looking at the subject through these calculations, does it not seem exceedingly strange that English, and even American, farmers will purchase nitrate of soda and sow from one hundred to two hundred and fifty pounds per acre on their wheat?

Why *will* they do it? Because they want *available* nitrogen. They want it in such a condition that it can be taken up by the plants the moment it is sown. Green manures must decay: a complete decomposition is necessary to convert the nitrogen into nitric acid and ammonia.

But let us have patience; there never was a pile of hay or grain or grass that would not rot down, and in reasonable time make manure.

But how shall we hasten this decay to the best advantage?

By keeping the material upon the surface. Dr. Voelcker discovered that hay or new-mown grass lost more than half of its richest elements when left on the field and exposed to leaching rains for a short time.

Unless the soil is very loose and sandy, vegetable matter will not decay when ploughed in as soon as it will upon the surface.

Combustion is a rapid condition of decay, and the whole process of decay is a slow combustion—in both cases a union of oxygen with carbon and hydrogen. Cover your fire with ashes or earth and it will not burn as brightly as when uncovered. Bury half-rotten manure or straw or wood so deep that air will be *entirely* excluded, and no further decay can take place. This

is still further evidenced in peat bogs where the air is naturally excluded. Here trees and other plants remain preserved for centuries.

Stirring the soil promotes the slow burning (decay) of the vegetable matter in the ground. A pile of clover hay may lie for years apparently but little changed by decomposition. But a careful examination will disclose the fact that nearly all its valuable constituents have been carried into the soil. The shell remains, but the oyster has been extracted.

Minute division favors oxidation. A substance dissolved by water and deposited on the soil has its atoms in a state of great refinement, and will soon be converted by a chemical change into *available* plant-food. Hence the unquestionable advantages of cutting down green crops in midsummer and leaving them to cover the ground as long as possible. At the same time another green one may be encouraged to grow up through the mulch.

CHAPTER XIII.

MORE ABOUT GREEN CLOVER.

ONE ton of green clover contains twelve pounds of nitrogen, three pounds of phosphoric acid, ten pounds of potash and sixteen hundred pounds of water. These fertilizing elements have a value of about three dollars. A normal yield is about 6 tons of green tops per acre valued at about eighteen dollars. One ton of the dry roots contains fertilizing materials worth approximately \$12.50.

We may by good management have fifteen tons by the middle of June to cut down or plough in for wheat. If left on the surface as a green dressing, a second crop will grow up, and the two together will amount in tops and roots by the middle of August to twenty-five tons per acre. That will be five hundred tons on a field of twenty acres. This amount of green manure will contain six thousand pounds of nitrogen.

One peck of seed per acre, at ten dollars a bushel, will make the nitrogen cost less than one cent per pound and the green clover ten cents per ton. That is fifty dollars for five hundred tons of green manure.

Now, it will take six hundred tons of barnyard manure to furnish as much nitrogen as we get in the twenty acres of clover. If you buy stable manure and haul it home and spread it at a cost of one dollar and a half per ton, you pay nine hundred dollars for a pile that contains no more nitrogen than we can obtain for fifty dollars.

To this you may reply that when we purchase manure it is all a clear gain, but that the clover only contains what was already in the soil and air. This would be very plausible reasoning—indeed, it would have great weight—were it not an established

fact, as we have already shown, that land does not retain its nitrates and other soluble plant food materials, but allows the dissolving waters to carry it off almost constantly.

With this knowledge accepted as a great truth, the careful farmer will always employ a trustworthy collector of Nature's manurial treasures. Among these he will find by long experience that red clover stands in the highest rank.

It will always be profitable to raise clover in every field on the farm whenever other crops will permit it. And whenever the crop is not heavy we should assist the land by a free use of bone-dust and plaster or super-phosphate of lime.

Were all the merits of red clover emblazoned in letters of gold on a large canvas, it would fail to convey to the mind a full estimate of its true value.

The Hon. George Geddes says: "The agriculture of Onondaga County, New York, is based on the red clover plant. It is used for pasture, for hay, and for *manure*. Strike this plant out of existence, and a revolution would follow that would make it necessary for us to learn everything anew in regard to cultivating our lands."

Joseph Harris says: "Raise your own clover-seed, and sow it with an unsparing hand. You cannot raise too much clover. It is the grand renovating crop of America."

Allen says of clover in his *American Farm Book*, "*It is as a fertilizer*, however, that it is so decidedly superior to other crops. In addition to the advantages before enumerated, the facility and economy of its cultivation, the great amount yielded, and lastly the convenient form it offers for covering with the plough, contribute to place it far above any other species of vegetation for this purpose. All the grains and roots do well after clover; and wheat especially, which follows it, is more generally free from disease than when sown with any other manure. The introduction of clover and lime in connection has carried up the price of many extensive tracts of land from ten to fifty dollars per acre, and has enabled the occupant to raise large crops of wheat where he could get only small crops of rye; and it has

frequently increased his crop of wheat threefold where it had been previously an object of attention."

In 1843 *The Cultivator* said: "We know an extensive farmer, and a most successful one, who avers that he can manure his farm cheaper with clover than he can with manure, could he have it for only the carting from his yard and spreading."

Among experienced farmers a great diversity of opinion exists regarding the most profitable way of using clover. Some can hardly be induced to plough it in, or anything else which can be used as forage; among these we may number Joseph Harris, yet even he says: "In certain circumstances it may be better to plough under the clover instead of feeding it to stock on the farm. It is a *quicker* way of enriching the soil."—*Genesee Farmer*, 1863.

Now, is not this a great concession? He is such an eloquent advocate for feeding every straw that I almost thought if he were to see an ox eating his jacket he would give him his coat also!

Ten years after this was written he speaks still more favorably upon this subject in *Walks and Talks*, No. 116: "We shall have to go back to the old-fashioned plan of ploughing under clover," says the deacon; and, as usual, he is more than half right."

What a great satisfaction it would be to see the strong and powerful pen of Joseph Harris engaged in full faith in defence of green manuring!

Here is another example showing how little it cost to enrich land with clover:

D. D. T. Moore sowed clover-seed with barley, and the next spring, on the 8th of June, ploughed in the clover for corn. He says, to ascertain the weight of the crop of clover thus turned under, he cut a square foot of the sod, shook off the soil, and found the weight of clover and its roots to be two pounds and a quarter. This would give forty-nine tons per acre.

Hence he obtained five hundred and eighty-eight pounds of nitrogen for one dollar and a half, the reported cost of the seed per acre!

Now mark—and remember well this astounding fact—that we have a green manure which costs but a trifle over three cents per ton, and which is more valuable, ton for ton, than stable manure! And not a cart nor horse nor fork of any kind was required to spread it evenly over the whole field!

When I first read this account in the *Cultivator* for June, 1854, I was inclined to suppose that there was some error in the report.

That such a mass of clover could grow in less than fourteen months, and part of that time in the winter and with barley, seemed beyond all common experience. But after this, most fortunately, I came across the following careful estimate of the amount of vegetable matter which can grow upon an acre, and that reconciled me entirely as to the correctness of Mr. Moore's statement:

The Hon. George Geddes says: "Professor Kedzie, of the Michigan Agricultural College at Lansing, took a square foot of June grass-turf and washed away all the soil in running water, and then weighed the roots and surface grass to determine the amount of green manurail matter usually contained in a heavy green sward, and found it to be five pounds to the square foot, or at the rate of more than 100 tons to the acre."

It certainly is unnecessary to dwell any longer on clover as a means of enriching the soil.

But when and how to use it will require some attention.

Will it ferment and become sour when turned in in a green state? Some farmers say it will.

For thirty years John Johnston ploughed it in about the middle of June. How is it that we hear nothing from him about souring the soil?

The Hon. George Geddes says it is ready to plough in as soon as it comes to full maturity. Now, without any exaggeration we may say that there is not another person in the United States who has had such a long and large experience in the use of clover as a green manure as this distinguished farmer of New York.

He writes to the *Tribune* that he has on his farm in Central New York a field which from 1799 to 1873 has had no manure except clover grown on it and ploughed under, and that wheat, corn, oats, barley, meadow, and pasture have been regularly taken from the land in five years' rotation, the closing crop being winter wheat, with timothy and clover sowed. The clover has been regularly treated with gypsum for fifty years. He has particularly noticed it of late years, and says the land is more fertile now than it was twenty-three years ago.

Yet we hear nothing from him of any injury to the soil from this lifelong use of clover as a green manure. But such has not been the case everywhere.

Dr. Joseph Henderson of Mifflin Co., Pennsylvania, says: "Experience here is adverse to turning down green crops as fertilizers, and few, I believe, have repeated the experiment. In two instances in my immediate neighborhood wherein heavy crops of clover were ploughed in, in full bloom, upon land of excellent quality, the immediate effect, at least, was highly pernicious, as evidenced in an almost total failure of the succeeding crop of wheat."—*Agricultural Report*, 1864.

Here is another case from the same report: Joshua S. Keller says, "Clover, after growing up a few years, ought to be turned under when fully ripe with a good plough. Let those who advocate the green state do so to their hearts' content. I have the experience of both the dead-ripe and the young green, and would by no means suffer the latter if I could prevent it."

And here is another from an able writer whose name I have forgotten: "But powerful as are the effects of green crops ploughed in, it is the experience of some practical men that one crop allowed to perfect itself and then die where it grew, and then turned in dry, is superior to three turned in green."

What can be the cause of this? The crop that is left to ripen and fall where it grew, shades, protects, and mulches the soil. And it may be that half its substance is leached out and enriches the surface with liquid manure.

Sweet Clover showing flowers.

If this is the case, certainly no better way could be adopted to use clover to improve the land. Yet I would modify this treatment by following the device of Joseph Harris, that is, to cut down the clover when in full bloom, and let the second crop grow up through it, and also cut the second when ready, and let decay a while before ploughing for wheat.

This mode would effectually *head off* all weeds that might be among the clover. But with regard to the crop becoming sour if turned in green, that is another matter. If you are careful to plough in the green dressing very shallow, and the soil is mellow and loamy, there will be little danger from acid fermentation. If you are afraid of it, sow lime over it before ploughing, and that will prevent it and be a benefit to the wheat.

Clover has but one fault. In its infancy it is very tender and feeble, and cannot always stand the atmospheric changes. It may be that we are to blame. We may not know when to sow the seed to ensure a perfect germination. One farmer will tell you to sow very early, even on the last fall of snow; another will say, Wait till May; and some will declare that they never fail when they sow in June. Yet failures will take place.

In 1870, Joseph Harris writes: "Nearly all the spring-sown timothy and clover in this section is a comparative failure, and farmers are ploughing their wheat-stubble and going to sow wheat again."

He sowed about fifty acres, and says: "It is apparently an absolute failure."

In 1872, Mr. Straub of Maryland wrote to Harris that "for the last two years the clover crop has proved almost a total failure."

This is a serious matter, because it is always a double loss: you lose a crop of clover and all the money invested in the seed.

Have we no remedy? There is but one cause for all this trouble—the want of moisture in the surface soil.

Sidney Weller of North Carolina found that when he covered his wheat with pine leaves, even on his sandy soil, the clover

never failed, no matter whether he sowed the seed in the fall or in the spring.

When the wheat is protected with green corn, as recommended in *Chapter XI*, the clover will find a moist bed to grow in all the year.

If you wish to raise clover independent of any other crop, sow it with buckwheat in the spring, and when the buckwheat is in blossom cut it down, and it will mulch the clover and ensure a good crop.

CHAPTER XIV.

GREEN RYE.

ONE ton of green rye contains nine pounds of nitrogen, five pounds of phosphoric acid, fourteen pounds of potash, and fourteen hundred pounds of water, worth approximately \$2.75.

When we compare it with barnyard manure its great value as a green dressing becomes apparent. I have seen fifteen tons per acre growing on the 8th of May, and this was ascertained by careful measurement. Then on a field of twenty acres you could have three hundred tons of manure at very little expense, all evenly spread on the ground and ready to plough in.

The most careful analysis is worth nothing if green rye is not equal, ton for ton, to stable manure, with one small exception. The latter has half a pound of phosphoric acid per ton more than the former.

Now, what will it cost you to cover a field of twenty acres with three hundred tons of manure? Can buy it, haul it, and preads it for less than four hundred and fifty dollars?

The rye will cost you for the seed one dollar per bushel, and two bushels per acre will be forty dollars. That is, it will cost more than twelve times as much to improve with barnyard manure, at one dollar and a half per ton, than to use green rye.

The tillage always pays for itself.

And remember this: the rye grows at a time when you cannot use the ground for any other crop but wheat.

Mr. Root of Illinois regards this fact of the very highest importance in using this grain as a green manure.

Besides this great merit, it protects the field from washing during the winter.

It absorbs the soluble minerals and the ammonia and nitric acid that might under other conditions be lost.

For barnyard manure you can claim no superiority over this plant but its partial decomposition. It is more immediately available, because a part of it is oxidized.

The rye must undergo this change before its albuminoids can be of use to growing vegetation. But look at the ample time that it has to decompose, and then you cannot but acknowledge its value.

It may be ploughed in for a crop of corn, or may be cut down just as it blossoms and left as a mulch on the ground. A second crop will then grow up nearly as large as the first, and may then be ploughed in, and Hungarian grass or white mustard or buckwheat or green corn be sown, and make a third crop for turning in for wheat. If corn should be the third crop, I should prefer to use it as a mulch, as already explained in Chapter XI.

J. B. Root of Rockford, Ill., writes in the *American Agriculturist*, 1875: "The labor of applying evenly forty loads of manure per acre is considerable. All this is done more evenly by the green crop. Seed and labor together cost me but three dollars and a half per acre. I cannot say that it adds as much fertility to the soil as forty loads of manure, but I do say that in our drouthy seasons it produces as great an increase of crop as do forty two-horse loads of good manure. It certainly pays to practise it, and to practise it largely, even on the land well supplied with stable manure."

Every one acquainted with the writings of Joseph Harris for the last twenty-five years will suppose, of course, that clover is the only green crop which could obtain such a high recommendation from a practical farmer.

But such is not the case. Mr. Root makes but little use of it. He says: "Rye has been my most profitable green manure."

Harris thought it just as useless to plough in cereal crops for manure as to attempt to carry buttermilk in a basket. He believed they spilled the most of their nitrogen while growing. He has now changed his views, and is conscientious enough to acknowledge that for twenty-five years he was in error,

He now writes: "I thought then that wheat, barley, oats, corn, and other cereals during their growth gave off nitrogen into the atmosphere, while clover, peas, beans, vetches, and turnips retained all the nitrogen they got from the soil and from dews and rains. The theory was simple and plausible, and the practical deduction safe and sound. But more recent investigations failed to sustain this view." [The clover, peas, etc., do obtain nitrogen from the air via the tubercles on their roots and therefore, as nitrate conservers and formers they excel the cereals. *Ed.*]

CHAPTER XV.

GREEN BUCKWHEAT.

ONE ton of green buckwheat contains about 1675 pounds of water, eight pounds of nitrogen, two pounds of phosphoric acid and six pounds of potash, worth about \$2.00

It stands very high as a green manure. Two large crops can be raised in one year to plough in for wheat. In 1875 I raised in fifty-one days twenty-seven tons per acre of green buckwheat. It was sown on the 14th of July, and cut and weighed on the 3d of September.

Besides its value as a manure, it is of some value as hay. In July you should make an estimate of the forage on hand to keep the stock through the winter, and if you need more, instead of cutting a second crop of clover, better sow one or more acres of buckwheat and top dress it with lime and bone-dust or super-phosphate, unless the land is already good; and before the equinoctial storms of September you may have from the buckwheat three or four tons of good hay per acre. It contains two-thirds as much nitrogen, and phosphoric acid and potash per ton as does red clover hay.

If wet weather should prevent you from making it into hay, you can plough it in for wheat, and no loss will occur.

Even buckwheat straw, after you have thrashed out the grain, should be saved for hay. It contains four times as much nitrogen, four times as much potash, and three times as much phosphoric acid, as wheat straw.

John Johnston once said to Harris: "I should have made more money if I had found out the value of straw for fodder fifteen years earlier."

He alludes, of course, to the straw from his immense crops of wheat.

No wonder farmers cannot raise corn after buckwheat, when seed and straw have all been removed! They say it poisons the land. So does a check on the bank when it removes all your deposits. But plough the money into the bank, and it will antidote all the poison.

That buckwheat is beneficial as a green dressing the following may be relied upon:

"We cannot," says the editor of the *Theatre of Agriculture*, "too much recommend, after our old and constant practice, the employment of this precious plant as a manure. It is certainly the most economical and convenient the farmer can employ."

The *American Agriculturist* for 1867, p. 253, says of buckwheat: "It affords one of the most valuable green manure crops to be used on light leachy lands, for with 100 to 150 pounds of good guano, or three to five hundredweight of bone-dust, a heavy crop of manure may be produced on almost any soil."

It also says, on p. 285: "When this grain is sowed the 1st of August it will be in condition to plough in for a rye crop the last of September. We have seen rye taken from a field four years in succession, with no other manure than buckwheat turned in at the time of sowing the rye. There was a constant increase in the yield of the grain, showing the benefit of the green crop."

Here we see what a number of green crops may be turned in for wheat every other year. Of one fact we may be certain—that no person ever made money by raising small crops of wheat. Hence every effort should be made to prepare the ground and enrich it, so as to ensure a large crop of grain. The cheapest and best way to accomplish this is to plough in three or four green crops in one year for wheat. And in this way it may be done: Where the clover has failed, as soon as the wheat is off in July plough and sow rye and buckwheat together. When the latter is in full blossom cut it down on the rye. Here we have two crops on the field all winter. One acts as a mulch to the other, and both together protect and improve the soil. By the middle of May the rye will be in blossom, and should be carefully cut

down, and then a second will spring up, and in six or eight weeks may be as large as the first. Then plough all in together, and by the first of August put in sowed corn as a mulch for wheat, as directed in Chapter XI.

Take notice of this remarkable fact—that we have four green crops, and the wheat actually put in the ground, with only two ploughings.

If your soil should be a heavy clay, and you wish to plough it three times, the rye may be turned in about the middle of May, and Hungarian grass or some other quick-growing plant be sown for the third crop.

To conclude this subject, let us examine the relative value of green buckwheat compared with barnyard manure. In the three crops which you can plough in between two crops of wheat it will be safe to estimate them all together at forty-five tons per acre.

Then on a field of twenty acres you will have 900 tons, containing 7200 pounds of nitrogen, 1700 pounds of phosphoric acid, and 9900 pounds of potash. Now, it will take 720 tons of stable manure to yield as much nitrogen as we get in our triple crop of buckwheat, and nearly as much for the phosphoric acid and potash. If the last crop of buckwheat should absorb any material from the mouldering ruins of the first, it may be possible that we only gain from the soil about two-thirds of the amount above given. But that will be amply sufficient for a good crop of wheat.

CHAPTER XVI.

BARNYARD MANURE.

ONE ton of average barnyard manure piled in the open and well rotted contains about ten pounds of nitrogen, seven pounds of phosphoric acid, five pounds of potash, and 1500 pounds of water. At ordinary prices a ton of such manure is worth about two dollars and fifty cents. If piled in a covered barn, it is worth three dollars and a half a ton since much of its potash and considerable of its nitrogen is lost by leaching if the manure is not covered.

It may be that you live so near to some town or city that you can get manure for one dollar and a half per ton, and can haul it home and spread it for fifty cents a load.

Now, as we have more faith in clover than in any other green manure, let us compare these two together. You must put 360 tons of manure on the twenty acres to get as much nitrogen as we have in the single crop of clover. That will cost you \$540 for the manure, and that will be nearly twenty cents per pound for the nitrogen. I say "nearly," for we must allow something for the minerals. But how much? Harris says that "all the *mineral matter* in a ton of barnyard manure could be purchased for twenty-five cents."

This is too low an estimate for manure that has never been leached by rain, but may apply very well to any that has been exposed to the weather all summer and has lost by drainage nearly all its soluble elements.

Great care should be observed in purchasing manure. Its value depends entirely on the kind of material of which it is made and the care bestowed upon it afterward. If it has lain in a dry place, and become fire-fanged and white and mouldy, and so light that it feels on your fork like a bunch of dry leaves,

it is hardly worth hauling home at any price; and if it is made of nothing but straw, although it may look well, do not pay much for it.

But if preserved in a cellar or covered yard, and been kept moist with urine or drainage from the yard while rotting, and the animals while making it have been fed two or three times a day on grain or bran or oil-cake and good hay, and the pile is well concentrated by decay, then it is good manure and worth hauling several miles to your home.

On my Farm I have all the liquid which settles in a tank at the lowest corner of the yard pumped up and sprinkled over the manure under cover, and the process of decomposition goes on so regularly that it could not be made better any other way. Yet with all the care we can bestow upon it, it seems almost impossible to save all the liquid in the stables.

Barns are not ordinarily properly constructed for this purpose. Stalls should be eight or ten feet high from the floor to the joists above, so that three feet deep of manure may be left under the animals all the time. And when the stables will hold no more they may be cleaned out to the bottom, and then re-bedded with one foot of sods and turf, and a light coat of straw or any kind of litter over them. This way is nearly as good, and not so costly, as gutters behind the stalls to carry off the urine.

When in search of manure in the village or town near you, the most important question is not what kind of animals produce it, but how much and what kind of feed has been given to them. Joseph Harris says that one bushel of Indian corn will make twenty cents' worth of manure. And Lawes considers the residue from one ton of clover hay worth over nine dollars.

Now, when you find a pile under cover, and a reliable man assures you that it was made by feeding 200 bushels of corn and ten tons of clover hay, with a moderate amount of straw for bedding, then you may safely offer him two dollars per ton for it.

It will not do to buy everything that is called manure. Let me give you an example that is worth remembering.

Col. Waring of Ogden Farm says: "As I drive along the road I daily meet able-bodied men crawling along beside snail-like ox-teams with loads of stained straw from the private stables in which the summer residents of Newport keep their horses 'up to their knees' in litter. The cart holds about a cord of the stuff (128 cubic feet), for which five dollars or more have been paid in town, and to get which occupies the best part of a day's labor of man and team."

CHAPTER XVII.

GROUND UNBURNED LIMESTONE VS. BURNED LIME FOR GREEN MANURES.

THERE are two reasons why attention must be given to the application of lime or ground unburned limestone to soils upon which green manuring crops are grown for the purpose of soil improvement. In the first place most legumes make a much more vigorous growth if there be an abundance of lime in the soil. This is due partially to the fact that the legumes themselves require a great deal of lime to build up their tissues and also to the fact that the nitrogen gathering organisms which exist in the tubercles on the roots of these green manure plants grow much more vigorously in the presence of lime in the soil than when this mineral is absent. The second reason for the use of lime or ground limestone is, that when a green manuring crop is turned under, acids are generated by the decay of the green plants and this tends to make the soil sour. It, however, lime be scattered over the field in advance of plowing the lime will be ready at the bottom of the old furrow to counteract or neutralize any acidity which may be developed; in this way the soil may be kept in its original sweet condition instead of becoming sour and unfavorable in this respect for the growth of many of the ordinary farm crops.

Lime or ground limestone is of special value in the soil in that any acids will combine with the lime or limestone liberating the harmless carbon dioxid and forming an ordinarily harmless compound which is either leached out of the soil or is taken up by the growing plants and utilized by them. Red clover, alfalfa and sweet clover usually require considerable amount of lime in the soil. Cowpeas will grow on soils which are too acid for the growth of such legumes as those just mentioned. There has been considerable discussion as to the proper form of lime that

should be applied to the land. There are three different kinds of lime that are used to a greater or less extent. These are (1) burned lime or quick lime (2) slaked or hydrated lime and (3) ordinary limestone or lime carbonate, consisting of the ground unburned limestone with no further treatment. Gypsum or land plaster has occasionally been classed as lime but this has practically no value in neutralizing soil acidity. The former extensive use of this land plaster especially on clover and other legumes has largely given way in favor of the use of the forms of lime just referred to. There soon comes a time when a soil will cease to respond favorably to applications of land plaster. This condition is quite prevalent throughout the eastern State.

Unslaked lime is the most concentrated form in which it is possible to purchase it, that is, a ton of burned unslaked lime will neutralize more acidity than the same quantity in any other form. The reason for this is that the burning drives off all the carbon dioxid, leaving only the active principle of the lime remaining. The advantage accruing to the use of lime in this form is that being concentrated it can be transported at a less relative cost, as when the other forms are used one has to pay freight charges on the water in the hydrate of lime and in the carbonate or ground limestone. Hydrate of lime is made by adding water to the quick lime. This puts the lime in a very convenient form to handle as it is very finely pulverized and runs through a drill very readily. The cost of the lime in this form, however, is usually considerably in excess of that asked for the freshly burned lime even though it requires over 2600 pounds of the hydrated lime to do the same work that is done by 2000 pounds of the quick lime. If the ground limestone is used it must be held in mind that about one-half of the constituents of the ground limestone are of no use as far as neutralizing soil acidity is concerned. Fifty-six pounds of freshly burned lime will do the same work in the soil as a hundred pounds of ground limestone. The very finely divided condition of the freshly burned lime when applied to the ground and allowed to slake permits it to do its work much more quickly than is the case

with the ground limestone. Figured on the same basis as the hydrate of lime it will require 3600 pounds of carbonate to neutralize the same amount of soil acidity as will be accomplished by 2000 pounds of the freshly burned lime. These points must be taken into consideration in figuring the cost of freight and hauling the lime together with the price that one has to pay for the lime in these different forms. If one can obtain the ground limestone for \$2.75 per ton he can afford to pay \$3.75 for slaked lime and \$5.00 per ton for quick lime. The expense of hauling the carbonate of lime is usually more than that of either the hydrated or the freshly burned lime owing to its greater weight for a given amount of effectiveness. The points in which the ground limestone differs from the freshly burned lime is that it does not induce such rapid bacterial action in the soil, it may be stored without detriment, and is easy to handle not being in the caustic form. Its disadvantages lie in its increased weight and rather slow effect upon the soil in overcoming its acidity. The points in which the caustic lime differs from the ground limestone are as follows. It is more active owing to its finely divided conditions and caustic properties. It has more favorable action on heavy clay land than does the ground limestone.

While it is possible to apply too much caustic lime it is practically impossible to apply so much of the ground limestone as to injure the soil or growing crops. In Illinois one plot of ground was treated with ground limestone at the rate of 100 pounds per acre without any detriment to the growing plants. This is an important point to be considered especially when the ground is supporting tender vegetation and requires liming. The farmers of Illinois have been able to obtain ground limestone at from \$1.00 to \$1.25 per ton delivered at their freight station. This has been accomplished only by their creating a demand for the same in sufficient number of carload lots as to enable the manufacturers to make the carload the unit of sale rather than the ton. At these rates one can afford the slight increase in freight charges and cost of scattering upon the land and

it is probable that in the end the results will be much less harmful to the land than is repeated applications of the burned, slaked lime which has a greater tendency to deplete the humus content of the soil. The burned lime should always be water slaked before being applied. This is usually accomplished by piling it in small piles over the field before spreading it.

Except for the convenience of handling and storing, the purchase of hydrated lime (water slaked lime) is seldom to be recommended as the price is usually greater than the much more concentrated burned lime.

In applying lime at any time to green manure crops it is recommended that at least one-half of the lime be applied before turning under the crop. This will insure the lime being present in that part of the ground where the greatest acidity will develop owing to the decay of the green material.

CHAPTER XVIII.

FORAGE FOR THE HORSES ON THE GREEN MANURE FARM.

WHEN we have concluded to use green crops for manure, of course we should leave all the clover and all other vegetation stand for this purpose, and cut as little as possible to feed to animals.

It will not do to take the clover or the Hungarian grass or the sowed corn from the fields intended for wheat.

We should have a clear understanding of the amount of forage which our stock will need, and then make ample provision for them.

What is the experience of the best farmers upon this subject?

Colman writes in his *European Agriculture*, "It is estimated by many intelligent farmers in England that the horse-teams require for their maintenance full one-fourth of the produce of the soil."

Again he says: "Indeed, so far as my observation goes, there is no single source of expense, none which abstracts so much from the profits of farming, and none of which the farmers in general are so little aware, as that of horse-teams."

Alderman Mechi says: "This brings me to the fearful question: What portion of the acreage of this kingdom do farm-horses consume? I answer, Nearly one-fourth of all the arable land in the kingdom."

This is a very discouraging picture—that one-fourth of all you raise will be devoured by the horses which are required to work the farm!

Is there no way to remedy this? Certainly there is a way. We must raise enormous crops of forage; nothing else can save us from this great expense.

Joseph Harris, speaking of John Johnston, says: "Last summer he wrote me that he had raised a great crop of timothy, but that the story was too big to tell. I asked him about it yesterday. He top-dressed a piece of timothy grass with a compost of hen droppings, chip manure, and cow dung. The timothy was nearly six feet high and as thick as wheat straw, with heads almost a foot long. He weighed several of the cocks and estimated the crop at five tons to the acre!"

In 1860 a friend of mine cut and weighed and sold to his neighbors *nine tons and a half* of timothy and clover hay from a two-acre lot which had been manured from his slaughter-house.

We should learn two useful lessons from these examples:

First, that top dressing is all that is required to ensure a big crop of timothy; and second, that a little land can be made rich enough to furnish us with all the hay needed on the farm. Hay from Hungarian grass has few equals when well made.

"A correspondent of the *Prairie Farmer*, Mr. Philips of Butler County, states that the premium acre at the last fair of that county yielded eight tons and two hundred pounds of well-cured hay."—*Cultivator*.

Colman says of millet: "I wish my countrymen were more impressed with the extraordinary value of this plant. I know few plants which make a more abundant return, or which, when it is well cured, give a more nutritious forage or one more relished by stock."

In 1854, Lawes and Gilbert sowed some clover-seed in a rich garden. They say: "The estimated total amount of green clover obtained from this garden soil in six years, without further manure, is about 126 tons per acre, equal to about twenty-six and a half tons of hay.

"Fourteen cuttings have been taken without any re-sowing of seed."

Why was no re-seeding required during the six years? It was either because the soil was so very rich, or because it was cut so often and so early that no seed could mature; and it may be the nature of clover to live on till seeds are developed.

Besides the plants above mentioned, I advise you to have one, two, or three acres of orchard grass, and to use every available means to make the land very rich. It will be ready the first of all to mow in the spring. By top dressing it in the fall or very early in the spring it will never fail, never run out.

All the plants above mentioned have peculiar merits of their own; hence the great advantage of having a patch of each near the barn, for summer soiling as well as for winter forage.

It is said that the Hungarian is "so deep-rooted that severe drought does not affect it in the least, and it may be sown upon the highest and driest soils without fear of failure," and that it will yield, when kept for seed, twenty to thirty bushels per acre. Hence, the seed need not cost more than fifty cents to a dollar per bushel.

Let me say a few words about making hay. It has been found that untimely rains may leach out of hay while being made nearly one-half of its best material.

Therefore, how very unwise to cut grass in rainy weather, as many do to be ready to make hay when it clears up! Far better to mow on a clear morning, and put it up in well-made cocks in the evening should there be any appearance of rain; then it will be comparatively safe. Should even a heavy shower come, all that can fall on each cock cannot leach through it, and hence little damage will be done.

Another arrangement is worthy of your attention. Have your permanent hay-field as near the barn as possible, and then you can haul in two loads in less time than you could go to the back field for one load. This is a matter of the highest importance in stormy weather.

One or more acres of sowed corn will make an excellent addition to the winter provender, provided you need any.

A brief notice of what others have accomplished with it, I think will be acceptable.

David Miller of Fayette Co., Pa., writes to the *Cultivator* in 1842: "I have generally had from about sixty to seventy tons

of green food to the acre, and think it decidedly better than grass for either beef or milk."

H. L. Ellsworth, Esq., says: "I sowed four and a half bushels of common corn per acre broadcast, and harrowed in the same. Having soaked the corn in saltpetre, it took a rapid start, overtopped the weeds, and covered the ground with a forest of stalks. Being anxious to ascertain the quantity, I measured a few square feet of the stoutest. I found I had five pounds of green fodder per square foot—that is, 108½ tons per acre. I cut the first crop the early part of July, and ploughed and sowed the land again, and took a second crop two-thirds as large."—*Cultivator*, 1842.

Here we have 172 tons of green fodder per acre in one year. Of course this large amount of provender could only be obtained on rich land.

Mr. Peters says: "The amount of corn-fodder which will grow upon an acre is truly fabulous, and no one will believe it until they have had ocular demonstration. It is not a very large thing to grow 200 tons of green fodder to the acre. I think it possible to grow 250 tons with care and a good season."—*Genesee Farmer*, 1865.

"Gustavus Harmoir, president of the Agricultural College of Valenciennes, has been experimenting with Indian corn as a soiling crop. The variety used was the 'giant maize of Caraquá.' The seed was drilled May 31st in rows about three feet apart and eighteen inches in the drill. By the 16th of August the stalks were fourteen feet high, and the yield was over 450 tons per acre."—*Genesee Farmer*, 1863.

We have no higher authority on the value of green corn as a food for cows than Col. Waring of Ogden Farm, and so perfectly is he satisfied with it that he exclaims in the *American Agriculturist*, "Corn never! corn-fodder always!"

Again he says: "Throughout nearly the whole country there is no crop that can at all compare, when we consider both its value, pound for pound, and the enormous yield that may be obtained from an acre with corn-fodder. Whether the purpose be to make butter, cheese, or beef, or to keep young stock in

thrifty growing condition, it is at once most profitable and nutritious."

Colman, in estimating the value of different kinds of forage, says: "I have some doubts, however, whether for the purpose of soiling, for milk, or for fattening any product can be found equal to that of Indian corn cut green."—*European Agriculture*.

It is said that if we sow forty to fifty grains to the foot in drills three feet apart we will have one-third more fodder than with twenty grains to the foot. I have raised it for more than ten years on my Farm, and for winter fodder I prefer about six stalks to the foot, because it will then grow eight and ten feet high, and can be cut when ready, independent of all weather, and put in shock, and will stand well till November, when it may be put in the barn.

For feeding through the summer to horses, cows, and pigs, I care not how thick it is planted even fifty grains to the foot will be better than any less amount. But you will find this much more troublesome to save for winter provender, because you will have to cure it in the same way that you make hay, and may be very much annoyed with wet weather.

To conclude, remember the *great secret* of success in agriculture is the *concentration* of manure and labor. A poor soil with little labor, little tillage, and no manure will never produce a large crop of green corn or any other kind of forage.

CHAPTER XIX.

LOSS OF LIQUID MANURE.

WHILE making vast piles of manure by feeding grain and green crops, are you able to save all the residue?

Certainly not; that would be impossible.

How much of it do you lose?

Alderman Mechi declares: "Upon a careful investigation we safely assert that twenty per cent. of ordinary farmyard manure is wasted. An examination of ten farm-homesteads, consecutively taken, has fully established this supposition."

Manure is the farmer's capital. What business can be carried on with profit if you are obliged to borrow money at an interest of twenty per cent? And if you lose twenty per cent. of your capital every year, where is the difference between you and the reckless borrower?

Does Mechi save all the manure? Yes—we may say all of it. It is made over water-tight troughs, and is carefully washed into a great tank, from which it is pumped by a steam-engine through three-inch iron pipes over all the farm. But this is not all he saves by the operation.

It will cost you at least fifty cents a ton to haul and spread the contents of the barnyard on any distant field. It costs him but four cents per ton to spread in a liquid form all the manure he makes. Hence his profit as a farmer on all his great investments is fifteen to eighteen per cent. He very truly says, "It is the filling, carting, turning over, refilling, carting, and spreading, and wasting, that run away with the farmer's profit."

He has abandoned green manuring, which he once followed extensively. In fact, his great outlay will not justify it now, even if he wished to do it.

Notwithstanding all this, he says: "If stock is too dear, or you are short of capital, plough in green and root crops, particularly on heavy land."

So much for England's model farmer. Now for the greatest light in our own country.

John Johnston says: "I have suffered an immense loss from the liquids running from my barnyards, but I never could contrive a plan to prevent it."—*Cultivator*, 1861.

Probably no man ever estimated manure nearer its true value, or ever had a more striking experience of its power, than John Johnston; and how passing strange it is that even he, with all his wisdom and ability, could not save the whole of it!

It is an established fact that the liquid is the most valuable portion of the manure.

Joseph Harris, in alluding to its great waste, says in *Walks and Talks*, No. 49: "As ordinarily managed, however, the liquid either runs away or soaks through the crevices of the planks into the ground, and is lost."

The *American Agriculturist*, 1872, says: "The value of liquid manures is not sufficiently realized. It is safe to say that not one-thousandth part of this is ever saved for use, but nearly the whole is allowed to go to waste."

There is a way of saving the urine which should not be overlooked. Erect a temporary fence around a piece of ground which you can till, and keep your animals on it. Let them remain there till the cold weather obliges you to put them in the barn. You can keep the cattle there all the time, if the lot is large enough to require all their manure, during the warm season, or you may let them pasture in the field by day and feed them at night in the enclosure with green corn, Hungarian grass, clover, rye, cabbage, and everything eatable.

If you will sprinkle over this pen more or less straw or corn-fodder, it will be an advantage. But do not plough it up till you want to sow or plant some kind of crop. Better have two or three acres that are very rich than ten that are very poor. Cows may pasture among rocks and stumps and on hillsides

where you never plough, and may return at night to enrich the pen; and this will pay you well for their night and morning meal. Mechi says: "1500 sheep folded on an acre of land for twenty-four hours (or 100 sheep fifteen days) would manure that land sufficiently to carry it through a four years' rotation." By this wise arrangement they save all the liquid as well as the solid residue. This is a matter of vast importance.

However, as it is almost an utter impossibility to save all the liquids unless we adopt Mechi's costly plan, what an overwhelming argument in favor of green manures! For all the liquid of any value in grain or in manure originally came from the green stalk.

CHAPTER XX.

JOHN JOHNSTON AND OTHERS ON RAISING WHEAT.

IN 1874 one of the editors of the *Country Gentleman* after a visit to John Johnston said: "Mr. Johnston showed us a field upon which he had raised wheat for more than thirty years every alternate year, the average yield constantly increasing. His plan was to fallow-plough about the middle of June; plough again about September 1st, and top dress heavily with manure and sow wheat. Early the next spring he sowed on clover-seed and plaster. After harvest, if the clover grew large enough to head out, he pastured it more or less, but if no blossoms appeared he put no stock on it. The next spring he pastured the clover lightly until it blossomed, when it was turned under as before. He had found this two-crop rotation very successful."

Now, can there be any objection to the addition of one more green crop as a top dressing to this very successful mode of raising wheat? You recollect how strongly he is in favor of some kind of protection to save the crop from the blasting winds and other injuries. After ploughing in the clover there would be ample time to raise ten or fifteen tons per acre of green corn, and to cultivate and clean the field as effectually as if nothing was growing on it.

We should notice this fact—that he "top dressed heavily with manure." Yet even that did not prevent the wheat from being killed when exposed to north-west winds.

If the free use of the very best manure will always ensure a heavy crop of wheat, his crops should never fail. He was in the habit every winter of feeding many tons of oil-cake and about 1500 bushels of corn and a large amount of hay. With such a mass of rich material why should he need or use anything else? Yet he ploughed in clover. And such clover! How rank it

must have grown after the top dressing such as he gave the wheat! Yet how careful he was only to pasture the clover lightly before turning it in! In fact, he made use of every means in his power to insure heavy crops of wheat.

Joseph Harris, in his celebrated lecture on *Wheat-Culture in Western New York*, gives us Johnston's views on the use of salt and lime.

"On rich land," says Harris, "salt has a tendency to check an excessive growth of straw. In some experiments made recently on the farm of the Royal Agricultural Society the unmanured plot of wheat produced twenty-nine bushels per acre, and the plot dressed with three hundredweight of common salt thirty-eight and three-fourths bushels, or an increase of nine and three-fourths bushels per acre.

"A few years ago I was on the farm of John Johnston of Seneca county. He had dressed a part of a field of wheat with a barrel of salt per acre, and the effect was most decidedly beneficial. The wheat was heavier and the straw much brighter and stiffer. It also ripened several days earlier, and escaped the midge in consequence. Mr. Johnston is here with us to-day, and he has just informed me that he thinks there is nothing like salt for stiffening the straw on rich lands. He sows a barrel per acre on the fallows just before sowing the wheat. He has sown as much as seventy-five barrels in a year on his wheat.

"Lime is also a splendid manure for producing plump heads of wheat and a stiff straw. There is nothing like it. Mr. Johnston says if he were a young man he would lime every acre of his farm. In 1844 he applied 200 bushels of lime on two acres before sowing the wheat, and it was a magnificent crop—over fifty bushels per acre; and he says he can see the effect of that lime on the land to the present day."—*Genesee Farmer* 1863.

After reading this shall we be afraid to plough in green manure, lest it should make weak straw and cause the wheat to fall? Here we have a certain remedy in salt and lime. But we must

be careful not to use too much lime. There is an old proverb—the lesson, we presume, of observation and experience—

“That too much lime and no manure
Will make the farm and farmer poor.”

The reason is plain enough. Lime contains very little plant-food. A good crop of wheat of thirty-four bushels per acre takes from the soil only one pound of lime, and the straw about seven pounds.

Alderman Mechi found salt to be indispensable on his rich land. He says he salted all his wheat at the rate of four to eight bushels per acre, *and was determined to use much more*. He knew a gentleman in Northamptonshire whose wheat crop could scarcely ever be kept from going down until he used salt, which had effectually kept it standing.

When putting in wheat it is a matter of great importance to have the land in the right condition to receive the seed. If you plough in a very heavy green crop and sow at once, you may have an almost total failure and raise but a few bushels of wheat. The reason is plain. If dry weather should come on and continue for several weeks, there will be a nearly complete separation between the surface and subsoil. The wheat cannot grow in the dry crust, and as no moisture can arise from capillary attraction to soften this crust, the seed may perish, or make but a feeble growth till the ensuing spring. From a careless disregard of these facts even large crops of clover ploughed in have been apparently injurious, and the whole system of green manuring has been condemned and abandoned.

We find some very excellent advice upon this subject in the foreign correspondence of the *Country Gentleman*. The writer says: “We want the ground to settle before sowing. Never sow wheat or rye on new-ploughed land if you can help it, but give it the last furrow [plowing] from six to eight weeks before sowing-time. This is of the highest importance. The soil then becomes thoroughly pulverized by the alternate action of rain

and sun—it rots: ay, it will rise (puff) like well-made dough—I can describe it in no other way. The land must look as if yeast had been put into it, which had done its work well. Then is the time to sow.”

Here you see the ground must *settle*. Now, it cannot settle in dry weather if piled on top of green manure of any kind. In some seasons there will be so much rain just at the right time that all seeds will grow, no matter when or how carelessly they are put in. That we may never fail to raise a good crop of wheat, I prefer to have Indian corn for the last green dressing, and to keep it on top as a mulch, as directed in Chapter XI.

On spreading lime and other fertilizers I wish to say a few words. I have so often noticed the utter impossibility of spreading anything evenly with the shovel that I was induced to devise a machine which will sow from three bushels to three hundred per care of material as fine as plaster or as coarse as the grains of Indian corn. Its cheapness, simplicity, and durability will recommend it to every one. It consists of a hollow cylinder or drum from six to twelve feet in length and from two to three feet in diameter. It is formed of long boards or vanes, which have one edge fastened by a hinge at each end to a drumhead, and also by a hinge to a drumhead in the middle. The free edge of every board overlaps the hinged edge of the vane next to it. By means of movable bolts the space between the overlapping edges can be adjusted to the thirty-second of an inch, or to a whole inch, depending on the desired rate of application. A shaft runs through the drum and has a wheel at each end. One wheel is fastened to the drum to turn it.

CHAPTER XXI.

THE RESTORATION OF POOR LAND BY GREEN MANURES.

FARMS that have been worked by tenants or by careless owners for a long course of years generally become so poor that very little more than the seed sown is obtained in the yearly produce.

Now, it is a vital question to every farmer, What change has taken place in the soil that it will no longer yield a remunerative crop? If the minerals have been entirely exhausted, he may be living where he cannot procure ground bone and other fertilizers at any reasonable price, and hence he must abandon the farm and leave it to time and Nature to restore.

But, most fortunately for man, this is very seldom, if ever, the case.

Many well-established facts are on record that prove that the loss of power to produce even a small crop is owing to the consumption of nitrogenous compounds and vegetable matter in the soil. I call it a consumption because it is a positive burning up by oxidation of everything in the ground that had been deposited there by the growth and decay of organic matter.

And the more you plough and harrow and loosen up the soil, the faster will this destruction take place. Then you will please remember this plain truth, that fire and tillage with the plough and harrow act in the same way and accomplish the same object—the exhaustion of the farm. In corroboration of these views let me give you a very interesting and instructive fact to verify them.

Joseph Harris, in the *Genesee Farmer* of 1863, says: “Thirty or forty years ago the oak-openings in Western New York were considered far inferior to the heavily-timbered land and to the lowlands on the borders of the Genesee River. The Indians had

for years burnt over this land, and consequently it was to a great extent destitute of organic matter. On this soil plaster and clover acted like a charm. Large crops of clover have been raised for years and ploughed under. The plaster stimulated the growth of clover, and the clover when ploughed under furnished the soil with large quantities of organic matter; and the result is that this land, which was formerly considered poor, is the best and most productive in the State."

Here we have reliable and satisfactory proof that poor land can be restored to a productive condition without purchasing artificial manures beyond a small amount of ground limestone or lime.—Plaster has been found in recent years to be much less effective than formerly. Now, if we ask the chemist what must that soil contain to yield fine crops of grain, he will tell you, "The ash of agricultural plants consists of the phosphates, sulphates, silicates, and carbonates of potash, soda, lime, and magnesia, with small quantities of oxide of iron and manganese and alkaline chlorides."—*Johnston*.

Then all but the sulphates must have been in the soil, but were not available for some cause. What was that cause?

What was indispensable to enable them to become active? The earth was comparatively destitute of atmospheric food. There was the great and only deficiency.

The rich manure so much needed was floating in an invisible state above the poor fields. The chemist tells us that "When a vegetable is destroyed by burning it is mostly resolved into the gases of the air. On the other hand, when it is formed by growth its substance is mostly derived from air."

This being the case, it is imperative on us to introduce the elements of the air into the soil and convert them into plant-food. How shall we do this? We must loosen up the earth, and keep it moist and mellow during all the growing seasons of the year.

To accomplish this effectually and in the cheapest manner, we must cover the land with green crops, and keep them upon the surface as long as possible, and then plough them in when grain or anything else must be sown. To be satisfied that they

are all-sufficient we have only to study their wonderful effects. When the ground is loose from the presence of humus—that is, vegetable matter in a state of decay—the air is freely admitted, and its nitrogen is to a certain extent converted into nitric acid or nitrates and ammonia; by bacteria, and, most fortunately, these compounds are retained by the moisture and the absorbent power of the organic matter. And besides this, a large portion of the nitrogen contained in the green dressing also undergoes the same chemical change and is treasured up for future crops.

The incomparable merits of green manures are not all the qualities that make this mode of improvement the great sheet-anchor of the practical farmer.

The roots of growing plants have great power over the minerals of the soil in breaking up their texture and reducing them to powder. And here let me say, Have no fear of getting too much humus into the soil. An acre of land twelve inches deep weighs 2000 tons. If you could plough in 100 tons of green manure every one, two, or three years, that would only be mixing the one-twentieth of vegetable matter with nineteen-twentieths of the earth a foot deep. Would one gold dollar among twenty copper cents make the pile of money look too rich?

Even on the dark prairies of the Middle West the immense amount of good derived from the preservation and frequent replenishing of organic matter in the soil has been noticed and recorded by many practical farmers.

C. W. Babbitt of Metamora, Woodford County, Illinois, says in the Patent Office Report of 1855: "It would seem that the prairies here might be continued in their virgin richness, simply by annually ploughing under the stubble of our grain-fields and the stalks of Indian corn, never allowing them to be consumed by fire. A short distance south of this resided two farmers, one of whom every year gathered up this corn-stalks and burnt them, and also burnt over his stubble-fields before ploughing. The other never allowed a stalk or a straw to be burnt on his land, but always ploughed them under. After some fifteen years had elapsed the farm of the former yielded on an

average some fifteen bushels of corn less to the acre than when he commenced cultivating it, while that of the latter produced as abundantly as at first."

It is a matter of astonishment that a prairie soil, which is dark with the decayed remains of an old vegetation, should show in the comparatively short period of fifteen years any neglect to restore to the ground the humus it had lost by the production of grain.

David A. Wells, in his *Book of Agriculture*, 1855 and 1856, says: "It is estimated by intelligent farmers in Indiana that their river-bottoms, which used to produce an average crop of sixty bushels of corn to the acre, now produce only forty. In Wisconsin, which is younger still, it is estimated that only one-half the number of bushels of wheat are now raised on the acre which were raised twelve years ago."

Here we have whole districts suffering from the same cause—the exhaustion of organic matter, and which can be restored with little labor and little cost. If the loss of productive power was owing to the exhaustion of mineral food, this could only be renewed from the subsoil and rocks by a long rest or by purchasing the lost material at great expense.

Is it necessary to say anything more upon this subject? Is not every one convinced that raising wheat would ruin one-half of all the farmers in the world if the diminution of their crops arose from the loss of minerals in the soil? Why? Because one-half of them are living where they cannot obtain artificial manures at any reasonable price. I cannot close this subject without the presentation of one more argument, which has already been before the public for some time.

"An incendiary reduced to ashes a pile of barley-stacks from some twelve to fifteen acres of barley. The ashes were scattered over about half an acre of ground adjoining the stacks, thus concentrating the mineral constituents to about one-twenty-fifth of the land from which they were taken.

"A turnip crop, a barley crop, and a crop of seeds taken subsequently from this half acre showed no perceptible superiority

over the rest of the field, neither portions of the and yielding more than ordinary products.”—*Cultivator*, 1853.

This costly, but useful experiment proves beyond cavil that the nitric acid and ammonia in the air are not sufficient to supply all the available nitrogen which is needed to produce a luxuriant vegetation.

Did these compounds of nitrogen exist in the air or in the soil in ample abundance, what immense crops would have been produced on that half acre!

Suppose the farmer had spread this pile of barley-stacks, with all the grain in them, on half an acre of ground, what would have been the result? Twelve to fifteen acres of barley, even at twenty-five bushels per acre, would be from 300 to 375 bushels of grain in the stacks. Now, if you would spread this amount of barley on the half acre without the straw, it certainly would manure it well. Then add the straw, which could not have been less than twelve to fifteen tons, and when all was worked into the soil do you think the turnip crop, the barley crop, and the crop of seed would have “shown no perceptible superiority over the rest of the field.”

Now, let us see what lesson we are taught by the analysis of a very rich alluvial soil.

Prof. Johnson says the Zuyder Zee river bottom soil, contains enough of potash for 144 maximum and 648 average crops of barley, and enough of phosphoric acid for sixty-five maximum and 292 average crops, and enough of nitrogen in ammonia for seven maximum and thirty-one average barley crops. Here we see that without some addition from the air the ammonia would be exhausted by very large crops in seven years. Then, according to the teaching of the burnt stacks of barley, to obtain paying crops we should put on some kind of manure containing nitrogen or plough in green crops. Yet, according to common practice, many farmers would go to the expense of sowing on more phosphates as soon as the crops began to fail. This is a lesson which should not be forgotten. Then we will always know what to do when the crops begin to diminish. Not a

shadow of doubt will rest upon it. We must at once restore to the soil the organic elements by ploughing in green manures. Of course the first choice will be clover; if that will not grow even with the aid of lime or plaster, then we may resort to oats or rye or buckwheat.

The reader may entertain the suspicion that I set too high a value upon the restorative powers of clover. To prove that it is almost impossible to do this, I ask a careful reading of the following extract of a letter from the Hon. George Geddes of New York to Joseph Harris.

He says: "All that I shall try to prove to you is, that the fact that clover and plaster are by far the cheapest manures that can be had for our lands has been demonstrated by many farmers beyond a doubt—so much cheaper than barnyard manure that the mere loading and spreading of the latter cost more than the plaster and clover."

This clear declaration has more weight with me than the testimony of ten thousand unknown farmers, because George Geddes has experimented with clover intelligently, and relied upon it on his own farm for the last sixty or seventy years.

I will close this with the encouraging words of Dr. Voelcker, the able and reliable chemist who has devoted so much of his time and talents to the examination of this subject.

He says: "Indeed, no kind of manure can be compared in point of efficacy for wheat to the manuring which the land gets in a really good crop of clover."

We have said that if clover will not grow by itself you had better sow some other kind of seed. It is very probable that oats will grow ten or fifteen inches high if sown and rolled in with the clover-seed. Then you should watch it closely, and as soon as it comes in blossom mow it down with a machine, and let it lie to protect and shade and nourish the young clover.

Among old writers on agriculture I find that oats are strongly recommended to be sown in spring and summer, to be fed off by cattle to improve the land. If the animals receive nothing but the green oats for nourishment, of course their manure would

add nothing to the soil that the pasture could not return if ploughed in or cut down and left upon the field. But if the cattle were fed with oil-cake or Indian meal, or something else, twice a day, it would make a material difference in the value of the manure left while grazing on the green oats.

Buckwheat might be used in the same way either as a green dressing or as feed for cattle. But in the latter case you must only let the animals remain on the green buckwheat a short time once or twice a day. They are so fond of it, and it is so rich and so easily eaten, being soft and succulent, they would soon injure themselves if permitted to remain on the pasture all the time.

CHAPTER XXII.

HOW TO IMPROVE LARGE FARMS WITH GREEN MANURES.

IT is a very common practice among agricultural writers to advise all persons having large farms which are in a very poor condition to sell one-half or two-thirds of their land, and apply all the money they receive in manuring and improving the balance of their property.

In some cases this may be the most prudent course to follow, but, as a general rule, I am opposed to this advice for two very good reasons:

First, you can get but very little per acre for your poor fields; and, secondly, if you improve your property with judgment you can enhance its value so rapidly that in seven or eight years it will be worth double or treble its former valuation.

To begin your improvement, take the old field about half a mile from the house, and which is now covered with thin yellow grass and a mellow soil about one or two inches deep, produced by many years of exposure to the weather.

It has never been ploughed since you knew it. And, I beg you, do not plough it now at the beginning of your efforts to make better. Let me show you what a coating of fine mellow earth is worth upon the surface.

In Egypt the annual overflow of the Nile deposits on the land a thin stratum of very fine soil which amounts only to four or five inches in a century. This yearly settling, which is only the twentieth of an inch in thickness, of almost impalpable dust, does much towards keeping the farms rich and productive. The Egyptians do not plough this precious coat under, but sow the seed on the moist ground as the waters subside, and then if, possible, they drive sheep and hogs or goats over it to press the seed into the soil.

We should all learn a useful lesson from their example and experience. We should not plough down the only part which the air has enriched by mingling and uniting with it for so many years, but early in the spring we should harrow as many acres of the old field as we can sow with clover-seed at one peck to the acre.

The principal roots of all plants must be near the surface, that they may feel the life-giving influence of air and moisture, or the soil must be loosened by Nature or by tillage, that the atmosphere may penetrate even to the deepest fibres of vegetation. Hence the reason that plant-food acts so well upon the surface, and that all seeds germinate more quickly, more naturally, when covered by only one or two inches of soil. But these great truths must not be misunderstood. Though the soil must be loose, the finer the seed the greater the necessity when planting or sowing of pressing with the hand or foot or roller the earth into close contact with the grain.

I remember a little incident which will illustrate this subject and fix it in the mind. An old sea-captain who lived in our neighborhood tried every year to raise for himself a little tobacco. He prepared a little patch of ground with the greatest care. The surface was as fine and rich and mellow as he could make it. Then he sowed the seed and raked it over once more very gently.

Yet, much to his surprise and vexation, only a few stalks grew each year. But one spring, after the little bed had been sown with all the usual care, some fellow, to worry the old captain, went secretly on it and tramped and tramped, and danced and tramped it, till it was, to all appearance, as hard and solid as the most frequented public road. The poor old man gave him a seaman's blessing, whoever he might be, and left it to its fate. But on his next visit to it he was astounded to see the whole bed covered with vigorous plants of tobacco. It seemed that every seed had grown. He had a grand crop. After that he could always raise tobacco.

He tramped the ground himself after the seed was sown.

Here is a practical illustration of this plan which I know to be a fact.

A person bought a very poor farm near the southern boundary of Pennsylvania, and tried to raise grain upon it in the usual way. But nothing grew large or strong enough to produce seed. Fortunately, he did not sacrifice the property by selling it at a very low figure, as many would have done. He sowed every acre of it with clover-seed and plastered it every year. For a living he followed the profession of an auctioneer.

About seven or eight or more years the clover grew upon his farm, undisturbed by plough or hoof of any kind. Then he concluded to try his hand again at farming. Many of his neighbors gathered to see the first ploughing after so long a rest from tillage.

An old farmer who was present assured me that the soil turned over eight or nine inches deep as black as your hat and as mellow as an ash-heap.

More than fifty years have now passed since that occurrence, and the farm has the reputation of being rich and productive to the present day.

I passed it a few years ago, and looked over it with about the same interest I would survey the fields of Marathon and Plataea, where a noble work had once been achieved by man.

One thing about it was always a source of regret to me. I never could ascertain the precise number of years the fields remained undisturbed in their growth of clover.

Green crops have a manurial power equal, if not superior, to every other mode of improvement. Their roots penetrate the earth and open millions of channels, which permit the air with all its rich constituents to act upon the subsoil and improve it, not only by compelling the decay of vegetable matter, but by entering into new compounds and thus becoming available food for plants.

A farmer once dug up a clover-root seven feet ten inches in length. This of course might be a giant among them.

But what has once happened in Nature may happen again. We accept this as an index to the general average.

We suppose that three-fourths—yes, we hope that nine-tenths—of all clover-roots are three feet in length. But if they penetrate the unploughed ground but two feet, what a vast amount of good they will do!

How superior in their action to barnyard manure! They change the color, the texture, and the quality of the subsoil. We know what stable manure can do. The experience of ages is before us. The farmers of England have been ploughing in the residue of their crops and raising grain more than fifteen hundred years. Therefore, if the contents of the barnyard and artificial manures will make a deep, dark, rich, and productive soil, we ought to find it, as a general rule, all over Great Britain. But what are the acknowledged facts in the case?

Alderman Mechi says: "If you make a transverse cut or opening in the soil, you will find that the British agricultural pie-crust is only five to eight inches thick. The excavations and railway cuts plainly reveal this humiliating fact. Below this thin crust we see a primitive soil, bearing most unmistakable evidence of antiquity and unalterability. The dark shades of the cultivated and manured surface have not been communicated to the pale subsoil."

In another place he shows that all their labor and expensive fertilizers have extended only a few inches below the surface.

He says: "My observation of the present cultivation of our stiff clays would give an average depth of about four or five inches: all below this may be considered as unknown and unimproved territory."

Do not suppose from these quotations that we are in favor of plunging into the subsoil with a large plough and a strong pair of horses. Nothing of the kind: that task belongs to clover.

We know that it is reckless, if not dangerous, even with fifteen or twenty tons of stable manure per acre, to plough deeper than usual under the delusive hope that we can easily make a thicker "pie-crust," and thus be able to raise larger crops.

In 1865, on my Farm, we had a field ploughed so deep that its productive power was impaired for several years. It was done when I was not there, and of course I could not prevent it. We are so well satisfied of this fact that we record it as a warning to others.

Mechi says: "We know that there is nothing of which a farmer is so much afraid as the sub-soil six or seven inches below the surface; if he brings this at once to the surface, he will grow nothing for some time." This is owing to the absence of the proper bacteria and essential conditions for their growth in the sterile sub-soil.

These plain truths should convince every one that the cheapest and most effectual way to bring up a poor farm to a high state of productiveness, and also to prevent a good farm from becoming poor, is to keep every field in clover as long as possible. Other green crops are useful, but clover outranks them all. Follow this advice year after year, and you will find the dark crust of your farm is ten or twelve inches thick from the gradual decay of the clover-roots which have worked their way into the subsoil. Then it will be wise and profitable to plough even a foot deep into the new and rich fields which lie beneath the surface.

But what shall we do for a living on our poor farm while every field is growing clover? Well, that seems to be an important question, and most cheerfully I will answer it.

But let me first prepare your mind for the advice I am going to give you. If you will ask the best and most successful farmers what proportion of their crops do they return as manure to the land, they will answer, we presume, in the words of Joseph Harris: "We put on the unsold produce of ten acres to manure one." Here you see that all the straw, corn-fodder, hay, and the residue of grain consumed on a farm of 100 acres would be returned as manure to ten acres. Is not that a capital concentration? Certainly a field with such a dressing should bring forty bushels of wheat or eighty bushels of corn per acre. Yet for some reason this seldom happens.

CHAPTER XX.

JOHN JOHNSTON AND OTHERS ON RAISING WHEAT.

IN 1874 one of the editors of the *Country Gentleman* after a visit to John Johnston said: "Mr. Johnston showed us a field upon which he had raised wheat for more than thirty years every alternate year, the average yield constantly increasing. His plan was to fallow-plough about the middle of June; plough again about September 1st, and top dress heavily with manure and sow wheat. Early the next spring he sowed on clover-seed and plaster. After harvest, if the clover grew large enough to head out, he pastured it more or less, but if no blossoms appeared he put no stock on it. The next spring he pastured the clover lightly until it blossomed, when it was turned under as before. He had found this two-crop rotation very successful."

Now, can there be any objection to the addition of one more green crop as a top dressing to this very successful mode of raising wheat? You recollect how strongly he is in favor of some kind of protection to save the crop from the blasting winds and other injuries. After ploughing in the clover there would be ample time to raise ten or fifteen tons per acre of green corn, and to cultivate and clean the field as effectually as if nothing was growing on it.

We should notice this fact—that he "top dressed heavily with manure." Yet even that did not prevent the wheat from being killed when exposed to north-west winds.

If the free use of the very best manure will always ensure a heavy crop of wheat, his crops should never fail. He was in the habit every winter of feeding many tons of oil-cake and about 1500 bushels of corn and a large amount of hay. With such a mass of rich material why should he need or use anything else? Yet he ploughed in clover. And such clover! How rank it

must have grown after the top dressing such as he gave the wheat! Yet how careful he was only to pasture the clover lightly before turning it in! In fact, he made use of every means in his power to insure heavy crops of wheat.

Joseph Harris, in his celebrated lecture on *Wheat-Culture in Western New York*, gives us Johnston's views on the use of salt and lime.

"On rich land," says Harris, "salt has a tendency to check an excessive growth of straw. In some experiments made recently on the farm of the Royal Agricultural Society the unmanured plot of wheat produced twenty-nine bushels per acre, and the plot dressed with three hundredweight of common salt thirty-eight and three-fourths bushels, or an increase of nine and three-fourths bushels per acre.

"A few years ago I was on the farm of John Johnston of Seneca county. He had dressed a part of a field of wheat with a barrel of salt per acre, and the effect was most decidedly beneficial. The wheat was heavier and the straw much brighter and stiffer. It also ripened several days earlier, and escaped the midge in consequence. Mr. Johnston is here with us to-day, and he has just informed me that he thinks there is nothing like salt for stiffening the straw on rich lands. He sows a barrel per acre on the fallows just before sowing the wheat. He has sown as much as seventy-five barrels in a year on his wheat.

"Lime is also a splendid manure for producing plump heads of wheat and a stiff straw. There is nothing like it. Mr. Johnston says if he were a young man he would lime every acre of his farm. In 1844 he applied 200 bushels of lime on two acres before sowing the wheat, and it was a magnificent crop—over fifty bushels per acre; and he says he can see the effect of that lime on the land to the present day."—*Genesee Farmer* 1863.

After reading this shall we be afraid to plough in green manure, lest it should make weak straw and cause the wheat to fall? Here we have a certain remedy in salt and lime. But we must

be careful not to use too much lime. There is an old proverb—the lesson, we presume, of observation and experience—

“That too much lime and no manure
Will make the farm and farmer poor.”

The reason is plain enough. Lime contains very little plant-food. A good crop of wheat of thirty-four bushels per acre takes from the soil only one pound of lime, and the straw about seven pounds.

Alderman Mechi found salt to be indispensable on his rich land. He says he salted all his wheat at the rate of four to eight bushels per acre, *and was determined to use much more*. He knew a gentleman in Northamptonshire whose wheat crop could scarcely ever be kept from going down until he used salt, which had effectually kept it standing.

When putting in wheat it is a matter of great importance to have the land in the right condition to receive the seed. If you plough in a very heavy green crop and sow at once, you may have an almost total failure and raise but a few bushels of wheat. The reason is plain. If dry weather should come on and continue for several weeks, there will be a nearly complete separation between the surface and subsoil. The wheat cannot grow in the dry crust, and as no moisture can arise from capillary attraction to soften this crust, the seed may perish, or make but a feeble growth till the ensuing spring. From a careless disregard of these facts even large crops of clover ploughed in have been apparently injurious, and the whole system of green manuring has been condemned and abandoned.

We find some very excellent advice upon this subject in the foreign correspondence of the *Country Gentleman*. The writer says: “We want the ground to settle before sowing. Never sow wheat or rye on new-ploughed land if you can help it, but give it the last furrow [plowing] from six to eight weeks before sowing-time. This is of the highest importance. The soil then becomes thoroughly pulverized by the alternate action of rain

and sun—it rots: ay, it will rise (puff) like well-made dough—I can describe it in no other way. The land must look as if yeast had been put into it, which had done its work well. Then is the time to sow.”

Here you see the ground must *settle*. Now, it cannot settle in dry weather if piled on top of green manure of any kind. In some seasons there will be so much rain just at the right time that all seeds will grow, no matter when or how carelessly they are put in. That we may never fail to raise a good crop of wheat, I prefer to have Indian corn for the last green dressing, and to keep it on top as a mulch, as directed in Chapter XI.

On spreading lime and other fertilizers I wish to say a few words. I have so often noticed the utter impossibility of spreading anything evenly with the shovel that I was induced to devise a machine which will sow from three bushels to three hundred per care of material as fine as plaster or as coarse as the grains of Indian corn. Its cheapness, simplicity, and durability will recommend it to every one. It consists of a hollow cylinder or drum from six to twelve feet in length and from two to three feet in diameter. It is formed of long boards or vanes, which have one edge fastened by a hinge at each end to a drumhead, and also by a hinge to a drumhead in the middle. The free edge of every board overlaps the hinged edge of the vane next to it. By means of movable bolts the space between the overlapping edges can be adjusted to the thirty-second of an inch, or to a whole inch, depending on the desired rate of application. A shaft runs through the drum and has a wheel at each end. One wheel is fastened to the drum to turn it.

CHAPTER XXI.

THE RESTORATION OF POOR LAND BY GREEN MANURES.

FARMS that have been worked by tenants or by careless owners for a long course of years generally become so poor that very little more than the seed sown is obtained in the yearly produce.

Now, it is a vital question to every farmer, What change has taken place in the soil that it will no longer yield a remunerative crop? If the minerals have been entirely exhausted, he may be living where he cannot procure ground bone and other fertilizers at any reasonable price, and hence he must abandon the farm and leave it to time and Nature to restore.

But, most fortunately for man, this is very seldom, if ever, the case.

Many well-established facts are on record that prove that the loss of power to produce even a small crop is owing to the consumption of nitrogenous compounds and vegetable matter in the soil. I call it a consumption because it is a positive burning up by oxidation of everything in the ground that had been deposited there by the growth and decay of organic matter.

And the more you plough and harrow and loosen up the soil, the faster will this destruction take place. Then you will please remember this plain truth, that fire and tillage with the plough and harrow act in the same way and accomplish the same object—the exhaustion of the farm. In corroboration of these views let me give you a very interesting and instructive fact to verify them.

Joseph Harris, in the *Genesee Farmer* of 1863, says: “Thirty or forty years ago the oak-openings in Western New York were considered far inferior to the heavily-timbered land and to the lowlands on the borders of the Genesee River. The Indians had

for years burnt over this land, and consequently it was to a great extent destitute of organic matter. On this soil plaster and clover acted like a charm. Large crops of clover have been raised for years and ploughed under. The plaster stimulated the growth of clover, and the clover when ploughed under furnished the soil with large quantities of organic matter; and the result is that this land, which was formerly considered poor, is the best and most productive in the State."

Here we have reliable and satisfactory proof that poor land can be restored to a productive condition without purchasing artificial manures beyond a small amount of ground limestone or lime.—Plaster has been found in recent years to be much less effective than formerly. Now, if we ask the chemist what must that soil contain to yield fine crops of grain, he will tell you, "The ash of agricultural plants consists of the phosphates, sulphates, silicates, and carbonates of potash, soda, lime, and magnesia, with small quantities of oxide of iron and manganese and alkaline chlorides."—*Johnston*.

Then all but the sulphates must have been in the soil, but were not available for some cause. What was that cause?

What was indispensable to enable them to become active? The earth was comparatively destitute of atmospheric food. There was the great and only deficiency.

The rich manure so much needed was floating in an invisible state above the poor fields. The chemist tells us that "When a vegetable is destroyed by burning it is mostly resolved into the gases of the air. On the other hand, when it is formed by growth its substance is mostly derived from air."

This being the case, it is imperative on us to introduce the elements of the air into the soil and convert them into plant-food. How shall we do this? We must loosen up the earth, and keep it moist and mellow during all the growing seasons of the year.

To accomplish this effectually and in the cheapest manner, we must cover the land with green crops, and keep them upon the surface as long as possible, and then plough them in when grain or anything else must be sown. To be satisfied that they

are all-sufficient we have only to study their wonderful effects. When the ground is loose from the presence of humus—that is, vegetable matter in a state of decay—the air is freely admitted, and its nitrogen is to a certain extent converted into nitric acid or nitrates and ammonia; by bacteria, and, most fortunately, these compounds are retained by the moisture and the absorbent power of the organic matter. And besides this, a large portion of the nitrogen contained in the green dressing also undergoes the same chemical change and is treasured up for future crops.

The incomparable merits of green manures are not all the qualities that make this mode of improvement the great sheet-anchor of the practical farmer.

The roots of growing plants have great power over the minerals of the soil in breaking up their texture and reducing them to powder. And here let me say, Have no fear of getting too much humus into the soil. An acre of land twelve inches deep weighs 2000 tons. If you could plough in 100 tons of green manure every one, two, or three years, that would only be mixing the one-twentieth of vegetable matter with nineteen-twentieths of the earth a foot deep. Would one gold dollar among twenty copper cents make the pile of money look too rich?

Even on the dark prairies of the Middle West the immense amount of good derived from the preservation and frequent replenishing of organic matter in the soil has been noticed and recorded by many practical farmers.

C. W. Babbitt of Metamora, Woodford County, Illinois, says in the Patent Office Report of 1855: "It would seem that the prairies here might be continued in their virgin richness, simply by annually ploughing under the stubble of our grain-fields and the stalks of Indian corn, never allowing them to be consumed by fire. A short distance south of this resided two farmers, one of whom every year gathered up this corn-stalks and burnt them, and also burnt over his stubble-fields before ploughing. The other never allowed a stalk or a straw to be burnt on his land, but always ploughed them under. After some fifteen years had elapsed the farm of the former yielded on an

average some fifteen bushels of corn less to the acre than when he commenced cultivating it, while that of the latter produced as abundantly as at first."

It is a matter of astonishment that a prairie soil, which is dark with the decayed remains of an old vegetation, should show in the comparatively short period of fifteen years any neglect to restore to the ground the humus it had lost by the production of grain.

David A. Wells, in his *Book of Agriculture*, 1855 and 1856, says: "It is estimated by intelligent farmers in Indiana that their river-bottoms, which used to produce an average crop of sixty bushels of corn to the acre, now produce only forty. In Wisconsin, which is younger still, it is estimated that only one-half the number of bushels of wheat are now raised on the acre which were raised twelve years ago."

Here we have whole districts suffering from the same cause—the exhaustion of organic matter, and which can be restored with little labor and little cost. If the loss of productive power was owing to the exhaustion of mineral food, this could only be renewed from the subsoil and rocks by a long rest or by purchasing the lost material at great expense.

Is it necessary to say anything more upon this subject? Is not every one convinced that raising wheat would ruin one-half of all the farmers in the world if the diminution of their crops arose from the loss of minerals in the soil? Why? Because one-half of them are living where they cannot obtain artificial manures at any reasonable price. I cannot close this subject without the presentation of one more argument, which has already been before the public for some time.

"An incendiary reduced to ashes a pile of barley-stacks from some twelve to fifteen acres of barley. The ashes were scattered over about half an acre of ground adjoining the stacks, thus concentrating the mineral constituents to about one-twenty-fifth of the land from which they were taken.

"A turnip crop, a barley crop, and a crop of seeds taken subsequently from this half acre showed no perceptible superiority

over the rest of the field, neither portions of the and yielding more than ordinary products.”—*Cultivator*, 1853.

This costly, but useful experiment proves beyond cavil that the nitric acid and ammonia in the air are not sufficient to supply all the available nitrogen which is needed to produce a luxuriant vegetation.

Did these compounds of nitrogen exist in the air or in the soil in ample abundance, what immense crops would have been produced on that half acre!

Suppose the farmer had spread this pile of barley-stacks, with all the grain in them, on half an acre of ground, what would have been the result? Twelve to fifteen acres of barley, even at twenty-five bushels per acre, would be from 300 to 375 bushels of grain in the stacks. Now, if you would spread this amount of barley on the half acre without the straw, it certainly would manure it well. Then add the straw, which could not have been less than twelve to fifteen tons, and when all was worked into the soil do you think the turnip crop, the barley crop, and the crop of seed would have “shown no perceptible superiority over the rest of the field.”

Now, let us see what lesson we are taught by the analysis of a very rich alluvial soil.

Prof. Johnson says the Zuyder Zee river bottom soil, contains enough of potash for 144 maximum and 648 average crops of barley, and enough of phosphoric acid for sixty-five maximum and 292 average crops, and enough of nitrogen in ammonia for seven maximum and thirty-one average barley crops. Here we see that without some addition from the air the ammonia would be exhausted by very large crops in seven years. Then, according to the teaching of the burnt stacks of barley, to obtain paying crops we should put on some kind of manure containing nitrogen or plough in green crops. Yet, according to common practice, many farmers would go to the expense of sowing on more phosphates as soon as the crops began to fail. This is a lesson which should not be forgotten. Then we will always know what to do when the crops begin to diminish. Not a

shadow of doubt will rest upon it. We must at once restore to the soil the organic elements by ploughing in green manures. Of course the first choice will be clover; if that will not grow even with the aid of lime or plaster, then we may resort to oats or rye or buckwheat.

The reader may entertain the suspicion that I set too high a value upon the restorative powers of clover. To prove that it is almost impossible to do this, I ask a careful reading of the following extract of a letter from the Hon. George Geddes of New York to Joseph Harris.

He says: "All that I shall try to prove to you is, that the fact that clover and plaster are by far the cheapest manures that can be had for our lands has been demonstrated by many farmers beyond a doubt—so much cheaper than barnyard manure that the mere loading and spreading of the latter cost more than the plaster and clover."

This clear declaration has more weight with me than the testimony of ten thousand unknown farmers, because George Geddes has experimented with clover intelligently, and relied upon it on his own farm for the last sixty or seventy years.

I will close this with the encouraging words of Dr. Voelcker, the able and reliable chemist who has devoted so much of his time and talents to the examination of this subject.

He says: "Indeed, no kind of manure can be compared in point of efficacy for wheat to the manuring which the land gets in a really good crop of clover."

We have said that if clover will not grow by itself you had better sow some other kind of seed. It is very probable that oats will grow ten or fifteen inches high if sown and rolled in with the clover-seed. Then you should watch it closely, and as soon as it comes in blossom mow it down with a machine, and let it lie to protect and shade and nourish the young clover.

Among old writers on agriculture I find that oats are strongly recommended to be sown in spring and summer, to be fed off by cattle to improve the land. If the animals receive nothing but the green oats for nourishment, of course their manure would

add nothing to the soil that the pasture could not return if ploughed in or cut down and left upon the field. But if the cattle were fed with oil-cake or Indian meal, or something else, twice a day, it would make a material difference in the value of the manure left while grazing on the green oats.

Buckwheat might be used in the same way either as a green dressing or as feed for cattle. But in the latter case you must only let the animals remain on the green buckwheat a short time once or twice a day. They are so fond of it, and it is so rich and so easily eaten, being soft and succulent, they would soon injure themselves if permitted to remain on the pasture all the time.

CHAPTER XXII.

HOW TO IMPROVE LARGE FARMS WITH GREEN MANURES.

IT is a very common practice among agricultural writers to advise all persons having large farms which are in a very poor condition to sell one-half or two-thirds of their land, and apply all the money they receive in manuring and improving the balance of their property.

In some cases this may be the most prudent course to follow, but, as a general rule, I am opposed to this advice for two very good reasons:

First, you can get but very little per acre for your poor fields; and, secondly, if you improve your property with judgment you can enhance its value so rapidly that in seven or eight years it will be worth double or treble its former valuation.

To begin your improvement, take the old field about half a mile from the house, and which is now covered with thin yellow grass and a mellow soil about one or two inches deep, produced by many years of exposure to the weather.

It has never been ploughed since you knew it. And, I beg you, do not plough it now at the beginning of your efforts to make better. Let me show you what a coating of fine mellow earth is worth upon the surface.

In Egypt the annual overflow of the Nile deposits on the land a thin stratum of very fine soil which amounts only to four or five inches in a century. This yearly settling, which is only the twentieth of an inch in thickness, of almost impalpable dust, does much towards keeping the farms rich and productive. The Egyptians do not plough this precious coat under, but sow the seed on the moist ground as the waters subside, and then if, possible, they drive sheep and hogs or goats over it to press the seed into the soil.

We should all learn a useful lesson from their example and experience. We should not plough down the only part which the air has enriched by mingling and uniting with it for so many years, but early in the spring we should harrow as many acres of the old field as we can sow with clover-seed at one peck to the acre.

The principal roots of all plants must be near the surface, that they may feel the life-giving influence of air and moisture, or the soil must be loosened by Nature or by tillage, that the atmosphere may penetrate even to the deepest fibres of vegetation. Hence the reason that plant-food acts so well upon the surface, and that all seeds germinate more quickly, more naturally, when covered by only one or two inches of soil. But these great truths must not be misunderstood. Though the soil must be loose, the finer the seed the greater the necessity when planting or sowing of pressing with the hand or foot or roller the earth into close contact with the grain.

I remember a little incident which will illustrate this subject and fix it in the mind. An old sea-captain who lived in our neighborhood tried every year to raise for himself a little tobacco. He prepared a little patch of ground with the greatest care. The surface was as fine and rich and mellow as he could make it. Then he sowed the seed and raked it over once more very gently.

Yet, much to his surprise and vexation, only a few stalks grew each year. But one spring, after the little bed had been sown with all the usual care, some fellow, to worry the old captain, went secretly on it and tramped and tramped, and danced and tramped it, till it was, to all appearance, as hard and solid as the most frequented public road. The poor old man gave him a seaman's blessing, whoever he might be, and left it to its fate. But on his next visit to it he was astounded to see the whole bed covered with vigorous plants of tobacco. It seemed that every seed had grown. He had a grand crop. After that he could always raise tobacco.

He tramped the ground himself after the seed was sown.

Here is a practical illustration of this plan which I know to be a fact.

A person bought a very poor farm near the southern boundary of Pennsylvania, and tried to raise grain upon it in the usual way. But nothing grew large or strong enough to produce seed. Fortunately, he did not sacrifice the property by selling it at a very low figure, as many would have done. He sowed every acre of it with clover-seed and plastered it every year. For a living he followed the profession of an auctioneer.

About seven or eight or more years the clover grew upon his farm, undisturbed by plough or hoof of any kind. Then he concluded to try his hand again at farming. Many of his neighbors gathered to see the first ploughing after so long a rest from tillage.

An old farmer who was present assured me that the soil turned over eight or nine inches deep as black as your hat and as mellow as an ash-heap.

More than fifty years have now passed since that occurrence, and the farm has the reputation of being rich and productive to the present day.

I passed it a few years ago, and looked over it with about the same interest I would survey the fields of Marathon and Platæa, where a noble work had once been achieved by man.

One thing about it was always a source of regret to me. I never could ascertain the precise number of years the fields remained undisturbed in their growth of clover.

Green crops have a manurial power equal, if not superior, to every other mode of improvement. Their roots penetrate the earth and open millions of channels, which permit the air with all its rich constituents to act upon the subsoil and improve it, not only by compelling the decay of vegetable matter, but by entering into new compounds and thus becoming available food for plants.

A farmer once dug up a clover-root seven feet ten inches in length. This of course might be a giant among them.

But what has once happened in Nature may happen again. We accept this as an index to the general average.

We suppose that three-fourths—yes, we hope that nine-tenths—of all clover-roots are three feet in length. But if they penetrate the unploughed ground but two feet, what a vast amount of good they will do!

How superior in their action to barnyard manure! They change the color, the texture, and the quality of the subsoil. We know what stable manure can do. The experience of ages is before us. The farmers of England have been ploughing in the residue of their crops and raising grain more than fifteen hundred years. Therefore, if the contents of the barnyard and artificial manures will make a deep, dark, rich, and productive soil, we ought to find it, as a general rule, all over Great Britain. But what are the acknowledged facts in the case?

Alderman Mechi says: "If you make a transverse cut or opening in the soil, you will find that the British agricultural pie-crust is only five to eight inches thick. The excavations and railway cuts plainly reveal this humiliating fact. Below this thin crust we see a primitive soil, bearing most unmistakable evidence of antiquity and unalterability. The dark shades of the cultivated and manured surface have not been communicated to the pale subsoil."

In another place he shows that all their labor and expensive fertilizers have extended only a few inches below the surface.

He says: "My observation of the present cultivation of our stiff clays would give an average depth of about four or five inches: all below this may be considered as unknown and unimproved territory."

Do not suppose from these quotations that we are in favor of plunging into the subsoil with a large plough and a strong pair of horses. Nothing of the kind: that task belongs to clover.

We know that it is reckless, if not dangerous, even with fifteen or twenty tons of stable manure per acre, to plough deeper than usual under the delusive hope that we can easily make a thicker "pie-crust," and thus be able to raise larger crops.

In 1865, on my Farm, we had a field ploughed so deep that its productive power was impaired for several years. It was done when I was not there, and of course I could not prevent it. We are so well satisfied of this fact that we record it as a warning to others.

Mechi says: "We know that there is nothing of which a farmer is so much afraid as the sub-soil six or seven inches below the surface; if he brings this at once to the surface, he will grow nothing for some time." This is owing to the absence of the proper bacteria and essential conditions for their growth in the sterile sub-soil.

These plain truths should convince every one that the cheapest and most effectual way to bring up a poor farm to a high state of productiveness, and also to prevent a good farm from becoming poor, is to keep every field in clover as long as possible. Other green crops are useful, but clover outranks them all. Follow this advice year after year, and you will find the dark crust of your farm is ten or twelve inches thick from the gradual decay of the clover-roots which have worked their way into the subsoil. Then it will be wise and profitable to plough even a foot deep into the new and rich fields which lie beneath the surface.

But what shall we do for a living on our poor farm while every field is growing clover? Well, that seems to be an important question, and most cheerfully I will answer it.

But let me first prepare your mind for the advice I am going to give you. If you will ask the best and most successful farmers what proportion of their crops do they return as manure to the land, they will answer, we presume, in the words of Joseph Harris: "We put on the unsold produce of ten acres to manure one." Here you see that all the straw, corn-fodder, hay, and the residue of grain consumed on a farm of 100 acres would be returned as manure to ten acres. Is not that a capital concentration? Certainly a field with such a dressing should bring forty bushels of wheat or eighty bushels of corn per acre. Yet for some reason this seldom happens.

Indian corn more than any other crop clearly proves the wisdom and profit of concentrating green clover or stable manure and labor upon a little land. The careful and experienced farmer will often "use the unsold produce of ten acres to manure one." And yet we never hear any objection to this almost extravagant use of manure. But should we recommend the same thing to be done with green clover, you would probably hold up your hands in amazement at the advice. That is, the concentration of ten acres of green clover upon one acre! Most fortunately, you will not have to do that to raise an immense crop of corn.

If you will take a field that is thickly set with clover, and the crop so heavy that it will cut fifteen tons of green manure just as it is coming into blossom, you need only concentrate three acres upon one to raise 160 bushels of corn per acre if the season is very favorable.

But it must be done in a certain way to be successful. I will give you the plan in detail, and then it will look more reasonable to the practical farmer.

In a fifteen-acre field of clover measure off five acres in the middle of the lot, running clear across the field, leaving five acres on each side of it.

When the clover is just beginning to blossom cut down the whole crop and rake it on to the five acres. This first dressing will amount to 225 tons of green manure. The balance of the field, will be in bloom again by the 1st of August. This time we have but ten acres to cut. No doubt but this will give us 100 tons, and must be mown and spread on top of the first crop.

By the middle or last of September we may cut five tons more per acre; that will give fifty tons more to be spread on the other two crops. In all there will be 375 tons on the five acres, and every ton equal if not superior to a ton of stable manure.

Now, our best and most successful farmers when manuring for corn put on fifteen tons of barnyard manure per acre. Do you suppose that that will be equal to our seventy-five tons of green clover per acre?

This green dressing of seventy-five tons contains 900 pounds of nitrogen, 187 pounds of phosphoric acid, and 675 pounds of potash. The fifteen tons of barnyard manure contain only 150 pounds of nitrogen, 75 pounds of phosphoric acid, and 187 pounds of potash. Yet you expect to have eighty bushels of corn per acre, and in good seasons actually realize that amount. Then have we not a very good reason to expect at least double what you raise—that is, 160 bushels on each acre?

Our green clover is put on exactly at the right time—in the summer and fall—and, what is of equal importance, is in the proper condition to be converted into available plant-food. It holds the ground beneath it for seven or eight months in a moist and mouldering state and in a condition of constant improvement. Hence we depend not only upon the lavish amount of actual nourishment which we put on, but also upon the admirable preparation of the soil to produce a grand result. And when spring returns we are master of the situation. We can plough the very day that we should plant the corn. Dry weather cannot interrupt our farming operations.

Yet all our neighbors who have a naked, clayey soil may be moping about and wishing and praying for rain that they may plough to plant corn.

When ground is heavily mulched with clover and the soil is a rich loam, and, of course, so mellow that ploughing is unnecessary, we can raise corn without turning in the manure. If we are satisfied upon a careful examination that the clover is dense and deep enough to prevent all weeds from growing, we may put in the corn with a hand planter in the following manner!

In straight lines, three by three or four feet, all over the field till it is finished. After this you will have nothing to do to it till the crop is ready to cut.

I feel justified in recommending this method, having seen a report of a satisfactory experiment where leaves were used to mulch a crop of corn.

James Camak of Athens, Georgia, says in the *Farmers' Register*: "Last spring I planted a small piece of poor ground,

first breaking it up well. The rows were made three feet apart, and the stalks left about a foot apart in the drill. The ground had been very foul last year with crab-grass, whose seed matured. The corn was not well up this spring before the grass began to appear. When the corn had about four or five blades the young grass completely covered the ground and the corn was turning yellow. I spread a small quantity of stable manure around the corn, and covered the whole ground with leaves from the forest, taking care to do this when the ground was wet, and the leaves also, that they might not be blown away, and to leave the tops uncovered. In *ten days* there was not a particle of *living* grass to be found, and the corn had put on that deep bluish-green which always betokens a healthful condition of the plant.

"From the day the corn was planted until after the fodder was peeled and the tops cut nothing more was done with it, and the result is a product at the rate of *forty-two* bushels to the acre, about one-third of the stalks having two ears on each of them.

"I noted in the course of the summer the following facts:

"1st. The corn treated thus was always ahead of some planted alongside of it and treated in the usual way.

"2d. It ripened at least ten days sooner than other corn planted at the same time.

"3d. During the hottest and driest days the blades never twisted up, as did other corn in the neighborhood.

"4th. In the driest weather, on removing the leaves, the ground was found to be moist to the surface, and loose as deep as it had been at first breaking up.

"5th. The heaviest rains had scarcely any effect in washing away the soil or making it hard."

We cannot, of course, use leaves to raise corn, but we can obtain that which is far better—an abundance of green clover.

And when we remember that the chemist, after a careful analysis, has decided that dead leaves have so very little plant-food in them that they are not worth gathering, except as absorbents to be used as bedding for animals, we may be satisfied that the corn received no nourishment from the leaves, and all the

benefit arose from the protection bestowed upon it as a mulch. Then how vastly superior would a heavy dressing of clover be to the fallen leaves, which even hungry cattle will not eat, they are so worthless!

But another question comes up for settlement. Would that "poor ground," as he calls it, have produced forty-two bushels of corn per acre had he worked it in the usual manner? It certainly was in a most discouraging condition when all green with crab-grass and the corn turning yellow.

The crop would certainly have been a failure had he trusted to the common, careless, slovenly tillage so often seen in such cases. Of course, laborious attention with hand and hoe and fluke day after day would have saved it, but this would probably have cost more than the crop was worth.

I cannot leave this interesting experiment without a further examination.

Will corn do as well without any working, if the grass and weeds are kept down, as it will by frequent tillage with the fluke?

If we can prove this to be an established fact, then the very best way to raise corn is to use a heavy mulch of something that will effectually prevent the growth of weeds and grass and at the same time manure the ground.

I will here relate an authentic case where a crop was raised without the use of plough or fluke after the corn was planted:

"George W. Williams, of Bourbon county, Kentucky, has this year grown on one acre and one-eighth of land *one hundred and seventy-eight bushels*, or at the rate of *one hundred and fifty-eight bushels* to the acre! The corn was an early yellow corn, and was planted in rows two feet apart and one foot apart in the rows.

"The corn was dropped in a furrow, covered with hoes, the surface levelled and rolled after planting. The surface between the rows was scraped over with sharp hoes to cut the weeds, which was all the labor the crop received. The soil was good, ploughed deep in the spring, and before planting a thin coat of

fresh stable manure was spread over the surface, cross-ploughed, and harrowed.

“Mr. Williams attributes much of his success to not disturbing the roots of the corn during cultivation.”—*Cultivator*, 1841.

Now, to return to our field of five acres in clover in a state of decay. How shall we decide the matter? Which way will produce the most corn at the least cost of time and labor? Shall we plough in the heavy dressing and work the crop as usual, or shall we put it in with the hoe and leave the mulch undisturbed?

The only certain way to decide this question is by careful and repeated trials of both methods, year after year, by a number of farmers and on different kinds of soil. If the crops should be equal, we should declare at once in favor of the mulching process. The soil would lose nothing by evaporation. One rain in May would ensure the crop against all drought.

The labor would be reduced to one-third or one-quarter. The ground would remain in a state of improvement during the fall and winter. And if the mulch was not thick enough to bring another crop of corn, it could be ploughed in for barley or oats or a second corn crop. By adopting this plan the whole field will be in clover, either growing or decaying, and in both cases improving the land.

I presume, after all that has been said in favor of the new method of raising corn without tillage, or of the other method of concentration of all the manurial power upon a little land, very few will be willing to adopt either plan. They will still cling to the old practice of putting the whole field in corn, whether the land is rich or poor. Very well, let them do it; necessity will teach them a better way.

Why not let the field rest in clover three or four years, and then plough in by this means a heavy dressing of manure?

This plan will be equal, of course, to concentrating the growth of one year on to one-third or one-fourth of the field.

Either method will ensure a large crop and pay well for the tillage.

Remember, when a field is improved with green clover or other green manures the benefit will be seen for several years; this proves that the greatest expense in raising corn is the labor.

Let me prove this by an extract from Joseph Harris. In his last and best work, *Talks on Manures*, he gives the cost per acre of raising corn, as follows:

Preparing the land for the crop.....	\$5.00
Planting and seed.....	1.50

Cultivating three times, twice in a row—

Both ways.....	5.00
Hoeing twice.....	3.00
Cutting up the corn.....	1.50
Husking and drawing in the corn.....	4.00
	<hr/>
	\$20.00

Thirteen dollars per acre of this labor may be saved by the new method. But let that pass now; we wish to say something about the harassing and wearing labor of ploughing.

Let us turn to England, and there we can see what an immense waste of horse-power there is in the present mode of farming.

Mechi says: "In one place a pair of horses abreast will plough one acre per day; in another, four, five, and six horses *in a line* will only plough three-quarters of an acre.

"In Essex we plough once for wheat; in some other counties three or four times (in some places nine ploughings for turnips; in another only two). Here we allow seven shillings per acre for ploughing, while elsewhere thirteen shillings is a common price."

Until farmers adopt an entirely different mode of tillage the horses required to do all the work will consume one-fourth of all they raise on the farm.

There is no amendment to the old method that will do, but a radical change in the whole system of agriculture.

There should be for every crop, as far as possible, a concentration of plant-food to such a degree as to do away with one-half or two-thirds, or even three-fourths, of all the ploughing. Then the business will be much more profitable, much more certain.

It is the too frequent breaking up of poor land that keeps the farmer poor. And it is the sole dependence upon a scanty supply of poor strawey manure that keeps the land for ever in a poor condition.

CHAPTER XXV.

GREEN MANURES FOR POTATOES.

THE reader will please remember that one heavy crop of potatoes exhausts the land as much as *three* large crops of wheat. Hence he must expect his farm to suffer if compelled to produce potatoes every year. To provide for this great expenditure of plant-food you must either make or buy an abundance of stable manure or plough in green crops.

If you cannot obtain good rich manure for one dollar and fifty cents per ton within two or three miles of your farm, you had better conclude to depend on clover ploughed in or used as a mulch. Another fact must not be forgotten. Potatoes will flourish better and be more mealy, more palatable, and more salable raised on sandy loam than on clayey ground. Hence it will be to your interest to select the most mellow and friable soil on the farm for this crop.

Begin the year before to prepare the lot for potatoes. Take a field that is well set with clover and top dress it.

If the soil is rich and you have a reasonable expectation that by the next year the whole field will bring three or four hundred bushels of potatoes per acre, then you can prepare the land in the following way: As soon as the clover comes in blossom mow it down. This will check every weed that might be concealed among it. The second crop of clover will spring up and grow rapidly, and when in full bloom must be cut down like the first. Now, if August and September should be wet and warm a third crop will grow so rank that you had better mow it down when in full blossom. If you neglect this advice you may be troubled with weeds among the potatoes, and you will regret that you had not cut their heads off in their early growth.

Do not let any person persuade you to plough up this field in the fall. And when spring returns, and about a week or more

before you begin to plough in the seed-potatoes, sow on top of the half-rotted clover any commercial fertilizer that it is desired to apply. If you have plenty of seed, plant whole potatoes not less in size than a hen's egg. If you have not seed enough, cut the large tubers into two or three or four pieces, and drop them in every third furrow.

Do you think all this is too much expense and trouble? Have you forgotten that there is not a crop which you can raise which will pay as well as potatoes for all the labor and fertilizers bestowed upon it?

The above plan may be regarded as the usual way of putting in potatoes with clover, instead of using stable manure. Some farmers prefer to let the clover grow six or ten inches high before ploughing in the seed.

If you wish to adopt this mode you had better plough the field before planting, and then run out the furrows to receive the seed. I have known the tender germs to be very much injured by turning a crop of green clover in the spring directly on them. The potato-sprouts appeared to be killed by the rich juice of the clover-stalks.

On our farm at home I have seen, when a boy, 424 bushels of potatoes per acre produced by ploughing in clover and dropping the seed in every third furrow. But there were raised on a lot that was so much the pet of the family that every crop which grew upon it was carefully measured. When in wheat it yielded forty-nine bushels per acre, and the crop of corn eighty-eight bushels to the acre. And when in clover well do I remember my father measuring stalk after stalk that ran five feet six inches in height. Now, my good reader, if your farm and mine would always produce such crops as these on every field, we might regard the question as settled as to what plan we should follow to insure success.

Nothing else would be required but to plough in clover over the whole field, and be well rewarded for all our labor.

But what shall we do when we know that the farm is only in a poor condition?

We wish to raise per acre as large a crop as was ever produced. It is the cheapest, the best, the most profitable, and indeed the only sure way to make money by farming. But how shall we do it? By the concentration of plant-food. There is no other way.

Let us now prepare to raise an immense crop of potatoes.

There is a field of twenty acres well set with clover. With a good machine mow it all down when in blossom. Now rake it all on to five acres, making one land through the middle of the field. About the first of August the remaining fifteen acres will again be in bloom, and must be cut and moved with the rake on to the first crop. If a third crop should grow large enough to add considerable to the mulch, then mow it down when ready and spread it on the five acres.

You see the whole object of this labor is to concentrate all the green manure of a large field on to one-fourth of the ground. Probably the best way to do this would be to rake the first crop into large and close windrows on the middle of the land, and the second crop into windrows alongside of the first, a third up in the same way. This would require no spreading of one cutting on top of the other.

This plan leaves three-fourths of the field in clover, and yet it is very likely we can raise as many potatoes on the five acres thus prepared as on the twenty acres under tillage in the ordinary way.

Great credit must be given to the admirable preparation of the soil under the mulch, remaining undisturbed in a moist, mouldering and enriching condition from September to April.

And what a difference in the cost and labor! As it requires about ten bushels of potatoes to plant an acre, we will save 150 bushels of seed by confining our operations to the five acres, and also the ploughing, harrowing, planting fluking, and hoeing of fifteen acres of drier, harder, poorer soil. Is not this something? Is not labor the hole in the bag through which almost daily dribbles out one-half the farmer's profits? The balance of the

field, being left in clover, is in a state of gradual improvement. And how much better its condition than ground left bare and exposed all winter after a crop has been taken from it!

Has not experience taught the intelligent farmer to concentrate his stable manure to such a degree that he finds it most profitable to "use the unsold produce of ten acres to manure one?" Such is the acknowledgment of Joseph Harris, and doubtless of many others. As this is a grand truth respecting the residue of our crops, it must be the case with green manures.

Then every hour of labor will receive its full reward. But is it so when the manure and labor are spread over a large field? No, unless the field is very rich or the amount of plantfood almost unlimited.

When stable or green manure is concentrated till it forms a close and dense shelter to the ground, do we not place the soil in the very condition that the nitre-beds are in, where thousands of pounds of saltpetre are made by artificial means? And does not this fact shed an abundant light on, if not a full and satisfactory explanation of, the remarkable benefit derived from covering the land, as related by Johnson and Anderson in the second chapter of this book?

And mark the result of this wise concentration. Year after year you will be astonished at the great crops produced on land once carefully and deeply mulched by green manures or by any other means.

I have seen five tons per acre of clover and timothy hay taken from ground which had been heavily mulched for potatoes six years before.

To raise profitable crops of any kind, and particularly of potatoes, the greatest want of the farmer is manure.

If you have plenty of straw to spare, I would advise you to use it with clover to mulch potatoes in the following manner: Cover the patch as above directed with the three crops of clover cut from the whole field. Let it remain all winter to mellow and protect the ground. In the spring, when it is time to plant, you must rake off all the mulch and then harrow or fluke the surface,

if it is not already loose and mellow enough to receive the seed. Then drop the seed, about one piece to every square foot. Then cover, not with dirt, but with the half-rotten clover. Now, if the covering is not ten or twelve inches thick, so as to prevent all grass and weeds from growing, you must put on straw enough to make the mulch about one foot deep.

I consider this a better and cheaper way than to use stable manure and straw. Here, you see all the labor required is done at once—no weeding, no working, and nothing to do to the potatoes till they are ready to be taken up in the fall. To take them up, all you have to do is to turn the mulch over with a fork, and there are the potatoes all clean and ready to pick up without any digging.

With regard to raising potatoes under straw, great care is required not to disturb the roots during the last month or two of their growth. Hence the reason that you cannot raise potatoes under straw since the potato bugs have made their appearance.

The necessity of walking over the vines day after day to pick off the bugs, and to sow Paris green in plaster on every leaf, will almost ruin the crop of potatoes.

In 1863, before the potato bugs came, I raised over nine hundred bushels of potatoes to the acre under straw about fifteen inches deep. But I cannot do it any longer. In 1893 I tried it. The trampling incident to the battle with the bugs almost destroyed the crop.

I cannot leave this subject without one more word of advice. Never use cornstalks to mulch potatoes, they are so troublesome to remove when taking up the crop.

I once had a lot of sown corn—about thirty-five or forty tons to the acre—cut down with a mowing-machine, and then doubled over and left till spring for a mulch for potatoes.

It was entirely too heavy to handle; we never tried it again.

There is a much better way to use green corn to raise potatoes. Sow the corn about twenty grains to the foot, in furrows three and a half feet apart. Work it two or three times, and

when in full maturity run a deep furrow between the rows of corn, and then cut the crop with a machine. Now, when the hands on the farm have one or more idle hours set them to work filling the furrows with the mown corn. And when this operation is completed let them during the fall and winter haul out old hay, straw, yard-scrapings, waste ashes, hen and stable manure, and when the hogs are killed the hair and blood, and indeed anything and everything that contains plant-food, and spread it along the furrows on top of the cornstalks. Many an hour when nothing else can be done may be devoted to this profitable work.

When it is time to plant the seed potatoes in the spring all is ready to receive them. You have only to press the seed down among the manure, and then turn a furrow from each side on to every row. The middles may be fluked or ploughed, according to your judgment and experience.

In 1865 I raised a grand and heavy crop of Jackson Whites in this way. I bought the seed in Philadelphia (twelve barrels) on purpose for this lot.

The number of bushels per acre was not ascertained, because I had no idea then of ever publishing the result.

This little field has not yet forgotten the good treatment it received at that time. It is a grand truth that land which has been made rich by mulching or by any other means has a remarkable power of remaining good for many years.

Let me relate an interesting example of this fact from Mechi.

He says: "Walking before harvest with a friend in his wheat-field, I was struck with the marked superiority of one corner, and asked for an explanation.

" 'Oh', he said, 'this portion was once a cottage-garden.'

" 'How long ago?'

" 'Why,' said he, 'I have known the field fifty years, and it was ten years before that time.' "

With such a lesson as this before us, we should not be afraid of losing our golden treasures by piling on manure, particularly for corn or potatoes. Here we have undeniable proof that land

when well improved will hold its own for sixty years, and still show a "marked superiority." And is it not very probable that that corner got but little plant-food when the field was manured every four or five years for a crop of grain? Would not the farmer be likely to say, "Ah, you are rich enough; you got your dressing when a garden?"

I once had a singular experience on my Farm of the effects of mulching.

I wished to bring a field of ten acres into clover as soon as possible. I had oats and clover seed sown together in the spring, but was determined to have the oats cut when in blossom, to give light and air and perfect freedom to the clover. I concluded to raise late potatoes by using the green oats as a mulch. Not living on the farm, I was under the necessity of depending upon others to do all things right and at the proper time.

The oats grew finely, and when the grain was in the milky stage two broad lands were ploughed and planted with potatoes, and then the oats were cut and spread nearly a foot thick on the fresh ground.

On my next visit I was astonished to see how careless, how thoughtless, the foreman had been to let the oats get so far ahead before he cut them. It turned out just as I expected. The green stalks had strength and vitality enough in them to mature and ripen all the seed.

Then followed the most remarkable circumstance in the whole experiment.

It appeared that every grain of oats began to grow, and I am certain there were millions of seed that sent down their long roots to the ground, notwithstanding they rested near the top of the mulch and nearly a foot above the soil! The potatoes of course were smothered out after a feeble growth. In September I directed the lands to be ploughed up. A few days after I received a letter from the foreman, requesting me to send out an engine of ten or twenty horsepower if I wanted those lands ploughed.

I went out, and there was the plough sticking in the mulch, and not one yard could a pair of good horses move it.

The oats, new and old, were woven together, consolidated, compact, and so tightly bound to the soil that two years passed before we could do anything with it.

It is now nine years since that happened, and we have had the field in wheat and corn and in potatoes, and those two lands are so rich that the wheat lodges, although we are careful to salt the ground, and the corn proves by its big ears and thick stalks that the soil is twice or three times as good as any other part of the field.

It shows the great necessity of doing everything exactly at the right time. Had the foreman cut the oats just as it was coming into blossom, we doubtless would have had a splendid crop of potatoes, and still left the lands in a good condition. I record this failure as a warning to others.

Do we not repeat this experiment every year by cutting grass or hay when the weeds among it are ripe enough to re-seed the field when we spread the manure made from the weedy hay?

I am a firm believer in mulching with green clover, particularly for the purpose of raising immense crops of potatoes. I know that one thousand bushels per acre can be raised in that way easier than by any other method. I will relate a case which I know to be a fact: An acquaintance of mine, a gentleman esteemed for his integrity and reliability, was sitting one evening in a shoemaker's shop in New Jersey listening to the conversation of two farmers. One said that he believed that one thousand bushels of potatoes could be raised upon an acre. The other offered to pay all the expense and give him a handsome premium if he would accomplish the task.

The offer was at once accepted, provided there were no limitations enjoined as to time and means.

As soon as the acre was carefully measured off many loads of rich manure were spread upon the surface and ploughed in. In about two weeks the seeds of weeds and grass began to sprout up very thick; then the ground was again covered with manure, and

again ploughed as before. This process was continued for two years; that is, repeated manuring and repeated ploughing till the soil was as rich almost as a barnyard in midwinter and as mellow as a feather-bed.

Then the potatoes were planted by ploughing in the seed in every furrow. Nothing more was required. When the crop was taken up it measured eleven hundred bushels of good potatoes from that one acre!

My informant could not tell me how many loads of manure were put on; he seemed only to feel a deep interest in the results, and was careful to be present at the final measurement and decision.

I do not think that such a crop could always be obtained in that way.

The season must have been remarkably favorable in the amount of rain and heat and sunshine. Had the weather been very dry there might have been a partial failure. In all such trials the ground should be heavily mulched on top with clover or straw. Then there could be no such word as fail.

Do you regard this experiment as too extravagant ever to be repeated? Is there any great loss of manure?

What the crop could not assimilate remained in comparative safety. It was nearly all there, ready to produce great and grand harvests in future years.

The loss of plant-food by evaporation or by leaching would not be so great on that one acre as it would on six or eight acres had he spread the manure over that much ground. Besides this, he could spread clover or straw over this one acre without much labor or expense, and thus secure it in a great measure from future waste. No good reason can be given why he should not continue to raise potatoes on this highly-manured acre.

Boussingault says: "Potatoes may come again and again upon the same soil; they are incessantly cultivated at Santa Fe and Quito, and nowhere are they of better quality."—*Rural Economy*.

Again he says, in another place: "That there is no absolute necessity for alternation of crops where dung and labor can be readily procured is undeniable."

The reader will please remember that Henderson considers garden vegetables an exception to this rule. Experience has taught him that *vegetables* do better by alteration every few years, and in some cases every year.

The concentration of plant-food in general farm-tillage, which we have so earnestly commended, and, I feel, almost to a tiresome repetition of the subject, reminds me of a little instructive advice communicated to a young beginner.

Not many miles from his home lived an old man remarkable for the wisdom and knowledge which he had treasured up as a very successful agriculturist and a very money-making farmer. The youth asked him if he would please to reveal to him the choicest and most valuable secrets and gems of knowledge respecting their profession, as he was about to retire from it.

"Yes, I will cheerfully do it," said the old man with a kind expression. "Go home and make five acres of your farm as rich as a garden, and then come to me and I will tell you what to do next."

"Well, but suppose I cannot do that?"

"Then," replied the old man, "make one acre as rich as a garden."

Now, we never heard what else he intended to reveal to him, but we can easily conjecture that he would say, when informed that he had complied with his advice,

"Go and make another acre as rich as the first, and thus continue till the whole farm is as rich as a garden."

How many persons get discouraged because they fail to enrich a large field all at once and all the same year!

In conclusion, let me counsel you to follow the advice of the venerable farmer and you will never regret it. And to do this with profit and pleasure place your trust in green manures. And if not rank enough to bring a heavy crop over the whole field, then double it once or twice, or even three times, and "great will be your reward."

CHAPTER XXVI.

GREEN MANURES FOR THE MARKET-GARDEN.

THOSE who engage in raising vegetables for the market very soon discover that they can not make the business profitable unless they manure very heavily every year. They must put on from seventy-five to one hundred tons per acre every spring of good stable manure, or something else that contains about the same amount of plant-food. Now, it will be too expensive to haul manure several miles for this purpose, because every hundred tons contains about seventy-five tons of water. Therefore, you must depend on bone-meal or super-phosphate of lime, or on guano, or on green crops for your market-garden. This being the case, you will soon discover that green clover and rye are the cheapest and most reliable substitutes for stable manure or any foreign fertilizer.

Regarding this as a truth, it settles the question as to the amount of land required for a profitable business.

Ten acres are enough for all those who live near a city and can depend on it for all the manure they need, while all who live at a distance should have thirty or fifty, or even one hundred acres, according to the amount of business they wish to do.

Before we say anything about the preparation of the soil by the use of green crops, let me relate to you an example of a very profitable concentration of manure and labor on a little market-garden.

A man in New Jersey, within sight of the city of New York, in the spring of 1864 on one acre "planted 12,000 early Wakefield cabbages, which by the first week in July were sold in New York market, at eight dollars per hundred, for \$960. Between the rows of cabbages were planted at the same time 18,000 Silesia lettuce-plants, which, at one dollar and fifty cents per 100,

brought \$270. Both crops were cleared off by July 15, the ground being thoroughly ploughed, harrowed, and planted with 40,000 celery-plants, which sold before Christmas of the same year at three dollars per 100, or \$1200—making the total receipts \$2430. His expenses were: Manure, \$150; keep of horse, \$300; hired labor, \$400; incidental outlay, \$100," besides the interest on his investment.

Now, was it a misfortune that this man actually owned but one acre of land? What would have been his procedure had he purchased six acres and had only money enough left to buy \$150 worth of manure? Is it not very probable he would have spread this amount over the whole six acres? The temptation to do so would have been very strong.

Nothing but an intimate knowledge of the business could have prevented it.

And what would have been the result on six acres? Not more than one or two hundred dollars per acre would have returned to him, and but little would have been left after paying all expenses. We know that this would happen. We have seen it again and again with truckers who were not masters of the great secret of concentration.

The market-gardener must learn wisdom from the failures as well as from the remarkable successes of others.

Let us now commence our operations without stable manure on a rich field of twenty acres well set with clover.

With a good machine we must cut this without delay, and rake it on the five acres selected and measured off for the truck-patch. The remaining fifteen acres will have a second crop of not less than ten tons per acre, and will be in bloom about the 1st of August, and must be mown and raked on top of the first cutting.

Cut this third crop before the blossoms begin to fade, and rake it on to the other crops. These three dressings of clover will make altogether 525 tons of green manure concentrated on the five acres. Now, what will it cost to enrich the garden in this way?

We have the published declaration of practical farmers that they can mow clover and make it into hay and put it in the barn for one dollar and a half per acre.

If this can be done, then it will cost no more to cut the clover, and rake it and spread it on the plot in the centre of the field. Cutting the twenty acres once will be thirty dollars, the fifteen acres mown twice will be forty-five dollars, and one year's interest on the field, worth \$100 per acre, will be \$120, or altogether \$195.

Here we have the market-garden of five acres, manurèd with 525 tons of green clover at a cost of \$195, and all ready for seed-ing and planting in the spring. Now let us compare this rich deposit of plant-food with stable manure purchased in the city.

Peter Henderson, author of *Gardening for Profit*, in a letter to Joseph Harris says: "In a general way it might be safe to advise that whenever a *ton* of either cow, horse, hog or other stable manure can be laid on the ground for three dollars, it is cheaper than commercial fertilizers of any kind at their usual market rates. This three dollars per ton, I think, would be about the average cost in New York, Boston, or Philadelphia.

"We never haul it on the ground until we are ready to plough it in."

This is exactly the information we need for a fair and honest comparison between the two systems. We have the cost of the manure and all the labor of hauling and spreading given in one figure. Now, we only want to know how much is required.

You will find that question settled in Henderson's work. He says not less than seventy-five to one hundred tons per acre will answer for a market-garden, and this amount must be applied every year.

Taking the lowest quantity, the seventy-five tons will cost \$225 and of course the manure for the whole five acres the sum of \$1125.

Now, subtract the cost of our 525 tons of clover from this, and we have a balance of \$930 in favor of the green manure. In

other words, it will cost nearly six times as much for the stable-cleanings as for the green crop. Another matter of deep interest is involved in this comparison—the intrinsic value of the two in their capacity to furnish available plant-food.

Three hundred and seventy-five tons of stable manure contain 3750 pounds of nitrogen, 1875 pounds of phosphoric acid, and 4687½ pounds of potash. Now, the 525 tons of green clover contain 6300 pounds of nitrogen, 1312½ pounds of phosphoric acid, and 4725 pounds of potash.

In the most costly element you see that 525 tons of clover has nearly twice the amount of it found in the 375 tons of manure.

There is but one more question to be settled in this examination. Is the nitrogen more available in stable manure than in the green clover? No; it certainly is not. I base this declaration on the careful experiments of Lawes and Gilbert.

Whether it would be better to plough the mulch under in the spring before planting and seeding, or only disturb the friable and crumbling mould enough to receive the seed and young plants from the hot-beds, must be a matter of experience or knowledge gleaned from such works as Henderson's *Gardening for Profit*.

Besides clover for the market-garden you will find green rye of great value for all kinds of vegetables which can be sown or transplanted as late as the 10th or 15th of May. See the fourteenth chapter, Rye as Green Manure, for very strong testimony upon this subject.

You may plough in a heavy crop of clover in August or September and sow three bushels of rye per acre, and have fifteen tons per acre of good green manure to turn in by the middle of May.

CHAPTER XXVII.

GREEN MANURES FOR THE ORCHARD.

FRUIT trees of all kinds should be planted in a rich field well set with clover. In June, or whenever the crop is in blossom, you should cut the clover and rake it up and mulch every tree. This covering should be about one foot deep, and should extend not less than six feet from the body of the tree in a circle all around it. This mulch will last three or four years. But you must not forget every fall to open a space around each tree about twelve inches wide, to keep the field-mice from cutting the bark. And if the rabbits are plenty on your farm you must protect the bodies of all young trees by wrapping something loosely around them, extending from fifteen to eighteen inches from the ground.

Old bark from other trees, such as the oak and chestnut, will answer the purpose. In fact, anything will do that will protect the tree.

Where stones are plenty they may be so carefully piled around the trunk as to form a protection for years against every bark-destroying animal.

I had a fine young orchard nearly killed by rabbits eating the bark off near the ground and nearly girdling every tree. This was done before I was aware of the danger. I could scarcely believe that so much injury had been accomplished by a few rabbits till I gave permission to two hunters to shoot them; but when they killed thirty-five in one day I saw at once that my Farm was still entitled to its early reputation as being a place very attractive to gunners, and that all my fruit trees were in danger.

The first crop of clover, you recollect, is all devoted to mulching the orchard. Every year after this you must cut down the

green clover twice or three times and leave it spread on the ground to protect and improve the soil.

The apple, pear, peach, quince, plum, apricot, cherry, grape, strawberry, gooseberry, currant, raspberry, blackberry, and indeed all things that grow out of the ground, are greatly benefited by a thick mulch, particularly of clover. Besides this, some trees require a careful examination about their roots to destroy all worms that infest them. The peach above all others needs this inspection.

If the clover does not re-seed the ground, and thus keep the orchard well set with it, you should sow half a peck or more per acre wherever it appears to need it. Do not suppose the seed will not grow.

William West of Upper Darby on his fine grazing farm "found it necessary to sow clover thinly on the green grass sod every three or four years to correct a slight tendency which green grass has to bind the soil." If clover-seed will grow on such a sod, there is almost a positive certainty that it will grow beneath a mulch on a field of clover. If it will not, there is either a want of nourishment or the surface of the ground is too loose for the seed. Commercial fertilizer and lime will correct the first, a heavy roller properly used will remedy the second.

CHAPTER XXVIII.

ON DIVIDING THE FARM INTO FIELDS.

IT would be doing great injustice to the admirable system of farming with green manures to make no comparison as a matter of economy between it and the common mode of tillage.

When you plough in green crops you enrich the land without the necessity of making manure by grazing and feeding animals. Hence you save the great expense of erecting new fences every few years and the annual repair of old ones. What few horses and cows you are obliged to keep may run on lands that are never ploughed, or be kept in small enclosures by a judicious system of soiling. Few persons are aware of the cost of keeping a large farm well fenced into seven or eight fields until they have tried it for a number of years. To give you an idea of the immense outlay required for this kind of farming, I will quote two reliable authorities.

In the "*Year Book of Agriculture*" Wells says: "The amount of capital employed in the construction and repair of fences in the United States would be deemed fabulous were not the estimates founded on statistical facts which admit of no dispute."

Burknap, a well-known agricultural writer, says: "Strange as it may seem, the greatest investment in this country, the most costly productions of human industry, are the common fences which divide the fields from the highways and separate them from each other.

Here is a revelation so startling, and yet so true, that it should set every thinking man to a close, careful, and calculating investigation before erecting another panel of inside fence.

And when he sees all these structures which divide his farm into fields going down to dust by a decay which no human agency can prevent, he will rejoice to learn that he can save nine-tenths

of all this expense by adopting and combining together the green manure and the soiling system.

When I bought my Farm I found it divided into eight enclosures. But, strange to say, not a field had a name by which you could write or speak of it. I at once gave every lot a characteristic name. I give them here, to show you how easy it will be to know and remember them:

Littlefield is the smallest enclosure; *Brookfield* has a little stream of water running through it; *Clearfield* has no obstructions in it; *Woodsfield* has a woods in it; *Gullyfield* unfortunately has two gullies in it; *Springfield* has a cool spring of water in it; *Rockfield* has many rocks in it; and *Meadowfield* is a permanent meadow, which has a large run of bright water flowing through it from west to east, which divides the farm into two nearly equal portions. With this arrangement it is very convenient to charge every field with all we put on it, and to give credit for all we take off it.

My system of farming does not require the inside fences to be kept in repair, but we let the old landmarks remain. There is an advantage in having the farm laid out in fields, even when there is no necessity of erecting fences on the dividing-lines. The crops themselves are generally sufficient to show the boundary of each lot. Besides this, every field should be carefully measured and the number of acres noted down, so that you can tell without guessing what quantity of seed you may have to buy or how many tons of lime or fertilizers will be required for any particular field.

I remember seeing a statement that the Hon. Josiah Quincy on his large farm tore out seven miles of inside fences when they were getting too old to be of any value, and instead of erecting new ones adopted the more economical method of soiling all his cattle. By this plan he found that he could keep as many animals on twenty as he formerly could keep on sixty acres in pasture.

We are glad to find that the experience of many others coincides with his views.

Colman in his *European Agriculture* says: "That a great saving of food is effected by soiling there can be no doubt; no one rates it at less than two to one; many say that three animals, some assert with confidence that four animals, can be well kept upon the produce of land, if soiled, where not more than one could be kept if depastured."

Now, it is a common remark that if you make your land so rich that one acre will bring as much grain or grass as two acres would, but a few years before, you really double the size of your farm. This may seem like a paradoxical expression, yet if you double the productive capacity of your land it is certainly much better than to purchase a poor farm alongside of it. The man who owns one hundred acres of good tillable land which he has always devoted to grazing may well say that he is now running a three-hundred-acre farm if by soiling he is fattening as many cattle on his one hundred as others are doing on their three hundred acres. And this is fact, not fiction.

I think I hear the reader say, "Will you please to tell us something about the expense of cutting grass and other things and feeding the animals?"

In advocating the new system of soiling to save the expense of fencing, and to leave many broad acres flourishing in rich crops for green manures, we ask a complete modification of the old-fashioned way of stall-feeding. You know well that more than half the manure of animals is in a liquid condition, and cannot be saved in the stable or in the yard without great expense and trouble.

What, then, shall we do? We must combine the folding with the soiling method. We must put up a temporary fence, enclosing a half or one or two acres, and feed all the horses and cattle in this pen, and thus save all the liquid and solid excrements where they can be used without the labor of removing them.

We need not make any estimate of the amount of green corn or clover which will grow on this lot the next year. It will be so *rank* you will never get tired looking at it.

But how shall we shelter the animals from the hot suns of July and August?

That will be much easier than you suppose. A few crotches firmly planted in the ground and covered with corn-fodder or straw will make comfortable shade for them, beneath which the air will move in a gentle breeze.

This plan will be far more healthy than shutting the cattle up in the stable.

I always tell my patients to live and sleep as much as possible on the healthiest side of the house, and that is the outside. The same device is applicable to all creatures.

As this chapter has been devoted mainly to pointing out the difference between soiling and grazing, I cannot conclude without calling your attention to the appearance of the country in July 1880. For many miles around the city of Wilmington, Del. the pasture-fields were brown and bare and apparently destitute of verdure. The grass was nearly dead. The hungry animals wandered over the fields, and in many places found nothing but weeds to eat. It was more than two months since a deep wetting rain had fallen.

What better opportunity could occur to compare the merits of the two systems of feeding cattle! The sown corn was green, fresh, and vigorous; the drought had not withered it. The quantity was lessened, yet so little had it suffered from the dry weather it was still in a growing condition and was cut daily and fed to the stock on the farm. What a contrast between it and the dead grass of the fields!

Every farmer should put in one or more acres of sown corn, for green feed that he may be independent of all drought. By folding and soiling together we accomplish a great desideratum, the concentration and conservation of plant food upon the soil, this is a fundamental requirement of successful farming.

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