THE SCHOOL
AND FARM
— EGGERT —

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The School and Farm.

A TREATISE ON THE ELEMENTS OF AGRICULTURE

BY

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WITH INTRODUCTION BY

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Editor of Iowa Homestead

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the School, Farm and Home.

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ACKNOWLEDGMENTS.

The author has based his book largely on his personal experience in the management of a small farm for more than twenty years, though he has repeatedly owned and managed a larger farm. But he is under special obligations, which he gratefully acknowledges, to the labors of many distinguished specialists. At an early age he studied, in Germany, THÄER'S PRINCIPLES OF AGRICULTURE, one of the fundamental works on the subject; a little later he was initiated into the investigations of JUSTUS VON LIEBIG, incorporated in his LETTERS ON MODERN AGRICULTURE and his ANIMAL CHEMISTRY. The botanist SCHLEIDEN, the physiologist JAMES MOLESCHOTT, and other distinguished scientists were his teachers at about the same time. He followed up studies of this nature in England, where MECHI and JOHNSON, in France, where BOUSSINGAULT carried on work similar to that of THÄER and LIEBIG. Since then many distinguished writers have popularized and expanded the work of their great predecessors. In this country, ORANGE JUDD has been very active and very successful in agricultural and horticultural journalism. His successors in the AMERICAN AGRICULTURIST and PRAIRIE FARMER have continued his work with eminent success, while many other periodicals, in this country and abroad, have rivaled these in useful and efficient work, the RURAL NEW YORKER in the East, the IOWA HOMESTEAD and the IRRIGATION AGE in the West being specially noticeable among them. Among promi-

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nent works on the subject the following may be mentioned: TERRY'S OUR FARMING, MORTON'S NATURE AND PROPERTY OF SOILS, BAILEY'S PRINCIPLES OF AGRICULTURE, KING'S THE SOIL, ITS NATURE AND MANAGEMENT, HENRY'S FEEDS AND FEEDING, WILEY'S PRINCIPLES AND PRACTICE OF AGRICULTURAL ANALYSIS. To these and others the author is indebted for valuable information, and in addition to these, to many excellent articles, lectures, etc., contained in the agricultural reports of different states. Special acknowledgments are due to the admirable YEARBOOK published by the Department of Agriculture under the enlightened and competent direction of the SECRETARY OF AGRICULTURE, the HONORABLE JAMES WILSON, whom the author has had the pleasure and the honor of knowing personally during his long connection with the University of Iowa.

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PREFACE.

Ex-Governor W. D. Hoard said not very long ago: "I know of nothing in the curriculum of the average country school that tends in any matter whatever to encourage a farmer's boy to be a farmer. On the contrary, very much that is taught therein rather leads him to believe that there is not sufficient scope for his intellect and ambition in agriculture."

This remark is so pertinent that it has been frequently quoted in Farmers' Institutes. It has never been contradicted.

It is in order to meet the want pointed out in the remark that the present little volume has been written.

The author does not flatter himself to have done the impossible, but he ventures to hope that a careful perusal of his book will have a perceptible influence in modifying the low opinion of many farmers' boys of the value and dignity of their fathers' profession.

The book will also answer the purpose of the general reader who is interested in the principal industry of the country, and as a

PREFACE.

work of ready reference on the various topics of which it treats. To this end it has been provided with a full index.

While success in farming, as in every other pursuit, depends in the first place on such practical work as no book can properly teach, the stimulus of thought and information, found in appropriate reading and study, will help success by increasing the mental power of the reader. The importance of the connection of agriculture with science should be understood, and likewise the relation of the farming industry to the other industries of the nation. The farmer, while his work is the most important, is not the only worker; he is the most important member of human society, but not the whole society. Attention has been called to these matters in special chapters.

While the author knows perfectly well that on any of the topics he has presented a great deal more might be said than the compass of this work permits, he hopes that his book may help, not only to diffuse useful knowledge, but to contribute its share in the education of the rising generation to a noble type of intelligent citizenship.

INTRODUCTION.

IN exchange for the benefits conferred by civilized society and a stable government, the average man must *work*. To shun labor is therefore to go back to the blanket stage, and the educational system that does not fit both mind and body for some specific duty in life must step down and out.

But a distinction must be made between work and drudgery. If all are obliged to labor, then clearly the joy of living must be found in one's daily duties. Drudgery is synonymous with ignorance. In early times when soils were rich, implements crude, and keen competition unknown, there was necessarily much drudgery connected with farm life. Muscle ruled in those days. There was but little draft upon gray matter. Conditions have undergone radical changes, however. Soils have become more or less impoverished, competition has arisen in every line of production, insect enemies that prey upon crops have increased, as well as fungous diseases,—all of which but signifies that successful agriculture requires the highest type of ability. Success under present conditions implies an intimate knowledge of soils, plants, animals, insects and diseases of animals and plants. A mind stored with a knowledge of these essentials is fortified against disaster. One may call it science

or whatever he chooses, but this thing is certain that the producer who will combine a knowledge of these things with a fair amount of industry is bound to succeed. In no profession can the outcome be calculated with such mathematical accuracy.

This little volume has been prepared with two objects in mind. In the first place it is the belief of the author that much may be done by way of checking the migration of our young people from the farm to the populated centers, by imparting to them more accurate information concerning the every day affairs of home surroundings. Such information, in turn, will tend to convince them that successful farming requires just as brilliant talents as does any profession or business, and also that energies intelligently directed along this line are absolutely sure of liberal reward. In the second place, those who are now actively engaged in agricultural pursuits have been kept in view, and the volume prepared to suit their requirements. In other words, it has been the intention to make it a sort of handbook on things agricultural, a book to which the producer may turn at all seasons of the year for guidance. Without loading it with technicalities, it has been the endeavor to embody in its teaching the latest discoveries in the science of agriculture.

Jas Atkinson.

May 15, 1902

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PART I.

THE BASIS AND CONDITIONS OF FARMING.

CHAPTER I.

THE PROFESSION OF FARMING.

It is now almost fifty years since a bright boy was hoeing weeds in his father's garden. The boy did not like his job. He was fond of machinery and wanted to work in a machine shop. He had no idea of being a farmer, and yet he became after a while a very successful farmer, one whom everyone admired on finding out how he had managed to make farming a success on a small worn-out farm. The boy grew up to be a man without ever having lived on a farm. His father had sent him to college, but college work made him sick, and the doctor said, "If the young fellow does not do something that will keep him in the open air, his life will be in danger."

At the age of 22 the young man married. From ignorance, and because he was too trustful, he bought a worthless farm, or one which was generally considered worthless, incurring a debt of more than three thousand dollars. In about twelve years or so he man-

aged not only to pay off his debt but to make his farm of less than 50 acres pay him a net annual income of over two thousand dollars. He then built a fine house for himself and family and is now one of the men everyone wants to hear at Farmers' Institutes because what he has to say is sensible and true. He gained this knowledge by working the soil and by thinking.

He was 26 when he moved on his farm for which he could not find a tenant who would pay him anything. He had a hard time the first winter and spring to keep his cattle alive. He lost three cows from starvation and unavoidable exposure, and a neighbor told him that he had in past years helped to skin as many as ten cows on the same farm in spring that had died because the barn was so wretched and the feed so poor.

The young man had to live very economically and to work very hard. His farm contained at first 125 acres, but of these only about 30 acres were fit for tillage; some 15 acres, covered with scattering timber, were made useful for cultivation later, so that the total number of acres on the farm that could be turned to any use was 45. The most of this was rather poor land, and only a few acres could be called good. There were many stumps which had to be removed at considerable expense, and many swamps, so called cat-swamps, which caused great trouble until they were drained. This could be done at once, but required much time and labor.

Now with all that debt and the other drawbacks the young man worked on, improving his soil by laying drains of good drain tile, and enriching it by carefully spreading manure on his meadow land and on clover. He raised no crop for which the land had

not been previously enriched by a crop of clover, plowed under after it had been well manured and the manure well spread, and he thus managed to harvest heavy crops of wheat and especially of potatoes.

He worked with his head as well as with his hands, and astonished his neighbors by the crops he raised, so that it was generally believed that his land was of extraordinary fertility. But in this they were mistaken. It was proved that the most of his land was originally poor rather than rich, and that his success was due to his knowing how to do things in the right way.

The name of this successful farmer is T. B. Terry, and his home is near Akron, Ohio. Mr. Terry has demonstrated that farming pays if it is made a *profession*, and that the *professional* farmer may succeed where all others fail wretchedly.*

No one needs to be told nowadays that, in order to get a thing well done, we must have it done by a specialist. A specialist does a certain thing, or a certain line of work, every day in the year. He does not change about from this to that, but seeks to acquire perfection in the work he understands. We consult a dentist, a lawyer, a preacher for various ailments of mind and body; we buy our watch from the best watchmaker and our wagon from the best wagon-maker. It does not occur to us to ask our blacksmith to repair our watch, nor our watchmaker our plow, nor do we consult our lawyer about the right way to heaven.

It might seem that the rule does not apply to the

*Mr. Terry has written an admirable work on agriculture, entitled "Our Farming," in which he relates his own work and experience.

farmer. People will buy their wheat or oats, their potatoes or corn wherever they can be had, be the raiser of these articles a bungler or a man of great skill and long experience. They say, these things grow of themselves, if once sown or planted. The elements take care of them and man has scarcely anything else to do but to guard them from being ruined by careless people, or from being choked by weeds, or trodden down by cattle. In this sense, it may be admitted, any one can be a farmer. But is there, then, no difference between a first-class farmer and a bungler?

If we examine what farming really means, we shall see that there is such a difference, and a great one. The bungler lets his land run down so that his crops are poorer from year to year. The true farmer raises good crops as a rule, and often succeeds in raising more to the acre than any of his neighbors. The bungler grows poorer, the professional farmer grows steadily in wealth.

The farmer is the engineer, so to speak, of a vast machine, his land. The land will bring forth according to the seed that is in it, but it wears out like any other machine, and as it wears out the weak or missing parts must be repaired or restored. But what are these parts? They are not exactly the same for all crops, but all crops weaken this machine, and the work of restoring worn-out parts should never cease.

In another sense the soil may be compared to a bank. It is only what you put into your bank, and what you leave in it, that enriches it and enables you, in due time, to draw from it a heavy interest or dividend.

In order to work the soil tools are needed. Experience and good judgment are necessary in the selection.

of these tools, and in this also the professional or special character of the farmer appears.

We might include among these tools the animals used for cultivation, and again others which consume the products of the field and thus reduce them to a smaller bulk before they are sent to market. To do this economically, and with the greatest possible advantage, again calls for the skill of the specialist, the professional farmer.

For these and other reasons we must class the business of the intelligent farmer among the regular professions, and for his profession we claim an even greater importance than for any other. From this point of view we may consider somewhat in detail the various branches in which a professional farmer should be proficient. We must assume, of course, that a man who wishes to be a good farmer will apply himself early and late to the work he has in hand. Without work and considerable push and energy no amount of mere knowledge of how the thing should be done will be of any use in any calling.

The proper kind of soil and of the implements needed to work it; the right kind of stock, cattle, pigs, horses, etc., to be raised or used on it, and a market at a convenient distance; all these are necessary to enable a farmer to pursue his profession properly. He may have to begin under great discouragements, and it may take him a number of years before he can call even a small farm his own. But if he keeps up courage and continues to work and to study, success will come at last, as it has come to many others.

There is some general knowledge a farmer needs in common with other men. He must know some-

thing about *sanitation*, that is, how to prepare a suitable and healthy dwelling for himself and to give shelter and protection to his stock. A farmer need not be a house builder, but he should know the principles that will enable him to put his house in the best position as to drainage and other health conditions, to have an abundant supply of pure water, both for his family and for his stock, and he should know enough of the art of roadmaking to do as much as the finances of his district permit to build the most necessary roads. The progressive farmer should know what is being done in his profession by others, and he should at least know the foundation of the sciences that are of special importance to the farm and its products.

It will be seen from this that a good farmer must exercise his brain no less than his hands. If he has a well tilled farm and a comfortable home, he is a little king on his own territory. He is not compelled to inhale the disease-laden air of the city with its clouds of dust and masses of filth. He can breathe the pure health-giving air of the broad country and rejoice in the feeling of bodily vigor which surpasses all the nerve-exciting and weakening amusements of city life. The tilling of the soil changed the feudal aristocracy of Europe into peaceful members of the State, and to this day the aristocracy of the progressive European states is based on the ownership and cultivation of the soil.

CHAPTER II.

THE SOIL—FORMATION OF HUMUS.

The ancient Greeks had a story of a giant who was the son of the earth. His name was Antæus. It was said of him that his immense strength was due to his relation to his mother, and that as long as he was in contact with her no one could conquer him. Antæus was met by Hercules, another of the fabled strong men of antiquity, and the two fought for a long time. Hercules threw Antæus to the earth again and again, but, strengthened by his mother as he touched her, Antæus rose every time able to fight more vigorously than before. At last Hercules, finding out the cause of his opponent's strength, lifted him high in the air and there strangled him.

The story has often been quoted as illustrating the great truth that the strength of every human being is drawn from the earth, and that those who cultivate the earth or remain in contact with it one way or another, as hunters, herdsmen, farmers and gardeners, are the most vigorous members of the race, the conquerors of the earth.

This truth has often been proven in history. As long as the Romans honored agriculture and lived largely on their own land, their hardy men from the country overcame all nations. The time came when agriculture was the business of the slave, when the freemen flocked to the cities. Then came the downfall

of Rome under the irresistible onset of the hardy Germans, who were strangers to city life. The herdsmen and farmers of Switzerland showed in many a victorious battle what it meant to live in close touch with the soil, the earth, our common mother. The country people of New England resisted manfully the power of England, and the poet points to the scene of their heroic deeds:

"Here once the embattled farmers stood
And fired a shot heard 'round the world!"

If the earth gives us strength we may inquire what its nature is. Geology teaches us the names and the composition of the rocks, that are so to speak the ribs and the backbone of the earth. The soil from which we draw the food on which we live was itself once rock, and all our tillable soil is the product of a slow and long continued process of crumbling to pieces, or *disintegration*, of the primitive rocks. If we dig deep enough we find below the oldest soil, though often at a very great depth, the same hard rock that we see in the mountain that towers into the clouds. As these rocks differ so differs the nature of the soil which they produce. Sandstone produces sandy soil, the granite and kindred rocks produce clay soil. As the rains wash the crumbled and disintegrated particles down to the lower land, the valleys or plains, they often become mixed. This accounts for soils that are part clay, part sand.

How this happens can be best observed wherever there are hills or mountains. On apparently bare rocks we may see a thin crust of vegetable growth called lichen. After a while mosses may follow. In

the shelter of these a seed of grass, or, maybe of a shrub, and sometimes of a tree, may lodge and find sufficient moisture to strike its roots. The thawing and freezing process of ice and water in cracks or inequalities here and there will deepen these into fissures and crevices and afford a chance for a certain amount of moisture to stay and feed the roots that penetrate into them. As these roots gain strength and multiply they will loosen the rock and thus prepare a bed of soil which will deepen from year to

FIG. 1—Rock in the process of disintegration; vegetation and humus on top, followed by coarse subsoil, then rock in pieces and finally solid rock.

year, from century to century. (Fig. 1.) If the rock presents a slope so that the water will not stay on it, the mere action of it on the rock, continued for ages, will dissolve or loosen parts of it. These will be washed down the slope and afford places for chance seeds to germinate and develop, while the finer part of the soil thus produced will be washed down into the valley where a watercourse will receive it and spread it far and wide in consequence of the rise and

fall of the water, caused by the more or less abundant rains in the changing season.

Hence it is that the best or most fertile soil is

Fig. 2—Soil formation at the foot of a rocky hillside. (c) portion worn away; (1) debris without soil; (2) debris reduced to fine particles and mixed with soil—some vegetation has started; (a) solid rock.

found in the lowlands, along the rivers, and often in swamps and bogs. (Fig. 2.) We have seen that in order to obtain any vegetable growth it is necessary

that moisture strikes the soil and stays on it for a while. But if it stays on all the time the vegetable growth we desire is either prevented or at least made difficult. Hence the necessity for drainage, either natural or artificial. Nature insists on steady movement: she has placed her curse on stagnation.

We have thus far spoken of the general process of soil formation. It remains now to account for the vegetable growth on the primitive elements of the rock. We have mentioned moisture as the necessary condition, and no further proof is needed to support this statement. But all moisture is quick to disappear by evaporation under the effect of the sunlight and the winds. This is most clearly seen on the steep hillsides, on sandy soils and on land that lies in ridges so as to present as much surface as possible to the rays of the sun and the movement of the air; but it also appears on level and clayey soil. How then does nature proceed to retain the necessary moisture for plant growth?

When we examine the upper layer of wild prairie land that shows its fertility by an abundant growth of grasses and other plants, we shall find it very dark and almost black. What is the cause of this dark color? It is not due to the original soil, for this may be almost pure sand or yellow clay. The observer will say that it is the effect of decayed plant growth. The prairies have produced grass crops for countless centuries. As the older plants died off new ones took their place, on top of the decayed or decaying remains of the earlier plants. Gradually the soil grew higher by the accumulations of decayed vegetable matter. We find soils the dark outer layer of which extends

from 12 to 20 inches in thickness. This black mass of decayed roots, stems and leaves is called *humus*.

Humus has the peculiar quality of retaining moisture and with it some of the most essential elements of plant growth. The humble lichens and mosses begin the work of producing humus; the grasses continue it. After a while all other plants, among them trees of the largest size, grow by means of it and enrich it. The way to renovate worn-out land is therefore to provide the conditions of vegetable growth of some kind and to leave it on and in the soil. If grass seed be sown, or clover, or if the soil be allowed to grow a crop of weeds, or even grain, and the crop is plowed under, the land becomes enriched. The process is called green manuring.

CHAPTER III.

THE SOIL AND ITS FERTILITY.

On the 2d and 3d of May, 1863, was fought the battle of Chancellorsville in Virginia. The victory remained with the Confederate army, chiefly because their best general, Stonewall Jackson, succeeded in surprising a Federal corps which had been ordered to take up a position on the right. Here was found a thick growth of young trees, much underbrush, and enough open space to permit troops to advance. This growth made it possible for an enterprising enemy to come so near the Federal camping ground as to surprise the men there resting.

Now, why was this ground covered with trees? It used to bring forth heavy crops of tobacco and was of great value. But tobacco is an exhausting crop; that is, it takes from the soil mineral parts which the crop needs, and it takes so much of them that the best soil soon becomes poor unless what has been taken from it is returned to it. This had not been done, and the owners of the land finally abandoned it as worthless. Then nature began her work. By allowing these trees to grow she commenced her work of renewal. In course of time the trees, by the shedding of their leaves, produce a layer of rich soil. Their roots draw the mineral matter from the depth of the land as far as they can reach, and a part of it is deposited in the leaves. In this way much land was made

fertile in the ages gone by, and this fertility can be kept up by careful attention to the needs of the crops, and it can be regained in the same way.

In the case of tobacco we note that this plant contains an unusually large amount of potash. If we burn up a tobacco plant we find that the ash remaining forms from 15 to 20 per cent (that is, about one-fifth, or less) of the entire plant. This ash contains a compound which is extremely poisonous, called *nicotine*. The ending *ine*, or *in*, stands for some peculiar poison that is found in tobacco, in coffee, tea, cocoa, the bark of the cinchona tree, etc. In the ash of the coffee we find coffee-ine, written *caffein*; tea contains tea-ine, written *thein*; cinchona bark, *quinine*. Now, unless the soil contains the elements to form this compound (or mixture), tobacco, or coffee, or tea, etc., cannot be grown. What is true of these more or less harmful products of the soil is true also of the grains and of any other crops, even weeds. No weed could grow unless the soil contains enough of the mineral parts which are found in the ash of such weed.

There is an element called *phosphorus*, which combines with that part of the air which is called *oxygen*, and forms compounds, called *phosphides*, and in other combinations, *phosphates*. A soil deficient in phosphates cannot grow wheat or any similar plant.

But all the elements needed by any plant are found in the body, or the parts that make up the body, of animals. It is therefore found in the droppings, and more especially in the urine of animals. The bones are rich in phosphates. A careful farmer will save all the manure he can and especially the liquid part, by providing his stock and his horses with litter, gen-

erally straw. When this is scarce, sawdust or even dry earth will answer the purpose. By returning all barnyard manure to the soil, the fertility of the latter is maintained, and if lost it may be restored by continuing this work.

In order to know what peculiar elements it may be necessary to add to the soil in order to hasten the process of renovation, or to increase the natural fertility of the soil, it would be necessary in very special cases to apply to a specialist, that is, to some person who knows chemistry and understands the nature of soils and crops. Such persons are now found at agricultural colleges.

A practical and careful farmer who knows how to prevent waste in his manure pile will not be obliged to use many special fertilizers. Barnyard manure is a complete fertilizer, as it contains every element of plant life, but sooner or later some special or commercial fertilizer will have to be added. The necessity of manure will be more fully understood when we consider how large an amount of fertility each crop takes from the soil.

If we raise 1,500 pounds of tobacco on an acre, an average crop, the soil will lose 50 pounds of potash, 15 pounds of phosphoric acid, and 70 pounds of *nitrogen*. As for the nitrogen, there is an immense supply in the air which we breathe. It is a gas and useless for crops unless changed into compounds, called *nitrates*, as for instance ammonia or saltpeter or soda. Although over 80 per cent of the air is pure nitrogen the soil may be so greatly in want of nitrates that its fertility is very low and insufficient for the raising of a paying crop.

All crops need nitrogen. In 20 bushels of wheat, the average raised on an acre of good soil, we find 40 pounds of nitrogen, 18 pounds of potash and 15 pounds of phosphoric acid. Two tons of hay may be raised on an acre of land from which this crop will take 56 pounds of nitrogen, 60 pounds of potash and 14 pounds of phosphoric acid. It is clear that such a drain on these elements of the soil cannot go on for many years without exhausting its fertility.

Is there no other way to maintain or restore the fertility of our soils?

This question may be answered thus: If we can afford to wait until nature does the work of renovation, the fertility would come back after a while. Something would grow on the land. While some weeds cannot thrive, others will. These will run down their roots and bring up mineral matter from below. Rotting on the surface, these weeds will gradually restore the former fertility—if we can wait long enough. But a farmer cannot afford to wait so long. In former times it was the custom to allow one-third of a farm to remain idle, or *fallow*, in order that it might recover from previous exhaustion and be ready for the crops of the two following years. But this system has now been discarded by all progressive farmers. Another plan is far better.

We have noted that plants need nitrogen, and that there is plenty of nitrogen all around and over us. Wherever the air can go through there is of course nitrogen, and in a loose and mellow soil, especially if well drained, the air is present everywhere. But how are the roots to get hold of it? Unless changed into a *nitrate*, this nitrogen is perfectly useless, as useless

for instance as for animals and human beings is the mineral and other matter which may be turned into wheat by the wheat plant, but which they cannot use for food until it is changed into grain by the growth of the plant.

This leads us to the consideration of the most interesting as well as important family of plants, such as *clover*, *peas*, *beans*, *alfalfa* or *lucerne* and a few others.

Fig. 3 —Root of a legume showing knots or nodules or tubercles.

The name of this family of plants is *legumes*, and they are spoken of as *leguminous* plants. In olden times, when our methods of harvesting and threshing were not even thought of, the pods of peas, beans and lentils were picked and gathered by hand. This was expressed by the old Italians or Latins as *legere*, and the word *lego*, meaning "I gather," was so changed as to form the adjective *leguminosae*, which is Latin for *leguminous*.

Pull or dig up a clover plant, being careful to save

its roots. You will notice here and there on the far spreading roots little wart-like growths, knots or nodules, to which it is customary to give the name of *tubercles*. (Fig. 3.) These are due to parasitic plants so small as to be invisible to the naked eye. Scientists have given to these little plants the general name of *bacteria*, but there are many varieties of bacteria, some living on others, so that we see in these lowest beings the same strife that we find everywhere else in nature. Some bacteria are very hurtful to man, causing or aggravating sores, boils, etc., or attacking delicate parts of the body and producing fevers and other diseases. But others are useful, and so are those which form these tubercles on leguminous plants. It has been shown that these tubercles have the ability to draw nitrogen directly from the air and change it into nitrates. Hence, by sowing clover and plowing the crop under, we furnish to the soil a large amount of plant food, and thus restore or retain an important part of the elements that make up its fertility. Good farmers now raise clover for this very purpose. They take from the land one or two crops of clover hay, then plow under the stubble, when it is found that the roots contain enough fertilizing matter to secure the success of some other crops, as wheat, corn or potatoes.

But the better way is to manure a clover field heavily after taking one crop and to plow the next one under. The manure thus stored in the soil, with the clover roots and a part of the green tops, will furnish plant food for several years, and in order to raise several good crops in succession it will now be necessary only to till the soil very thoroughly, and secure good drain-

age. Of the necessity and advantage of good tillage and drainage we will speak in another chapter.

Soils are mostly classified as sandy, loamy and clayey. But there is a great variety of soils, owing to the fact that the sand, clay, humus and various mineral matters, such as lime, are found mixed in various proportions in different soils. A farm of 100 acres may contain in one part stiff yellow, or even blue clay; in another pure sand, in a third black soil, rich in humus; in a fourth a calcareous soil (rich in lime); and possibly an alkaline soil containing an excess of potash or soda. In addition to these there may be some acres of swamp containing muck. Nor is this all, for there may be fields which show a mixture of any or all of these.

This is due to the effect of water at the time when the land was forming. The overflow of lakes and rivers accounts for such differences. In New Jersey many farms contain marl beds. Marl is a deposit of lime and other matter which has been found very useful for the improvement of barren land. The New Jersey farmer digs down into his marl bed, carries away the valuable contents and enriches his sandy soil so that his land will bear crops that rival or surpass the crops of the Western farmers on their rich black soil of prairie land.

CHAPTER IV.

ELEMENTS AND CONDITIONS OF PLANT GROWTH.

Every plant and every animal body must have a sufficient supply of all the elements which they contain in order to grow and make good the inevitable waste. By far the most of these elements are to be had without cost. They are found in the air and in the water of springs, rivers and lakes, and enter the soil through the air, the rains, snow, dew and by irrigation. All human beings as well as all animals breathe out a gas called *carbonic acid*, which is the most essential food for plants. The plant, on its part, breathes out, by means of its leaves and under the influence of the sunlight, another gas, called *oxygen*, which all human beings and animals need to sustain life. Animals breathe by their lungs, producing carbonic acid; plants breathe through their leaves, producing oxygen. This is a beautiful arrangement you will say, and so it is. The growing grass, the leafy woods, the fertile orchard: all give forth the elements we absolutely need, and we in return breathe out the element that they need and without which they could not exist at all.

Water contains two gases, oxygen and hydrogen, which, combined, form a liquid. Oxygen means sour-maker, from its quality to turn milk sour and to produce similar changes in other material. Hydrogen means water generator, as it is the essential part of all water. About one-fifth of the body of air around and

above us, the *atmosphere*, is oxygen, while two parts of water are pure hydrogen, the rest being oxygen.

If we set fire to a lot of straw we find that the straw disappears in a flame and in smoke, leaving behind only a small heap of ashes. The ashes consist of mineral matter, chiefly *silica* and *potash*; the flame and the smoke are made up of *carbon*, the principal element in carbonic acid (the other being oxygen), and oxygen. Carbon combines with oxygen to form a great variety of vegetation, but under certain circumstances the two will combine so as to form a flame and smoke. The latter contains also the vapors of water, hence hydrogen and oxygen. Carbon is not a gas like oxygen or hydrogen, but a solid. It may appear as pure coal, as wood, as leaf, flower, stem, fruit; again it may assume the hardness and brilliancy of the diamond, or the pleasant form and taste of *sugar*, or take the form of lard, tallow, oil and butter. All these substances are forms of carbon.

Carbon is therefore the most essential part of the plant, and as it and oxygen are always present in the air, and as water is also present and periodically enters the soil in the form of rain or dew, it follows that by far the largest part of the elements that make up any plant are gratuitous; they cost nothing. Another gas which the plant needs, nitrogen, has already been spoken of. It appears in the soil, as has been explained, only in the form of nitrates. They are chiefly needed to form the seeds of plants, and through them the muscles of animals. We say, therefore, that beans, peas and other seeds that we eat are *nitrogenous*.

The nitrogenous elements of food are absolutely required to sustain human and animal life. Sugar and

fat contain no nitrogen, hence a diet consisting of sugar and fat only, though both may be furnished in abundance, would lead to starvation. Some nitrogenous matter is found in other parts of the plant besides the seed. It can be fed to animals in the expectation that the animal will digest the food properly and thereby form its muscular flesh. We eat this flesh and gain muscular strength thereby, while we should starve to death if we had to rely on the supply found in plants apart from their seeds.

Some seeds are rich in oil; that is, they contain more carbon than others; but all contain nitrogenous matter, and some so much as to come very near to the value of flesh meats. These are peas, beans, lentils and their varieties. Flaxseed, or linseed, is particularly rich in oil. Corn is rich in starch, that is, carbon; but it contains nitrogenous matter enough to sustain life, though it is not an ideal food. Wheat is richer in nitrogenous matter, but this is found chiefly on the outer layers of the kernel, so that the whitest flour is poorest in nitrogenous or flesh-forming material. Feeding the bran and middlings of the wheat to cattle and pigs will produce the needed material in a more acceptable form. The parts richest in nitrogenous matter—that is, the bran, etc., of wheat and other grain—consist chiefly of the hulls and outer portions of the grains, which are not readily digestible by the human system.

If we sell butter and lard we sell carbon, which is always present and available, hence we do not deprive the land of any fertilizing matter. It retains its former condition. If we sell potatoes we sell largely water, for potatoes contain only a very small part of

nitrogenous matter. The rest is carbon (starch) and water, the latter making up 70 per cent of the whole. But such crops as grain of all kinds, peas and beans and also grass, need a considerable proportion of nitrates. Hence it is that they are more apt to exhaust the soil by continuous cropping.

We have already spoken (in Chapter II) of the necessity of humus for plant growth. In humus we have all the mineral elements of plants, and this is easily understood when we consider that humus is essentially the result of the decay of plants. It is readily known by its dark color; it is that which gives their black color to our prairie soils, and in them, especially along rivers in the so-called bottom-lands, the thickness of this black soil is often extraordinary. But continuous cropping and too shallow plowing, with no change of crops, may practically exhaust even these rich soils, or at least deprive them of some of the mineral elements without which a plant cannot live.

One principal use of humus is its capacity of holding moisture, but even this may be a drawback on low land toward which the surface water will naturally run. Such land retains the water, so that it sours the soil, or affects it injuriously by the coldness it produces. Such soil is known as muck. Muck is often hauled on poor land with good effect. On land not naturally poor, muck may not at times produce any effect whatever. If muck soils can be underdrained they will generally show an astonishing fertility.

Barnyard manure is rich in humus, in fact it turns largely into humus, if allowed to ferment. Moisture and warmth will produce fermentation which is accompanied by loss of nitrogenous matter, especially am-

monia, which is evaporated. It is easily recognized by its pungent smell. The fermentation is brought about by little plants such as we find in yeast, invisible to the eye, called *ferments*. Dry earth spread on fermenting manure will catch or absorb this ammonia. Lovers of window plants often gather in the woods the decayed remains of some old tree which contains pure humus. It has a dark brown color, and looks like mellow soil. If old enough this mass has given off most of its carbon, or carbonaceous matter; it then is very nearly the same material as ashes, containing most of the mineral elements of the tree.

The beginning of the growth of a plant can be readily seen in an acorn or a bean that has started to swell its germ. (Fig. 4.) In the acorn, as in all seeds, the plant has put away a new plant compressed into the smallest possible space. Moisture and warmth swell the seed, which then breaks open its outer covering or husk. In the bean, for instance, this takes place very readily. We then see what looks like two thick leaves. These separate a little, allowing a little tip, the germ, between them to expand likewise and to grow upward. At the same time it develops tiny roots at its base which rapidly grow downward into the soil. As the roots grow and become fibrous, the stalk grows higher, bringing the two leaves above ground, and developing new and proper leaves. The first two leaf-like growths were not true leaves but only bags containing food for the young plant. They wither and drop from the plant when their food supply has been used up.

The whole process of growth is therefore an unfolding of the seed and a developing of its parts in two directions, upward and downward. In order that it

may take place there is required warmth and light, though the plant will make some growth without the latter. There is no force working on the outside to

Fig. 4—An oak plant starting from the acorn.

Fig. 5—A young pea-plant.

give their natural shape to the roots, stem, leaves and branches. All these parts were already in the seed; that is, in the germ attached to the kernel. The kernel

itself, apart from the germ, is simply food for the young plant until its roots begin to work. (Fig. 5.) The whole further growth of the plant is mainly intended to produce new seed. Many plants, after ripening their seeds, wither and die, as for instance all our regular farm crops, with the exception of grass. They are *annuals*. A plant that needs two years to perfect seed, and then dies, is called a *biennial* (two-year plant); and one that produces seed year after year is called a *perennial* (lasting for years).

The conditions for the growth of a plant may be therefore summed up as follows:

1. Healthy seed. This means that the germ of the new plant must be uninjured, and the rest of the seed must have the proper food for the young plant as long as its roots cannot do their work.
2. Warmth and moisture. Under their influence the germ swells and unfolds, so that top, roots, stem, leaves, branches, flower and seed can form in due course of time.
3. Suitable soil. The soil must be porous (loose and open), so that air and water can readily enter and *pass through it*, and which contains no elements injurious to plant life.
4. Mineral elements. The mineral parts which the plant needs must be in the soil in such a form or combination as to enable its roots to use them for its growth.
5. Sunlight. The leaves cannot breathe out their oxygen without sunlight, and on this breathing out of oxygen depends the healthy growth of the plant and the ultimate production of seed. It is the sunlight that causes the green color of leaves by developing in them

a certain substance to which the name of *chlorophyl*, that is, "leaf green," has been given.

This interesting subject of plant growth belongs to the Science of *Botany*; that is, plant knowledge. It includes all plants, both useful and injurious. Agriculture deals only with useful plants and looks upon all others as enemies that must be destroyed.

In this sense any plant that grows where it is not needed is a weed. Where plants are crowded, a thinning out of those that are not needed is as necessary as weeding. The strawberry plant is remarkable for the abundance of "runners" it sends out. These runners weaken the parent stem and are as injurious as weeds.

To the botanist the process is an interesting study; for the farmer or horticulturist it means labor.

CHAPTER V.

DRAWBACKS IN FARMING.

No trade or profession is without its drawbacks. It would be strange if farming had none. There are injurious insects that spoil a part of the crop; there are seasons when it rains too much, and others when it does not rain enough; at times the roads are so bad, especially in late winter and early spring, that it is difficult to get on the land or go to town. Again, there is the absence of neighbors in many localities, so that life is lonesome and offers no variety; many farmers live too far from town to market their smaller crops and products, if they have more than they need, such as garden truck, butter, eggs, milk and poultry.

Every farmer should do his best to abate these injurious or objectionable conditions as much as possible. A frequent change of crops and clean cultivation will do much to get rid of the insect nuisance. Underdraining and surface draining, providing there are good outlets for the drains that will not choke up with mud, or be filled with water in wet seasons, will secure better roads. The ground will dry out much more quickly, and if the top of the road is so shaped, by plowing, scraping and rolling, as to be high in the center with a good slope toward the sides, and a continuous furrow is left on either side for the water to run off, there will be little trouble even in a wet season, while the road will be in first-class condition the rest

of the time. Underdraining to secure good common roads is practiced far too little, while yet a very large amount of labor is spent on roads which fails to secure the best result. If all the farmers of the township or of the county would work together, well drained roads might soon be the rule instead of the exception.

In thickly settled localities it is the aim of every progressive farmer to foster a public sentiment in favor of macadamized roads to be built by the county. Whenever pebbles or other small stones may be had for the hauling or at a slight expense, it is a good thing to haul as many of them as possible for roadways on the farm, as from and to the house and the barn, and also to make passable in bad weather certain parts of the farm over which a good deal of wheeling is done throughout the year. Where soft coal is used cinders should be spread on the road bed wherever needed. The approaches and surroundings of the barn should be especially attended to, because nothing is more discouraging for the farmer and his boys or his help than to have to wade in the mud while doing chores.

In building more solid roads, such as are known as macadamized (from John L. McAdam, the name of their inventor), it should be understood that thorough rolling of the gravel or small stones is indispensable in order to keep wheels from cutting through. Small stones, not over three inches in diameter, are to be used, as pebbles will not pack well, owing to their smooth surface. Spread a layer of stones, then roll, and spread and roll again until the road bed is thick enough. As the top wears out more stones must be put on, and well rolled to make a smooth surface on which no water can stand. Several farmers should join in

the expense for a good roller, or it should be furnished by the county. Roads of pure soil that are to be underdrained should have a tile drain on either side and a shallow furrow over it. Ditches are not necessary, and are objectionable, as they generally get choked up with weeds. The furrow over the drain must be renewed as often as it fills up with earth washed into it by rains.

The important subject of road making has recently received a great deal of attention. The states of Ohio and Indiana have built many hard roads, being favored by a supply of rock and gravel at hand.

It is claimed that other western states, not being so favored, cannot afford to imitate their example.

As the next best substitute the following plan was suggested at an Institute: "The only point for us to consider is how to build a good road without rock, sand or gravel. We ought to have a system in improving our roads and adhere to it closely. I would suggest the following plan: First, grade the road from fence to fence in a manner that would leave the middle of the road about two feet higher than the outer edges. To do this work I think an engine with a plow and grader would be the best, although it can be done with good teams. All elevations should be cut down, and all depressions be filled as much as possible, making an uniform and easy grade. All trees should be removed from the right of way, and be planted in future only on the fence line at not less than 100 feet apart, and then only hardy trees such as sugar maple, ash and elm, or walnut. The law should be enforced in regard to hedges and the trimming of them, and the roadbed

kept so that the mower can pass over every foot of the ground without cutting hedge brush or wire.

"When the grading is completed it should be well harrowed and rolled with a four-horse heavy steel roller, made in three sections, so that it will fit any ground and can be turned easily. The roller is to be used in place of the smoothing grader, especially in the winter months. It will do good work on rough, partly frozen ground where the grader could do nothing. It should be owned by the township, and be free for any farmer to hitch to when he wanted to deliver his grain to market. Notice of a cold wave coming is the time to give the road a round trip with the roller. Next comes the drainage—the most important thing in good roads. Tile can be run only at the outer edge of the roadbed, as a traveled track will not let the water down to the tile. The culverts should be as few as possible and should be made of sewer tile covered deep, and extend clear across the roadbed and be protected by a good stone or brick wall laid in cement at each end.

"The road is prepared for the regular visit of the smoothing grader, which can be run in each township one hundred days at a cost of \$500, which is only about one-third of the road and bridge tax usually laid in each township. Most of our roads are laid four rods wide and some few three rods. We ought to be thankful that we have the wide road. The properly graded wide road has virtually ten tracks for the wagon, while the narrow road has not quite eight, and in the long wet spell will be cut up more.

"We ought to adopt the wide tired wagon, and a law that exempts it from taxation, or gives a bonus for

its use, would help us to better roads. Finally, and last, all road taxes and poll tax should be paid in money, and the office of path-master be abolished. Let us pay more attention to the office of highway commissioner, electing only the very best men without regard to party, men who will work to a good plan and enforce the law in regard to obstructing the road in any manner with plow or hedge.

“A smooth road that farmers can mow will be kept free of weeds and in a short time will grow only blue grass or clover. Our roads should have all the sunlight and breeze that can be given them. Of course, shade is very nice on a hot summer day, but we can not keep a well shaded road in good order. It is sure to breed mud holes, and will have a good, solid road-bed only in midsummer.”—(Van Vleck, Philo, Ill.)

When farmers understand that a farm of 40 acres may yield more, if well tilled and intelligently managed, than one of 160 acres where the management is of the jog-trot, old foggy way, farm houses will be built nearer each other. This is the case in many sections, though the farms may be larger. Good roads would do away with the objection to farm life because of its loneliness. The women and the young people will not mind a ride of a few miles even in cold weather, and sociability can be kept up between friends and acquaintances without any sacrifice of comfort or risk of exposure. Our constantly extending and spreading net of railways will gradually put a good market within a reasonable distance of almost any farm, so that this objection also will have less weight as the years go by.

This is the century of electricity, as the last century was that of steam. We may soon see electric road-

ways, the trolley, the telephone and other electrical apparatus, connecting districts now isolated from each other. All this is in the future, perhaps in the near

Fig. 6—Farmers departing with their Boxes for Rural Route at Attica, Ind.

future, but it is necessary that public sentiment be aroused among the farmers themselves to hasten the approach of these new aids of civilization and social happiness.

The general government has largely introduced rural delivery of the mails, and will continue to do so. (Figs. 6 and 7.) This is a great step toward some of

Fig. 7—U. S. Rural Mail Equipment, Los Gatos, Cal.

the most important advantages of town life. The outlook for comfort and convenience in farm life is decidedly encouraging.

CHAPTER VI.

THE VALUE OF MARKETS.

If all men were farmers great poverty of the entire nation would be unavoidable. Purely agricultural countries are always lowest in civilization and in wealth. Agriculture in such countries cannot rise to the dignity of a scientific pursuit, for there would be no incentive to increase production. The farmer needs markets, and this means that there must be people who are *not* farmers, who will *buy* what he *raises*. It is one of the most dangerous mistakes for the farmer to see in the growth of manufacturing industry a menace to agriculture, or to regret that towns and cities grow and wealth accumulates in them. The more prosperous the manufacturers are, and the wealthier the people who live in cities because of the presence of various industries there, the more surely will the farmer thrive.

It is true that our exports to other countries of agricultural products are enormous, far excelling the value of manufactured goods, but the sum total of these exports is after all only a fraction of the total value sold at home.* We cannot sell to a market from three to five thousand miles away without loss of profit arising from the cost of transportation. It is true that by condensing agricultural products into cattle, pigs, horses,

*See Statistics of Production and Exports in the Appendix, page 261.

etc., the cost of transportation of the raw material, hay and grain, is far less than if these raw materials were directly exported; but even in that case it is considerable. Hence it is that the home market is of such great value to the farmer and that he ought to be heartily in favor of the growth of towns and cities by the help of the manufacturer.

Nowhere is agriculture so flourishing, so scientific and rational, as it is in the states that have their markets at home. In New England the average yield of grain crops per acre is several bushels higher than in Illinois or Iowa, and in all our Northern States much higher than in the Southern. As manufacturing industries increase, towns and cities grow and demand more and a greater variety of the products of the farm. The farmer can obtain a fair price for whatever he wishes to sell, and the farm becomes more productive because he can afford to restore to the soil the elements of fertility which the crops take from it; and although he may not hope to rival the successful manufacturer or merchant in the piling up of wealth, he is sure of a competency and of many blessings which are not found in the city.

A young farmer starting into business should pay much attention to the nearness of the market. While stock-raising may be profitable at some distance, mixed farming, or the raising of specialties, like potatoes, etc., will hardly pay him well enough, if the distance from a market be too great. Twenty or forty acres near a good market are often found to yield more income than five times as many at such a distance that the cost of transportation diminishes the profit. For a

large amount of his produce, especially hay and corn, the farm itself furnishes the best market for the farmer if he feeds these to stock and returns the barnyard manure to the land.

In many localities creameries have been established which afford a good market for milk. Cheese factories offer the same advantage. A near market enables the farmer's wife to sell her butter directly to the consumers. This is often an important advantage. Many consumers prefer to pay a uniform price all the year round. This enables a good butter maker to dispose of all her butter profitably when prices are low in the summer and fall. The same is true of eggs and poultry. Fresh eggs from the farmer are advertised in the city, but the real article is not always found. Even a small village with a railway station may afford a good market, if there is a competent agent and shipper. Any surplus in the fruit garden would thus find a market and help to swell the receipts.

In a certain sense the family of the farmer furnishes a market for his products, and this is an important item which is often imperfectly understood. All the articles consumed in the house should be credited to the farm. Very few keep an account of this kind, but even a superficial estimate must satisfy anyone that a very considerable amount of the profits of farming is represented by the consumption at home. A farmer may make a specialty of raising wheat and corn for seed. Very great care and much intelligence are required to do this, but the profits are such as to justify the efforts. For such seed there is always a market at home, or at a reasonable distance. On farms where only thorough-

breeds are kept many sales of young stock are effected at home.

By co-operation farmers may do much to bring markets nearer to their door. They may build or assist in building an elevator at the nearest railway station for their grain crops, which will enable them to sell the whole to a commission merchant at once and on the spot. They may also erect cold storage houses to keep their surplus of eggs and other perishable products off the market until late fall or winter, when prices are highest.

The farmer who seriously tries to raise only the very best will soon establish a reputation with buyers. Such a farmer will not sell much grain, and *no clover* or *hay*, for these he needs for his stock. But he will sell the best pigs, cattle and sheep in the very best condition, never sending to market half fattened or lean stock. He will steadily improve his stock by using only thoroughbred sires for breeding purposes, and will take the very best care of every animal he feeds. A good warm stable need not cost very much, and good care of animals means that they must not be exposed to the cold and wet for any length of time. With such care a farmer will very soon get the means of building a better barn, to increase his stock and to improve his land. The certainty he has of being able to find a good market for all he can produce will make him energetic and persevering.

CHAPTER VII

PURE AIR AND PURE WATER.

What are the principal products of the farm? Who will deny that they are the human beings upon it, the boys and girls and their parents, and that these are of incomparably more importance than any other product.

As this will not be denied, the question how to provide for the health and comfort of the farmer and his family should be carefully considered, and the best answer possible given to it.

There are two things of which a full supply should always be at hand; fresh, pure air; fresh, pure water. These cost nothing, and yet we know from experience that they are not always found in the homes of our farming population. This is proven by the fact that some preventable diseases, like typhoid fever, scarlet fever, measles, and others, are quite as frequent in the country as they are in large cities. We might say they are more frequent in proportion to the population. In the large cities great attention is paid to the abundant supply of pure water, and the effect of bad air from the soil is counteracted or done away with by sewers and systems of drainage.

A poor man who is starting life on a farm cannot always have things as they should be. He must be satisfied at first with a poor house that does not give complete shelter from the extremes of the weather. Sometimes he may be forced to live for months in a

tent until he can put up a shanty to provide for his greatest needs, while he raises a crop that will give him ready money. There are many farmers now well off or wealthy who commenced in this way.

But the tent and rude dwelling may often be found to furnish better conditions for health than a house that costs many times as much, but has some defect in ventilation. The tent admits a plenty of fresh air; a big house does not always do so. But we need pure air above all other things, for it is by breathing pure air that our lungs rid our blood of its poisonous element, carbonic acid, and thus furnish the first and most important condition of health. If this carbonic acid stays in a house or a room, sickness of some kind, nearly always accompanied by headache, is the necessary result. And a house, owing to the difference of the temperature in it and in the soil, draws from the ground on which it is built whatever noxious gas there may be in it or come through it. A house should therefore be so built that the air in it can be renewed frequently. This is easy in summer, but often somewhat difficult in winter. The simplest way to supply fresh air is by opening the windows. Even at night some of the windows should be at least partially open. Double windows are excellent in winter because, by raising the inner window, we have it in our power to allow fresh air to stream in through an opening made in the frame of the outer window without causing a direct draft. A constant draft, by chilling a certain part of the body, may cause a serious sickness, and even death, while a uniform cold temperature will cause only discomfort.

Poorly built houses admit plenty of fresh air, but there is the objection that this air comes in as a draft. An open fire-place furnishes a first-rate opportunity for good ventilation; but open fires cannot warm our rooms in the cold winters we have in the North. It is hardly necessary to say more about this subject of ventilation, because the matter is now pretty well understood by those who build large houses for others, and a farmer who can afford to build a large house will of course consult men who understand the business. Those who live in small houses must do their best to escape the results of drafts on the one hand, and the effects of bad air on the other.

We might say as much of furnishing good water to the house, but the case is different. There is a simple way, as has been shown, to provide for fresh air, but to have a constant supply of good water is not so easy. Wherever human beings or any animals live for any length of time the soil is sure to become filled with dangerous gases arising from the filth that gradually accumulates. If you dig a well, you invite all these gases to enter it and poison the water, unless your well is so deep and so well protected as to make this impossible. But it is very hard to say when you are safe in this respect.

In a certain farm-house, provided with an apparently good well, typhoid fever was frequent. Two children died of it, the rest of the family were more or less sick. The doctors knew no remedy, but finally an old doctor was consulted, who had spent many years in the country and who knew the danger that lurks in impure water. The first thing he said was: "Boil the water you wish to drink. Don't drink any water on the farm

without first boiling it." But the people objected. They said, "Our well is far away from the barnyard and the sink into which we throw the slops from the house, how then can its water be bad? It is a deep well and the water comes up from below." The doctor asked to be shown the sink. It was about 100 feet from the house. Then he asked for a barrel of salt. This he poured into the sink. It was found on the next day that the water of the well was salty, a clear proof that there was a constant drainage from that sink to the well. When this was understood the remedy was applied, and from that time on there were no more cases of typhoid fever in that house. Boiling the water kills the disease germs in it; but boiled water has a flat and stale taste; it does not refresh like natural water. The question arises, therefore, how can we supply good natural water for drinking purposes? If the house stands higher than the barnyard, as it should, and the latter is at a good distance from the house, the danger is greatly lessened. And as it is one of the duties of a farmer to save all his barnyard manure, it follows that he should make such provisions as will make it impossible for any part of that manure to sink into the soil, except when applied to the field.

Cemented stalls for all farm animals secure this end perfectly, provided the manure is housed under some cover where no rain will touch it. Even ordinary wooden floors, provided the planks are tongued and grooved and put close together to catch all the liquid, will do well for this purpose. The contents of the stall should then be wheeled to a covered shed. This is better than the cellar under the barn, because in the

cellar manure is very apt to heat and thereby lose much of its value, besides contaminating the air above where the cattle and horses are. In the shed the manure should be occasionally tramped on during the day by cattle or horses. It has been found that manure well tramped by cattle or horses will not heat, thus retaining its full value; and as no water from without can draw any elements from it, the soil is not contaminated and no injurious gases can go from it to poison any well in the neighborhood. Such a shed may also serve other purposes in case of necessity. It may be used to run wagons, tools or machinery under for which there may not be any other room available at the time. In winter such a shed will be a convenient place for cattle to take some exercise.

As for the sink hole, it should not be necessary to have one. The slops should be emptied on the surface of the ground, *but never twice on the same spot*. In this way no filth will accumulate, all being absorbed by the soil or dried out by the sun.

When the well is shallow and on lower ground, the following precautions may be taken: Dig a ditch about $1\frac{1}{2}$ feet wide around the well, at a few feet from it, and not less than 6 feet deep. Fill this with charcoal and sand. In some localities a cistern may be the best thing. It should be made of brick laid in cement, and the inner wall well coated by a man who understands how to handle cement. The work of putting on this coat must be done quickly as the cement soon hardens and is then useless for putting on. One part of cement to four of sand makes a good mixture. The cistern should have a neck which ought to reach above ground and be well covered to prevent rats and other animals

from falling in. Either in a corner of the cistern, or at one of its sides, or above it, a filter should be put up (a tight barrel will do), filled with clean sand and charcoal in layers. The water from the house roof should go through this filter before it enters the cistern.

A very excellent cistern was provided with a large filter in the ground built of bricks laid in cement and coated like the cistern. A pipe from the side near the bottom connected it with the cistern. This filter was about five feet deep and six feet in diameter. It was divided into two parts by a brick wall, 4 inches thick; the larger part was filled with charcoal and sand in alternate layers. All the roof water as far as needed, ran into this part, and then through the brick wall. The result was water as clean as crystal, fresh and cool, the cistern being over 14 feet deep. In order to get a constant supply of air into the water, to prevent it from becoming stale, a chain pump was used.

All cisterns must be thoroughly cleaned once a year. The neck should therefore be wide enough to admit a ladder, on which a man can reach the bottom. After cleaning it, it is desirable to light a fire of good clean material in the bottom of the cistern. This will kill any noxious elements that may have been overlooked in the cleaning.

Water for stock should also be as pure and wholesome as possible. Windmills are now pretty generally used on well appointed farms, which pump the water from a great depth. This water, being cool, may be used for the dairy; it may also be pumped into the house. These arrangements, and particularly how to

get the water to the barn as conveniently as possible for the use of stock, need not be discussed here, as the work of putting up such mills is done by people who understand it thoroughly, and their suggestions should be followed.

The importance of the subject will justify the addition to this chapter of a few extracts from an address of Professor Arthur N. Talbot on the subject of "Sanitation for Country Homes."

"One test of the effect of improved sanitary conditions lies in the decreased death rate. The average yearly rate of mortality in the United States is now about 18 per thousand inhabitants. In the cities as a whole it averages 23 and the rural districts about 15. As an example of the change in mortality rates may be cited the case of London, whose death rate has been reduced from 80 per thousand in the seventeenth century to 20 per thousand at the present time. The medium age of the American people has increased by four years in the last century. The introduction of public water supply and sewers into German cities was accompanied by a marked reduction in the death rate, and the improvement in the quality of water supply has generally been followed by decreased mortality.

"Certain diseases classed as preventable diseases are caused by infection from outside the individual and are produced or propagated by organic germs or microbes. Local diseases, such as those of the brain and heart and those of the digestive and circulatory systems, and constitutional disease like rheumatism and scrofula are not of this class. Typhoid fever, typhus fever, malarial fever, diphtheria, diarrhœa, cholera, yellow fever, consumption are considered to be propa-

gated by such germs, and several of them are water-borne diseases; that is, are conveyed through the agency of drinking water. About 40 per cent of the deaths in the United States result from causes of a zymotic or infectious character. Sanitary science seeks to decrease this percentage, and ultimately to render these diseases as infrequent as death from small-pox now is. By so doing, an annual death rate of 20 per thousand will be reduced to about 12 per thousand, and the consequence will be a marked increase in the average age and length of life of the population.

“The marked decrease in the mortality rate in the past hundred years is, of course, not due to sanitary science alone. Hygiene, medical science, more widely diffused knowledge, improved individual conditions, all have been great aids, but by far the greatest portion is due to the improvement in sanitary conditions. As individual cases of decreased death rates due to sanitary reforms may be cited a reduction in the death rate by typhoid fever in Lawrence, Mass., amounting to 90 per cent after the introduction of filtered water, and a similar reduction of 60 per cent in Chicago by the extension of the water tunnels beyond the region of great sewage pollution. A comparison of the typhoid fever mortality of the principal cities of the world shows that those cities having a pure or purified water supply have low typhoid rates, while those whose supply is subject to contamination run very high. Munich, Berlin, Vienna, London and New York range from 2 to 17 per 100,000, while Chicago, St. Louis and Cincinnati range from 31 to 50, and Cairo, Egypt, is 135. Statistics, as far as they are available, indicate that the mortality from typhoid fever in rural districts is

even as high as that in Chicago and St. Louis and several times as great as may be expected under fair sanitary conditions. Truly, there is room for improvement in country as well as in city.

"It is difficult to fix directly the connection between a polluted water supply and an epidemic of disease like typhoid fever. The identification of the typhoid bacillus in suspected water would be a thousand times worse than the traditional search for the needle in a hay stack. Moreover, an individual may many times throw off an attack of the germs if his system be in an immune condition. Two examples may be cited to show that drinking water may cause an epidemic.

"The little Swiss village of Laufen is supplied with water from a spring near the foot of a mountain ridge. No typhoid fever had been known for several years, when an epidemic broke out affecting 17 per cent of the whole population. Six families, which did not use water from the spring, were exempt. It had been known that the irrigation of a meadow on the other side of the ridge affected the volume of the spring, and as upon investigation it was found that a peasant taken sick with typhoid fever in a distant city had returned to his home near this meadow and that the brook in which his clothes and that of two later cases had been washed, and into which the slops from the house had been thrown, had been used to irrigate the meadow, it seemed probable that this was the cause. To prove that the spring was supplied with water from the meadow, several hundred weight of salt was dissolved and poured into a hole in the meadow, and in a few hours the water of the spring supplying the village became very salty. Flour mixed and poured into the

hole gave no trace in the spring, showing that solid particles were filtered out.

"In Plymouth, Pa., then a town of 8,000, within a period of a few weeks in 1885, there were more than 1,000 cases and 100 deaths from typhoid fever. It was found that the following conditions existed: During the previous hard winter the hydrant water had been supplied from the Susquehanna river, but with the spring floods the supply was taken from the usual source, a mountain brook. A man coming from Philadelphia sick with typhoid fever was cared for in a house near the source of this brook. The waters from the sick room were thrown on the snow on the side hill near the brook. With the general thaw this mass of typhoid refuse was swept into the stream and thence was pumped into the water mains. The typhoid fever cases were confined exclusively to persons using the hydrant water. Those using well water or river water exclusively escaped entirely.

"Similarly epidemics of typhoid fever have frequently been traced to the use of certain wells, families using city water being free from the disease, and many similar instances may be told of villages and country. An instance in the country, when three-fourths of those engaged in a job of threshing were taken down with typhoid fever, might be cited, and others detailing the fatalities attending tenant after tenant who had used water from a well which must have been contaminated. Nor are such direful effects confined to typhoid fever, or even to water-borne diseases. The full list of communicable diseases is applicable to country conditions. Malarial fevers, for instance, form a considerable part of country ills. While it is known that the presence

of stagnant water and the upturning of old sod are conditions favorable to its genesis, there are unknown factors in the life history of the malarial germ which it is hoped the future will bring to light. In the meantime, thoroughly drained and tilled soil and the absence of decaying vegetable matter tend to make immune conditions. With these effects in mind, compare the value of life, or even of the expense of sickness, with the cost and the necessary effort required to keep proper sanitary surroundings.

"That surface pollution may easily reach shallow wells may be seen from an experience told by a friend of mine living in Urbana. Wishing to utilize a kit which had held fish, he buried the two remaining spoiled fish and the salt and brine from it some fifty feet from a well. The result was that in forty-eight hours the water from the well was so salty it could not be used. Many well waters quickly change their chemical analysis after heavy rains; many are found to be polluted by cesspool infiltration. A supposed medicinal spring in this State was proved to be only badly contaminated ground water."*

The subject is of such great importance that the facts here given deserve the serious attention of every one.

Questions of the kind here discussed are properly the subject of *sanitation*. It was a long time before the importance of this science was properly understood, and it is even now far from being generally appreciated by the people at large. This is the reason why still so many die of preventable diseases, like typhoid and malarial fevers.

*Annual Report of the Illinois Farmers' Institute. 1900. P. 64-71.

As the malarial germs are very apt to enter the house from the cellar, the greatest attention should be paid to a perfectly dry location for the house. This can be secured by laying drain tile directly under the cellar walls and providing for a good outlet. Cementing the cellar floor, or still better, covering it with a coat of asphaltum, is strongly to be recommended. If vegetables or fruit are kept in the cellar, it is very desirable to plaster the ceiling of the cellar, and to provide for good ventilation besides. It should be vividly impressed on young and old that fresh air is the sovereign remedy wherever there is any attack from malarial poison, either in the air or in water, and that in all cases of doubt the water for drinking purposes should be boiled.

Good health being the most precious of all gifts, it is the duty of every one to assist in keeping down and destroying filth in every place. Public sentiment has been aroused on the subject; schools and colleges are teaching the importance of sanitary measures; the universities are on the lookout for the dangers that lurk in unexpected hiding places, and the leading men of the country everywhere lend their help and co-operation to further the good work. Nevertheless, even in our wealthiest cities filth accumulates in streets and alleys, and an energetic and systematic fight against the evil is the exception rather than the rule.

The farmer has an unlimited supply of fresh air; he is not hampered by an ignorant mass of voters on his own farm; the sanitary measures he ought to apply do not involve an excessive cost; he can, if he earnestly will, secure perfect health conditions for himself and his family.

PART II.

FIELD CROPS.

CHAPTER I.

RAISING AND ROTATION OF FIELD CROPS.

The tillable surface of an acre of soil, unless either very barren or unusually fertile, contains about 3,000 pounds of nitrogen, 5,000 pounds of phosphoric acid, and 6,000 pounds of potash, in a form available for plant growth. It is these elements, to which should be added black humus, the value of which consists largely in its capacity of retaining moisture, that constitute a large part of the farmer's capital; it is these which he really sells when he disposes of his crops. He actually sells in farm produce a part of his soil. Hence the necessity of preparing worn-out lands for a crop by proper manuring, and by economizing the fertile elements in the soil by a change of crops.

In a ton of wheat the farmer sells 38 pounds of nitrogen, 19 of phosphoric acid, and 13 of potash, and these amounts are lost from the soil.

In a ton of milk, on the other hand, his soil loses only about 12 pounds of nitrogen, $4\frac{1}{2}$ pounds of phosphoric acid, and $3\frac{1}{2}$ pounds of potash.

Hence, other circumstances, such as markets, roads,

Fig. 8—The Sub-soiler following the Plow.

etc., being equal, the dairy farmer will be in possession of a greater amount of his original soil at the end of ten years than the wheat raising farmer.

These facts should be well considered. Whether to raise one crop rather than another depends on many circumstances; sometimes it is simply a question as to the quickest way of obtaining some ready money. It is for this reason that tenant farmers are often so destructive in their treatment of the farm. The owner, or any conscientious farmer, will look ahead, make his plans a number of years in advance, and will use all possible care and diligence to prepare his land in such a way that each crop to be raised shall find all the conditions favorable. (Fig. 8.)

We have learned that natural soils which have never been used for raising crops contain humus and all the elements of fertility needed to produce paying crops. But we have also seen that some crops need more mineral elements than others, that they exhaust the soil more and that, if continued on the same ground, they will rob the soil of special and necessary elements of its fertility. The way to restore such fertility has been pointed out, and we have seen that clover, or clover-like plants, peas, beans, alfalfa, furnish the most useful crop to be plowed under in order to enrich the soil.

Now if we use a field in such a way that we raise clover one or two years, potatoes or corn the next two years, and finally wheat or oats, or barley, etc., we *rotate* our crops, that is we use them as it were in a circle. *Rotate* means to turn like a wheel, and the changing of crops, as just described, is called *rotation of crops*.

The advantage of rotation is in the fact that different

plants use different elements, and that after taking off one crop, for instance, potatoes, or beets, turnips, mangel-wurzels, etc., we may raise another with a good chance of success, even without further manuring.

The ash of clover contains more nitrates than the ash of wheat, but as these nitrates are stored not only in the seed, but also in the roots, stems and leaves of the plant, all of which may either be returned in the form of manure or plowed under and thus fitted for direct use, it follows that clover leaves more nitrates in the soil than it takes from it. Feeding clover to stock, and returning the barnyard manure, is therefore an excellent way to increase the fertility of the soil and at the same time to get a good crop of clover hay for stock.*

It is easy to see that potatoes and root crops contain so much water that a ton of them will not take as much solid, that is mineral, matter from the soil as from 7 to 8 bushels of wheat will require. Hence if potatoes sell at a good price they are in many respects a more profitable crop than wheat, provided the yield is satisfactory. By a proper rotation a good yield can be secured, provided the cultivation of the crop is well managed. A small part of the money obtained will then suffice to restore the lost fertilizing material. In most cases it will be sufficient to use the manure made on the farm.

One ton of wheat needs almost as large a proportion of phosphates as two tons of clover hay. As already stated, the clover brings up valuable plant food from

*If fed to horses, clover should be moistened by sprinkling with water as it is apt, in the dry state, to irritate the throat and lungs of some horses.

the lower part of the soil, thereby enriching it in its upper part where the roots of corn and wheat can reach it. Hence these two crops, clover and wheat, may follow one another, and good results be obtained. But if wheat alone be raised on the same land for a number of years, the supply of nitrogen, potash and phosphoric acid in the soil will finally be so small as to produce only poor crops which do not pay, and leave no profit by means of which the farmer can afford to buy the needed fertilizers.

What is here said of wheat is true also of corn, oats, barley and rye. On dairy and stock farms root crops pay well. With them and clover the fertility of the soil can be maintained a long time, provided all the barnyard manure is returned to it. A good rotation would therefore be: First, *clover*; second, *corn*; third, *potatoes*; fourth, *turnips or mangel-wurzels*; fifth, *wheat*. With the wheat, if it is of the winter variety, clover should be sown, and the rotation again started. If winter wheat will not do, it may be best to sow rye with clover in the fall, or the term of the rotation may be extended one year. These are matters of detail which can be arranged by anyone who understands the nature of his soil and the reason why manuring and a proper rotation of crops are necessary to make farming pay. The rule of rotation in Illinois seems to be, first, wheat; second, corn; third, oats or rye; fourth, clover. On stock farms a root crop is often added.

One great advantage of such rotation is that it makes possible an effective war on weeds which would otherwise deprive the soil of much of its fertility. It also helps to kill many injurious insects, though in

order to do this well, it will be necessary to give the soil the very best kind of tillage. Clods and weeds furnish hiding places for the insect pest. A clean and mellow seed-bed exposes the eggs and larvae of the insects to the effects of sun and rain, of heat and cold. Good tillage, deep plowing, (where the sub-soil permits it), frequent harrowing and the use of the new styles of cultivators, will open the soil to the air, secure sufficient moisture in dry weather and enable the soil to absorb a great part of the rain and snow water. This should be supplemented by drainage. Sandy soils may not need to be tile drained, but it has been stated that even they are benefited by it. Heavy soils derive the most benefit from under draining.

Tiles are now generally laid at least three feet deep, many think from four to five feet is better, and 30 feet apart. It has been found that large tiles, from 3 to 4, and even 5 inches, pay best. The land should be carefully examined in order to find a permanent outlet for the main drain, at its lowest place. Then work backward, laying the tiles on a perfectly smooth surface, covering the joints with paper, and then fill in with soil so as not to disturb their position. A good farmer will look after this work himself, as any carelessness in the laying out of the tiles may result in their getting filled up with soil. There should be an even fall throughout, though this fall may be very slight.

The advantages of draining are very great. It makes possible the working of the soil shortly after the heaviest rain, so that crops can be put in early, or in the short interval before another rain comes on. It goes far to prevent wasteful washing of the soil, during

rainy periods or by heavy rains, and as it keeps the soil dry enough to absorb water nearly all of the time, it furnishes to the roots of the growing crop the best possible conditions for growth. The roots will run deeper and feed the plant on top better, so that heavy crops are the result.

Good tillage and perfect drainage take the place of manuring to some extent. They make available a greater depth of soil for the growing crop, so that the roots reach further down for material that is deficient near the surface.

A good judge* of the subject has said:

"Had I to take my choice between a given quantity of manure, and tillage implements such as we had twenty or twenty-five years ago, on most farms, and one-half the quantity of manure and the best tillage tools of the day, I would choose the latter for my farm. We can turn and stir and tear up and pulverize in a way now that was not possible when I began farming."

Prof. I. P. Roberts says in the "Rural New Yorker": "We do not half estimate the value of culture. There are vast stores of fertility in our soils if we will only bring them out and render them available by thorough and persistent culture. Good agriculture means, first, culture, and second, careful conservation of farm manures. To these add commercial fertilizers."

The rotation of crops also tends to prevent waste of fertilizing matter that is not used by the crops, but evaporates in the air. Wherever the same crops have been raised for a number of years in succession the loss of nitrates in the soil, and also of other elements,

*Mr. Terry in his book, "Our Farming."

is very much greater than what the crops actually take away. It has been stated by the Agricultural Experiment Station of the University of Minnesota that in that state the loss by continuous wheat raising of nitrogen that did not enter the wheat plant at all, was $146\frac{1}{2}$ pounds per acre. The wheat itself took up only $24\frac{1}{2}$ pounds. When wheat is grown in rotation with clover no such loss occurs; on the contrary, the gain in the soil of nitrogen far exceeds that lost or carried away by the wheat crops.

The continuous cotton and tobacco growing in the Southern states shows like results. The lesson is so startling that no doubt can remain as to the value, nay, the necessity, of a rotation of crops, and that one of these crops must be of leguminous plants: clover, alfalfa, the soja bean, cow pea, or the regular field bean and field pea.

CHAPTER II.

GRAIN CROPS.

All grain crops do best on new or virgin soil. When our prairies were first turned into fields the first crop of wheat would generally average over 30 bushels. After a number of crops were taken from the same field, the average yield of wheat per acre would be only 15, 12 and finally less than 10 bushels. The reason was that the soil had been gradually robbed of its fertility. A wheat crop requires for every 20 bushels 40 pounds of nitrogen, 18 pounds of potash and 15 pounds of phosphoric acid. If any of the nitrates or mineral elements in the soil prove insufficient for the full development of the wheat plant the crops necessarily become lighter. Hence the modern practice of raising wheat on clover soil or on soil that has been used for some time as meadow land or pasturage. Clover is superior for this purpose to grass because its roots run deeper, and particularly, as was explained in a previous chapter, as these roots gather nitrogen from the air and thus restore the nitrogenous elements of the humus. In many localities winter wheat can be successfully raised, in others the young plants will be destroyed in the spring by the sudden freezing and thawing of the ground.

Land for winter wheat should be plowed in August or September, and the seed sown in September in order that the young plants may gain sufficient strength to

pass safely through the winter. As there can be no after cultivation it is very important to prepare the soil well and to make sure that the weeds do not get the upper hand. It is therefore often best to raise a crop of corn or potatoes after breaking up the clover or grass soil, because these crops favor the killing of weeds. The ground should be gone over several times with a disk harrow, then thoroughly rolled, and finally a smoothing harrow should be used until all the soil is thoroughly mellow. There must be no clods, hence avoid cultivating or plowing directly after a rain, while the ground is wet. These remarks apply also to spring wheat which should be sown as early in spring as the fields can be put into proper condition. Seeding is now generally done by drills. These secure a more even stand and place the seed at a more uniform depth.

As in the case of corn and other crops, it is very important to sow only the best kind of wheat suitable to the locality, and further, to sow only clean seed. Carelessness in the selection of good and clean seed is sure to entail loss, for every weed grown deprives a wheat plant of necessary food and moisture. It is also best to obtain seed from a more northern region. Such seed will grow a little more slowly and thus secure a better filling out of the kernel. The raising of seed wheat may be made quite profitable as its market price is generally more than double that of the ordinary wheat, but in order to succeed in it the greatest care must be bestowed on keeping out weeds, and if the fanning-mill does not separate the weed-seed perfectly from the grain, it may be necessary to hand-pick the wheat before sowing or drilling it. The more care is

given to obtain perfect cleanliness from weed-seed the greater will be the profits of the business.

In order to secure a good crop of winter wheat it has been found necessary in many localities to cover the field with straw, either directly after sowing in the fall or during the winter months before thawing sets in. This involves a great deal of labor, as it must be carefully done. If the straw is put on directly after sowing the young plants pushing through it will hold it in place from the wind, which otherwise greatly interferes.

The quantity of seed required for an acre varies with the fertility of the soil. The more fertile the soil the less seed is required, from 4 to 5 pecks being considered sufficient on the best soil, if put in early. If sown late it may be advisable to sow a peck or more per acre, in order to make good the loss in weight and in the size of the ears by a larger number of stalks. Sowing from 6 to 7 pecks on very good land would cause much of the crop to lodge. There is also a difference in the varieties as to the size of the kernels; small wheat would not require so many pecks.

The harvesting of the crop used to be a very serious job, but the labor is now much reduced by the use of the binder. Wheat may be cut when it is in the dough state, that is when the kernels easily yield to the pressure of the fingers. Cut then, they will ripen perfectly afterwards. Wheat may be cut when dead ripe, but this will spoil the shape of the sheaves. Their tops will hang over to the sides instead of standing up straight, and it will therefore be more difficult to dry them after a rain while they are in the shocks. Ten sheaves may be put in a shock; more will not dry out

well after a rain. It has been recommended to put 8 or 9 bundles in the base and two for caps. Put the first cap sheaf with its head to the south, the other with its head to the north, because most of our winds blow from these directions and the caps will thus lie more firmly. These caps should be broken in the middle, not merely bent, in order to make them rest more securely. The breaking can be done by taking a few straws at a time. Every precaution should be taken to enable these bundles to dry out well, for some seasons are so wet that it is not easy to save the whole crop.

Wheat is one of the crops it does not pay to raise while prices are low, and it seems that prices must necessarily be low as there is so much competition from the new land in countries like Argentina, Russia, the Danube provinces and states, and India. To raise wheat and ship it abroad might almost be called a way to impoverish ourselves, as this takes away the fertility of the soil. To restore it is a difficult and expensive undertaking. Only very good prices, such as will enable the farmers to buy fertilizers, can justify this practice.

What is true about sowing and harvesting wheat is also true about other grains, oats, barley and rye. Barley is used by brewers and also as food for stock. For the use of the brewer it must be of a bright color, and well filled. Such barley will sprout early and produce the malt out of which beer is made. The two-rowed variety requires more time for ripening than the four-rowed or six-rowed, the latter ripening most quickly.

Rye can be sown both in the fall and in the spring.

It will produce fair crops even on poor soil. In Russia, Germany and Scandinavia rye is extensively grown for bread, as wheat is an uncertain crop.

Oats produce very heavy crops on rich soils, but they grow well enough on poor soil and can be grown much farther north than either wheat or barley.

Corn is our principal crop and deserves a chapter for itself.

There are a number of other field crops which in some localities prove profitable, and which may receive mention here. Tobacco is one of these. It requires extra care in curing and the crop is very exhaustive of the mineral elements in the soil.

Buckwheat may be sown as a so-called "catch-crop." Its roots are short, and fair crops can be raised on poor soil as the plant draws its nutriment largely from the air. Buckwheat answers well as green manure for plowing under.

Flax is an important crop. It is an annual and grows to the height of about two feet. When in blossom it is easily known by its bluish flowers. The seed is called linseed or flaxseed, the former name being formed from the Latin or botanical name *linum*, the latter from the Saxon flax. Linseed oil is an important article of manufacture and in this country the crop is mainly raised for this purpose. Linseed oil cake, made of the ground seed after the oil has been pressed out, is one of the very best foods for stock. The stalk of the plant furnishes a fibre which is the material for linen.

Cotton, and other special southern crops, cannot here receive any attention, as their importance requires a more extensive treatment than is consistent with the limited scope of this book.

CHAPTER III.

CORN.

In 1891 the United States produced its largest crop of corn—two thousand millions of bushels. A railroad car will hold 600 bushels, and a train of such cars, sufficient to hold the entire crop, would have extended around the entire globe. The crop was raised on 96,000,000 acres. This proves that a large portion was raised on land not naturally fitted for corn, for the total area of land in this country fit to produce paying crops of corn is only 47,000,000 acres.

The average yield per acre of this immense crop was not quite 21 bushels, but as in the true corn region a yield of 40 bushels and over is the rule rather than the exception, it follows that millions of acres must have yielded much less than 20 bushels per acre, and that hence very many farmers either made nothing out of their crops or lost by them. It has been shown again and again that on land adapted to corn culture and kept up to the proper degree of fertility, it is possible to raise from 80 to 90 bushels per acre.

There are 3,488 hills of corn to the acre, if planted in the customary way. These ought to average two stalks each, or 6,976 stalks, each producing a large and well-filled ear, or an average of 90 bushels per acre. With very rich manuring and regular garden culture it is claimed that an acre may yield 240 bushels.

Reports at Farmers' Institutes have shown that 32

to 34 bushels per acre is often the average yield of corn the ears of which, on the average, are only $4\frac{1}{2}$ inches long. But ears of the same variety of corn might be grown 15 to 16 inches long, thereby trebling the total yield. How can this be done?

Suppose that we plant corn with a first class planter on mellow land that was seeded down to clover and was plowed under in the fall. We choose our seed corn with great care, rejecting the tips and also the first rows of the thick end. Directly after planting, the entire field should be gone over with a good harrow and, in order both to keep the soil mellow and to kill weeds, this harrowing should be repeated. It will do no harm even after some of the corn has come up, the advantage to the growing crops, from thoroughly mellowing and pulverizing the soil, being so great that the work will pay even if a few of the small plants should suffer injury. After the rows show and the young plants develop and extend their roots near the surface, great care must be taken not to break or otherwise injure these roots, hence cultivation should be shallow, though it may be at first tolerably deep toward the center of the row. Care should also be taken not to produce ridges. The ground should be as level as possible. The implements now in use are well adapted to this kind of work, but the one who uses them must know what he is about and, if necessary, make such a change in the position of the teeth of the cultivator or harrow as to be able to do his work thoroughly and without injury to the roots.

Rains beating on the surface will harden the latter, and the sun will bake the soil so as to exclude the air. Hence as soon as possible after a rain the cultivator

should be run between the rows. It is very essential not to postpone this work, for if done too late the ground will break up in clods, or be so hard that the teeth of the cultivator cannot enter it. If set deep they will injure the roots on the strength of which the success of the crop depends.

Remember that if we can give to each ear that grows its full natural length, we may obtain a crop that is from 10 to 50 per cent heavier than it would be if our work was careless.

Continual cultivation will be the very best remedy against drouth. There is always a large quantity of moisture in the air, as any one knows who has walked in the dewy grass on a summer morning. This moisture will enter the soil with the air, and as the lower soil is naturally cooler than the air, the water will separate from this air exactly as the water that forms the dew separates from the air that rests on the ground after it has been cooled off during the night. At the same time the mellow top layer of the cultivated soil forms a mulch, a protection from the heat of the sun, and thus favors the growth of the roots. These can therefore do their peculiar work of pumping water from the soil and sending it, with the mineral elements dissolved in it, to every part of the plant.

In some parts of the west the practice obtains of planting the corn in furrows, which are gradually filled in as the plants grow up. This process is known as "listing." It secures strong roots and hence good crops, but is not practicable on heavy clay soils.

The injury to crops by running the cultivator too deep has been shown by careful experiments. It was

found that by root-pruning growing corn to the depth of 2 inches a row would yield 144 ears weighing $63\frac{1}{2}$ pounds. Another experiment shows that where the root-pruning was 6 inches deep the number of ears was 123 and their weight $38\frac{3}{4}$ pounds, while without any pruning there were 132 ears which weighed $60\frac{1}{4}$ pounds. At 4 inches the pruned corn showed 116 ears weighing 51 pounds, the unpruned 146 ears, weighing $63\frac{1}{4}$ pounds.

We conclude therefore that corn should not be cultivated so as to injure any of the roots. But cultivation must be given in order to kill the weeds, and as it is very necessary to provide for a layer of several inches of loose and mellow soil to act as a mulch and thus keep in the moisture needed by the roots, it will require very careful work to secure these results. All depends on getting ahead of the weeds. This may be done by deep cultivation, as long as the plants are very small, following on several harrowings before the plants show above the surface; and by shallow cultivation later, as soon as possible after a rain, before the formation of a crust. Shallow cultivation should then be continued until the corn is high enough to shade the ground.

At the Illinois State Fair of 1898 the highest premium was given for a crop of corn of 180 13-70 bushels, the product of one acre. It was raised on comparatively new and very rich land. Two crops of wheat had been taken from it, then it was sown in clover which was allowed to stand three years, and pastured with cattle and sheep. It was broken early in the spring, thoroughly pulverized and prepared in the most

perfect manner. Soil, naturally as good and equally as rich as this, if continually cropped with corn, would scarcely produce 25 bushels an acre. This has been proven by careful experiment.

According to the Yearbook of the Department of Agriculture (1900), recent experiments at several Agricultural Experiment Stations seem to prove that no difference in the quality or yield has been found when the grain from either end of the ear is used for seed.

Great importance is attached to the rule of selecting seed corn only from such stalks as bear two good ears.

As all our improved varieties are due to careful selection of seed, the importance of using extra care and the best judgment in selecting seed corn, or any other grain for seed, must be apparent to every one.

CHAPTER IV.

GRASS, CLOVER AND HAY.

"All flesh is grass," says an old and sacred authority. It is the particular food of the cattle and other stock, and wherever stock raising is the principal business, grass is the principal crop on the farm. But to sell hay from the farm is to rob the soil of its fertility with little chance of adequate return. The crops will become lighter, and finally it will be found absolutely necessary to apply commercial fertilizers.

It is an expensive and slow undertaking to restore fertility where it has once been lost. Hence it is the object of the intelligent farmer to combine cattle breeding with field and meadow culture. Feeding the hay to stock on the farm saves the most valuable part of the crop for manure, while at the same time the cattle sold bring in money enough to pay a good profit and make good the loss of so much of the fertility of the soil as is carried away in the bones and the fleshy part of the stock.

Some land is especially adapted to grass crops, much of it to pasturage. Kentucky blue-grass is the best for pastures; timothy, which should always be mixed with clover, is the best for hay. If then from time to time the hay or meadow grass-land be plowed up for a rotation of other crops, the last of which to be clover, a farmer will have reason to be satisfied with the results.

We must bear in mind that clover crops answer far

better for the purpose of preparing the soil for a rotation of other crops than timothy. It is a fact that clover collects nitrogen, timothy eats it. Timothy is not a renovating crop like clover, though it answers a good purpose in any system of rotation of crops.

For pastures it is recommended as advisable to sow one bushel of blue-grass per acre on good soil the first week of March, or somewhat earlier if possible. Timothy should be sown alone early in the fall, from 10 to 12 pounds to the acre. Early in the spring from 6 to 8 pounds of clover seed should be added. Timothy may also be sown with winter wheat in the fall, 8 to 10 pounds to the acre. Some sow timothy with spring wheat, but the practice cannot be recommended. Pastures once established should be maintained as long as possible. It takes time to establish a good sod on pastures. Where there are trees, orchard-grass, as it does well in partial shade, may be sown with the blue-grass. All seeding must be done on well prepared soil. Scattering the seed on uncultivated soil is for the most part sheer waste of time, labor and seed.

In our northwestern states, especially in Iowa, Nebraska, Minnesota and parts of Illinois, Wisconsin and Indiana, the successful sowing of grass seed requires the use of the harrow far more than in states farther east. The seed should be harrowed in, the same as wheat and oats when these are sown by hand. This is on account of the dry winds and the general dryness of the atmosphere which prevail at the time when this sowing takes place. Many successful farmers have given it as their opinion, based on experience, that failures are frequently due to a disregard of this fact.

The hay crop requires particular care. It should be housed before a rain can injure it. Our present implements for cutting and gathering the crop on the field enable us to do this, except in unusual seasons.

Where hay has to be put up in ricks, a skillful hand is required to place it so that the rain cannot enter on any side. The center should be well tramped and the top laid in with special care to secure a good water shed. Hay ropes to which stones or heavy pieces of wood may be attached, should be laid on the top to prevent heavy winds from blowing it off.

Manure can be applied to grass-land and clover in the most efficient way by means of the spreader. Care should be taken to have the machine in good order, and well cleaned and oiled before using, as it is hard on the horses. If the barnyard manure be hauled from a covered shed, where it has been tramped solid by the cattle, one man ought to stay at the shed for the purpose of loosening the mass with a fork, while the other should keep hauling and spreading. A good spreader will distribute the manure evenly over the whole field. The practice of piling up manure in small or large heaps in the field is apt to produce heat and consequent loss. It is best to spread it as soon as possible on the growing grass or clover. The effect on the crops will then be very satisfactory and last for several years, benefiting other crops that are raised in rotation.

If clover is cut for its seed the cutting should not begin until the seed is fully ripe. If cut sooner the crop must be left on the ground until the seed has had time to ripen perfectly. Unless these precautions are taken the value of the seed will be greatly injured,

and the price obtained in market will not be satisfactory. Where seed is the main object, the value of the plant for hay is greatly diminished. As a rule the leaves drop and thus the greater part of the feed value of the hay is lost. This can be avoided in part, as can also the loss of over ripe seed, by cutting very early in the morning while the field is wet with dew.

A crop of clover hay requires great care in the curing while in the field. It must be thoroughly dry when hauled; and as its succulent stalks do not dry quickly, and the dense mass of its vines and leaves do not allow the sun to reach every part after cutting, frequent turning and spreading are necessary, requiring time and expense. In spite of these drawbacks, few progressive farmers will refuse to undergo the trouble of raising good clover hay, for its nourishing value is such that all stock is greatly benefited by it, even horses, though with them it may be necessary to moisten the hay with a sprinkler before feeding, to avoid irritations of their breathing apparatus by the dust that is generally found in the hay.

Cowpeas are preferred by many to clover for quick returns. The late varieties, if sown in May, may be cut for hay, and the roots will furnish new growth for a good pasture in the fall. If turned under the roots will furnish a large supply of humus for future use.

The earlier varieties of the cowpea may be sown in corn the last of June. They will ripen and make good pasturage for sheep or hogs. They can also be sown with a wheat drill at the rate of three-quarters of a bushel per acre after the grain crop has been removed. There will be a good growth which will amply pay for

the trouble and expense, both in respect to the fertilizing effect and to the shading of the ground during the fierce heat of July and August. For the same reason cowpeas will do well in an orchard if sown after cultivation has stopped.

The total production of our meadow lands in hay amounts to 50,110,906 tons, but this would not feed our horses, cattle, sheep, etc., for more than one-third of a year. The other two-thirds of fodder required must therefore come from other sources, from our pasture and grazing lands. A variety of nutritive grasses grows on the arid lands of the west, and the value of these and others cannot be easily estimated. Special investigations are being made by the Agricultural Department in Washington in regard to all these various grasses and their value for stock.

CHAPTER V.

ROOT CROPS.

Root crops are rarely a principal crop for Western farmers. Turnips are frequently sown in cornfields, after cultivation has been stopped, and a good yield is often obtained if the weather is favorable.

Carrots are rather a garden crop. They should be sown in rows and thinned out.

All root crops require a rich, well-drained and deep soil and thorough cultivation. The most important is the beet root, which is now being extensively raised in some sections for the production of sugar. Sugar beets are set out when the plants are yet small, and cultivated the same as cabbages. Where the soil is not friable and deep, the growth of the root is apt to be irregular and the yield in saccharine (sugary) matter insufficient.

The sugar beet, the same as other roots, consists mainly of water and carbon, hence it does not draw much fertility from the soil. As only the sugar is extracted, *i. e.*, carbon, hydrogen, oxygen, there is absolutely no loss in fertilizing matter, provided all the other parts are restored to the land.

This makes it one of the most desirable crops for the farmer, except for the fact that the setting out of the young plants and their subsequent cultivation require a great deal of labor. Where the beets can be

taken directly to a sugar factory, without shipping, the crop is a profitable one.

In cultivating the sugar beet, great care must be had to keep the roots completely covered with earth, as any exposure to the light and air will diminish the sugar in them.

Originally, this beet was small and contained very little sugar. By a process of careful selection the best seed only was used in a series of crops until the present sugar beet was obtained. This process is of universal application and just as applicable to other plants. New varieties of beet roots are produced even now by this process.

The manufacture of beet root sugar has assumed enormous proportions in Germany. Recently the United States have followed the example set by Europe, and accordingly we find large factories in many states, even as far west as Utah and California.

This industry seems to be threatened by the free, or partially free, import of cane sugar from Cuba, the Philippine Islands and Puerto Rico. It is believed, though, that the steadily increasing consumption of sugar in this country will avert the danger, enable the manufacturer to get a fair price for his product, and to buy from the farmer all the raw material in the shape of sugar beets that he may choose to produce.

Turnips, carrots, beets, etc., are biennials. They complete their root growth the first year and run up a seed stalk the second. In the growth of this stalk, and in the production of seed, the solid parts of the root are consumed, so that the latter presents at the end of the second year a thin and fibrous appearance. Roots grow vigorously in the fall, when the moist

weather enables them to draw on the nitrates which were formed in the soil in late summer.

Root crops require heavy manuring, except on new land. They need a great deal of mineral matter for their large leaves and the outer coating of the roots. It is, therefore, very important that these parts should be returned to the soil.

The roots commonly raised belong to different families. The carrot belongs to the same family with parsnip and celery, the umbrella-shaped, or *umbelliferae*, so called from the form in which their blossoms appear. The turnip belongs to the family called *cruciferae*, to which also belong the cabbage, rape, radish, mustard, wild and cultivated, wild flax, and the flowers candy-tuft and stocks.

The beet root and the mangel-wurzel (*root of want* or *famine*, because it proved a blessing during a famine in Germany) belong to the goose-foot family (*Beta cicla*).

Mangels grow enormously on rich soils and are raised by many farmers for stock.

CHAPTER VI.

POTATOES.

When the English navigator, Francis Drake, first sent potatoes from America to England, such was the ignorance concerning this article of food that the friend who received the potatoes and raised a small crop from them had the berries growing on the top prepared for a new dish and threw away the tubers, that is, the potatoes.

Potatoes are a root crop, differing from other root crops in that they grow from the roots. Such growths have the general name of tubercles, and hence we often hear the potato spoken of as the useful tuber.

While the potato has but little value as a food for strength, it is universally relished as an important part of our regular diet. Hence the consumption of potatoes is enormous and their cultivation one of the prominent objects of farming.

Near good markets, and especially within a reasonable distance of the very large cities, potatoes are a valuable crop. They contain so much water, and so little of nitrogenous matter, that they do not remove much fertility from the soil. They require a rich, deep soil; one underdrained, especially if it contains a certain amount of clay, being the most productive.

A crop of potatoes may follow directly after clover. As they require the very best cultivation and leave the land in excellent condition, they may be

profitably followed by wheat. An objection sometimes urged against this plan is that if clover sod is manured in the fall and plowed in the spring, the potatoes grown on such land are apt to be attacked by scab. For this reason it is recommended to follow clover closely by corn and to let potatoes come after corn. Manure may be spread in the fall and the ground sown to rye, which should be plowed up in the spring to make way for the corn or other crops. No further manuring would be necessary for the potato crop the next year.

Land for potatoes should be plowed early in the fall in order to kill the wire worms and grubs in the soil, and while the land is yet moist. This plan, however, interferes with a corn crop, as the corn occupies the ground till late in the fall, unless it is cut and hauled from the field early. The regular plow may be followed by a sub-soil plow, which will stir the ground to a depth of some 10 or 12 inches without bringing up the sub-soil. One advantage in plowing up clover sod for potatoes is in its being naturally mellow, thus making further preparation easy. Such preparation must be thorough, but plowing after clover requires only one going over the ground with the smoothing harrow, on which a plank should be laid to enable the driver to stand on it. This harrowing must be done before the soil has had time to become very dry, or else after a shower, allowing time for the surface moisture to disappear. For clay land the disk harrow is considered a better tool. It should be followed by the roller to secure the finest tillage before planting. There must be no clods, all the soil must be mellow, easily crumbling to the touch.

Potatoes should be planted in rows three feet apart (some recommend a shorter distance), and about 20 inches apart in the rows. Pieces with one eye are as good as whole potatoes, if not better. Choose only sound and well grown potatoes, not necessarily the largest, but do not plant the small ones. Like produces like, and fair-sized potatoes of even size sell better than a mixture of very large and very small ones.

It is important to guard against scab. This is due to tiny germs, invisible to the naked eye, that may harbor in the vessels, boxes, baskets, etc., in which the potatoes are hauled. Not only all seed potatoes should be washed in a solution of corrosive sublimate (one part in a thousand parts of water), but also every article in which they are carried and hauled. There must not be the slightest amount of dirt on any of these because dirt is the favorite hiding place of these germs. Where potatoes have been raised before, it may happen that these germs are in the soil. In such a case the safe way to do is to select a field that has not yet borne potatoes. Buying seed potatoes from a distance may introduce scab germs. They may even be found in the planter, and for greater safety it may be desirable to thoroughly clean and wash this instrument some days before it is to be used. If this is postponed until planting time, the probability is that it will not be done well.

After planting, cultivation must be kept up in order to get ahead of weeds and to secure that fine tilth which is as important as the proper manure for the success of the crops. When the ridges can be seen, as they can when a planter has been used, a horse

may be used to cultivate deeply between the rows. After this a Thomas harrow or other good instrument should be used with two horses, which must be kept between the rows.

One of the most successful potato growers in the country, Mr. Terry, recommends a Thomas harrow having seventy-two round steel teeth slanting backwards and taking a sweep of about 10 feet. He harrows only three rows at a time, lapping the rest of the width. After such a harrowing, it is well to roll the ground, if the weather is dry. But if rain threatens, this rolling should be omitted, because the soil would be more benefited by a rain if loose than if closely packed. If time permits, it would be advisable, in order to secure the highly desirable fineness of the soil, to roll and again harrow, and even to repeat this several times. After a rain there should always be another harrowing, as soon as the ground is workable, to prevent the forming of a crust. Sometimes it may be that the rain threatens while the weather is hot enough to kill weeds. It is then best to keep on harrowing, for one cannot tell whether there may not be rainy weather for some time, making it difficult to get ahead of the weeds. As long as the ground is dry, harrowing can do no harm, but will greatly help to destroy the weeds. Finally a crosswise harrowing should destroy all ridges and leave the field clear of weeds. After the plants come up no more harrowing should be done; yet slightly covering a young plant will not hurt it. However, great care should be taken that no soil is removed from a plant, as it would surely be injured.

Three harrowings before the plants start will be enough, as a rule. The work can be done quickly, hence there will be time enough. When the rows show, cultivation must be continued by means of a one-horse weeder; one that harrows only two rows at once is very useful, provided the ground is dry. If packed by rain a cultivator should be run first, followed by a weeder. In order that the latter may be beneficial, the soil should be just right for thorough work; not too dry, for then the weeder cannot take hold; nor too wet, for in that case it will clog.

The proper selection and use of the necessary tools is important. Hilling the plants is not recommended; the ground should remain level; but it is desirable to throw an inch or so of soil under the plants from each side. This will check weeds ready to start, and prevent the roots from becoming exposed to the sunlight. The throwing of so much of the soil can be effected by a sod shovel put on a small horse hoe. Whatever weeds remain after careful horse cultivation must be destroyed by hand weeding. No weeds should be allowed to go to seed under any consideration, if a paying crop of potatoes is desired.

The Colorado beetle, commonly known as the "potato bug," causes much trouble, though the pest seems to be on the decrease in many localities. The use of a shallow pan and paddle has been recommended where hand picking is used. Going through the rows you strike each bush with the paddle and let the beetles and their young drop into the pan. Beginning very early to pick by hand will prevent the laying of eggs, and therefore there will be a smaller crop of the pest.

It is best to begin with the outside rows, where the beetles are apt to settle when they arrive from other fields. Where the beetles are too numerous the plants may be sprinkled with a mixture of Paris green and water. Great care must, of course, be taken to prevent accidents, because Paris green, and also London Purple, often used in its stead, contain arsenic, a violent poison. Careless spraying with too strong a mixture will injure the vines.

The harvesting of a large crop of potatoes is now generally done by a machine. Hand-digging, if done by one who understands the work, is preferable when the crop is not very large.

Keeping potatoes for seed requires a good deal of care. They must be kept at a low temperature to prevent sprouting. For ordinary storing, in order to keep as much as possible the natural flavor of the potato, boxes or barrels should be used, and the potatoes should be well covered to keep out air and light. Special root cellars, perfectly dark, with arrangements to keep the temperature low by allowing currents of cold air between the piles (for which purpose narrow boards nailed together so as to form a pipe may be used), and cold storage houses especially built for the purpose furnish the best means for keeping potatoes. An increase of cold storage houses for general use is much to be desired.

CHAPTER VII.

VALUE OF DIFFERENT FERTILIZERS.

Every crop takes from the soil, as we have seen, a certain amount of mineral matter. Though the soil may be naturally rich in such matter, yet by continuous cropping the available part will become exhausted, and it is not always possible to make the rest useful for the crops, that is, *soluble*, so that the roots can absorb it. Drainage and cultivation will do much, a proper rotation of crops will help greatly, but there often comes a time when additional and special fertilizers are absolutely required to make certain kinds of farming pay. Barnyard manure is, of course, a perfect fertilizer and should always be saved and applied with the greatest care. But while it restores the fertile elements used on the farm it cannot make good the loss that comes from the cattle sold, nor from any other product that is sent to market. Some crops require more fertilizing elements of a special kind than others, and this again makes a special supply necessary.

Let us remember that the products of carbon, hydrogen, and oxygen, the stalks and leaves of grain, and the greater part of all root crops and of potatoes cost nothing, for these elements are in the air and enter the soil without difficulty. All starchy or wooden matter belong to this kind of products, and as starch turns into fat in the body of the animal, the

fatty part of any animal takes nothing or scarcely anything from the soil. The greater part of an animal is water. The same is true of all green crops, and of roots and potatoes. It is only the remainder, the nitrogenous and mineral elements that need to be considered.

In a ton of the following products the fertilizing elements were found to be in:

Butter	\$.48
Potatoes	2.02
Milk	2.80
Fat pigs.....	6.92
Wheat	7.09
Fat sheep.....	8.14
Fat calves.....	10.55
Fat oxen.....	11.80
Cheese	20.83

That is, in 2,000 pounds of butter there is only 48 cents worth of the fertility of the soil; all the rest is carbon and water. In the case of potatoes, 2,000 pounds take only \$2.02 worth of mineral matter, the rest being carbon and water. Cheese, takes the largest amount of fertilizers from the soil, but as it commands a good price, the fertilizer may be bought and yet leave a large profit.

The following table was prepared by the Geneva (N. Y.) Experimental Station, and though based on prices for produce in a certain locality and for a certain year, it is relatively correct everywhere. The value of the fertilizing element in the following products, based on the price of fertilizers in the market, was found to be as follows:

In a ton of cotton seed meal	\$28.60
In a ton of linseed meal	21.42
In a ton of wheat bran	11.65
In a ton of clover hay	8.20
In a ton of crushed oats	8.17
In a ton of corn meal	6.31
In a ton of timothy	5.48
In a ton of oat straw	2.58
In a ton of wheat straw	2.21

Hence, if stock is fed largely with the first seven articles, the manure obtained will almost restore the fertility taken from the soil in the production of cheese, and allow the farmer to take heavy crops of roots and potatoes at the proper time in the rotation of crops besides. The great value of cotton seed meal and linseed meal is becoming more and more appreciated, though not yet so much in the west as in the east, and in Europe more than here. This is because farmers are rapidly learning to understand that loss in fertilizing matter by the sale of stock, cheese, etc., cannot be fully made good by fertilizers produced on the farm.

The value of clover hay is very great and as clover has the further good effect of supplying the soil with nitrogenous matter, its value can hardly be over-estimated. It will be seen that to sell timothy hay at \$6.00 a ton, when the average yield per acre is less than $2\frac{1}{2}$ tons, yields but a small profit, if the loss in fertilizing elements be taken into account. For, according to the foregoing table, $2\frac{1}{2}$ tons would take from the soil \$13.70, while the price obtained for the hay would be only \$15.00, leaving a profit of \$1.30 per acre, provided each acre averages $2\frac{1}{2}$ tons. On the

other hand, if the crop be potatoes, and the farmer raises 6 tons to the acre, as he can if his land was in the best condition when planted, he will lose in fertilizers \$12.12, but will obtain for his crop even at the low price of about 25 cents a bushel, \$50.00; or, let us say at \$8.00 a ton, \$48.00, which will leave a profit of \$35.88 per acre, less cost of cultivation, \$6.00, \$29.88. In the case of the hay, if allowance be made for expense of cultivation, of cutting, curing and gathering the hay in, there would be a considerable loss. Hence the importance of feeding hay, corn and straw on the farm, and also of alternating with root crops and potatoes, in order to make farming pay and keeping and increasing the fertility of the soil.

In raising stock for market, it should be remembered that the more fat your animals carry the more profitable they are, for this fact takes no fertility from your soil. On the other hand, the bones, muscles, horns and hides contain a considerable amount of fertilizing elements, especially nitrates and phosphates. On many farms it has been found that the profit to be derived from fat stock is exclusively in the manure. By putting this manure on the land heavier crops can be raised, and the value of the farm increased proportionately.

Large quantities of guano (the excrements and remains of birds in the tropics), of saltpeter from Chili, which is a nitrate, and of seaweed on the Atlantic coast, are used to aid farms that need nitrates in their soils. Nitrates being soluble are easily washed from the soil. In the places where guano is found it rains very rarely, hence the nitrates are retained, and this is the principal

reason why it is so valuable. It needs close calculation as to the market price of these, and of the crops intended to be raised, in order to decide whether their use is profitable or not, but there is no question about this use becoming more general from year to year.

Considering the extreme importance of fertilizers it is a fact greatly to be regretted that so much of our farm manure is allowed to go to waste. The loss from neglect and waste of this important material has been estimated to be as much as one-half its money value.

The Missouri Experiment Station made a careful estimate, a few years ago, of the value of the farm manure in that State, and found it to be in the neighborhood of one hundred and fifty million dollars a year. It was believed that one-half of this amount goes to waste.

There are circumstances which make it impossible for a hard working beginner to save all his barnyard manure under a shed. He is compelled to expose it to the elements, but he can, nevertheless, do much to save the greater part. The important fact should be borne in mind that dry earth, dust, will absorb and preserve the ammonia which evaporates from the manure. Using the fine dust of the roadside, and when this is not available, scraping the surface earth from any plowed field for the purpose, will enable the farmer to prevent much loss from rain and leaching.

The manure should be piled up in layers of about a foot thick, each layer to be separated from the next by a lot of dry earth, and well beaten with the back of the spade in such a way that the surface slants in all directions. This will allow the rain water to run off quickly. It is also desirable to prepare the ground on which the

manure pile is to be built. Dig down a foot or two until you reach clay. With the help of some water tamp the ground well, using a small post with a smooth headpiece, or any similar tool, so that the surface gets as firm as possible. It will then be almost watertight. Fill in with manure, beating and tramping it down well, and add dry earth as before stated. In this way a large square pile may be put up that will lose but little of its fertilizing value, if not allowed to stay too long.

It may not be out of place here to call attention to the enormous waste of fertilizing material in our cities. Most of these actually lose untold millions in the value of the sewage which they allow to flow into rivers and lakes, or into the sea. The drainage canal, which was built to carry off the sewage of the city of Chicago, is undoubtedly a wonderful work, but the avowed purpose for which it was built would have been attained with an outlay of money probably not larger than the cost of this stupendous canal, if the sewage had been led into large reservoirs outside the city, whence it might have been pumped for irrigation purposes. The city of Berlin, with its larger population, does this, and the city of Paris, after studying the Berlin system, is about to adopt it and has already adopted it in part. Berlin afforded one of the most unpromising chances for the success of such an undertaking, the city and surrounding country being almost on a dead level, the ground very sandy and difficult to handle on account of much moisture that quickly accumulates in the lower strata. An enormous area of waste land, consisting only of sand, has been changed into soil of the most surprising fertility.

CHAPTER VIII.

SILOS AND ENSILAGE.

The word "silo" means pit. The early Mexicans used to keep their grain in pits, from a lack of buildings on the ground. "En-sil(o)-age" means putting into a pit.

But the modern sense of the term has changed. The first practice of ensilage, in the modern sense, occurred in Germany. It was soon taken up in Belgium and France. A publication in Paris, which appeared in 1877, made the subject generally known in this country, though the *American Agriculturist* had called attention to it as early as March, 1874.

Ensilage is the practice of keeping fodder in a pit by tramping and otherwise pressing it thoroughly, so as to keep out the air, and by covering it carefully for the same purpose.

The oxygen of the air (the word as explained before means sour-maker) brings on fermentation, which would soon end in decay. Hence the necessity of excluding it.

To build such a pit, or silo, involves labor and expense, and thus far the method has been adopted only by the more wealthy farmers. In order to be thoroughly satisfactory and permanent it should be built of stone or brick laid in cement. Great care should be taken to have a well cemented floor; over the top

there should be a roof to keep the water off, and drains should be laid which will take away any surface water. A tile drain near the bottom of the silo may be necessary in most localities.

At first only corn fodder, cut fine, was put into silos. Salt was used to preserve the corn and the process resembled that of making sourkrout; that is, of cabbage sliced fine, put into a barrel and then pressed down by weights. The cabbage ferments slightly and its own juice soon accumulates at the top to keep out the air. At present, however, the object is to prevent all fermentation and to keep the fodder as nearly as possible in its natural condition. It has been often claimed that fodder of any kind put up in silos has a larger feeding value than if fed dry. Cows, used to ensilage and then returned to pasture, have been known to shrink as much as 20 per cent in their milk in a few days. Silos are claimed to be more profitable than pastures, the latter being advisable only where land is very cheap. In building a silo of planks and boards it is necessary to provide a good bottom in order to keep the rats out. Use the best kind of cement for a floor. There must be no water around it. Lay drain tile outside to keep away all surface water. The walls should be of matched boards, the roofing may be cheap or expensive, but it should keep rain or snow out. In Illinois a round silo 20 feet in diameter, 38 feet deep, according to a good authority,* can be built for \$300.00 and will contain 250 tons of ensilage.

Grain cut for ensilage should be in the closing seed, or just as it begins to close. If put in too early, when

*Mr. H. B. Gurler, of Dekalb.

just tasseled, it is nine-tenths water. It costs from 50 to 60 cents to put in a ton of green hay. After the grain, corn, etc., has been put into the silo and well tramped down, enough water should be put on top to cover the mass completely. This is to give it sufficient weight to pack and to exclude the air. If not properly packed it will get mouldy. In filling the silo the mass should be frequently tramped. If cut fine the packing of the fodder will be more close, and the result more satisfactory.

Why ensilage produces such good results is a disputed question. It is probably due to its being more succulent than hay. The animal can digest such food more readily, and it will eat and assimilate more of it in that condition. If well handled ensilage has no bad effect on the butter made from the milk of cows fed on it. It is often claimed that the finest flavor of butter can be most surely obtained by ensilage.

If ensilage is to be largely used it is important to keep the land in good condition. The crops should be heavy to make the expense of handling as low as possible. Poor land cannot produce large crops unless it is well manured, and light crops increase the expense per ton on account of the extra labor.

PART III.

ANIMALS ON THE FARM.

CHAPTER I.

THE HORSE.

It will be some time before electrical power can take the place of the horse on the farm, though steam plowing has been practiced in Europe and some parts of the east for years. Nor is it likely that even with the general introduction of steam and electrical power the horse will be altogether displaced. It is a fair estimate to put the sum total of horses in this country at not less than 15,000,000. Most of these are used on farms.

While the farmer need not be a breeder of fast horses, it is as much his business, if he can afford it, to breed the kind of horses he needs on the farm as to do the same for his cattle. There are several breeds more or less adapted to the farm. The *Clydesdale*, of English breed, and the *Percheron*, French, are types of the best and heaviest draft horses. The *Hambletonian* and *Cleveland* are types of lighter and more active horses, especially well adapted to carriages.

Much depends on the lay of the land, the nature of the roads and the amount of hauling, in determining

Type of a Fine Horse

Rosa Bonheur.

the choice of the kind of horse most useful for a given locality. A good sire of established reputation should be chosen. The mare should be of a gentle disposition, with ample girth of body, sound legs, a broad forehead, clear eyes and a good, rapid gait. If horses are raised for sale it may be laid down as a rule that large horses alone should be produced, as they fetch the best prices. To compete with breeders of fast horses is not the business of the average farmer, although where the attempt is seriously made it may prove very profitable.

In buying a horse one should look well at the head and the teeth, but more particularly at the legs of the animal. The hoofs should be perfect. There should be no sign of weakness in the legs, as there would be if the horse, standing still, puts one front hoof before the other. A horse very long in the body is apt to be fast, but may not be enduring. For the farmer's work a more compact horse would be preferable. The outline from the back to the dock (back of the croup) should be as nearly straight as possible. The thighs and haunches should be muscular and full. Width of the forehead and a clear eye indicate intelligence, and a good bodily constitution.

The age of a horse can be told from the teeth, but minute details are hardly in place here. Examine the front teeth of colts and young horses and compare these with older horses whose age is well known. Facilities to do so are so frequent, and mere descriptions are so apt to be misunderstood, that personal inspection is by far the better plan.

The horse has a small stomach and therefore needs

to feed oftener than cattle; but overfeeding should be avoided. Instead of corn, oats should be fed more generally, especially in the summer. Clover hay should be moistened before feeding.*

In training a horse adhere to this rule:

Teach only *one* thing at a time, but do not give up until it is *well* understood.

To accustom the horse to the bit, hold the lines stiff, *without jerking*, after you have put the bridle on, and keep them so until he arches his neck, puts down his head and begins to champ the bit. This lesson is very important and should be well taught. Jerking a horse's mouth and unduly pulling the lines should be avoided. The horse should remain sensitive to the touch and keep the head down by arching the neck. Excessive checking up a horse, forcing his nose to be on a line with the driver's head, is not only a cruel, but also a very foolish practice. The horse does not look at his best that way, and is apt to become hard in the mouth, a great fault.

It is best to put a young horse alongside an old one when teaching him to pull. The load should be very light at first. It will soon acquire the habit of pulling a heavier load. Great gentleness is necessary, but any vicious attempt may be at once punished with the whip. A slight application will suffice. Cruelty will defeat the object. After driving a young horse a few times in double harness he may be tried alone, hitched to a light vehicle. With ordinary patience any one will succeed in getting good results.

When the young horse is put into the field it will

*See page 80.

Fig. 10—The External Parts of the Horse.

1. Face.	23. Elbow.
2. Forehead.	24. Forearm.
3. Ears.	25. Knee.
4. Muzzle.	26. Canon or shank.
5. Cheek or fowl.	27. Fetlock joint.
6. Poll.	28. Pastern.
7. Throat.	29. Coronet.
8. Carotid.	30. Foot.
9. Neck.	31. Ergot and fetlock.
10. Crest.	32. Haunch.
11. Jugular Channel or Furrow.	33. Thigh.
12. Breast.	34. Stifle.
13. Withers.	35. Buttock.
14. Back.	36. Leg.
15. Ribs.	37. Hock.
16. Girth.	38. Canon or shank.
17. Loins.	39. Fetlock joint.
18. Croup.	40. Ergot and fetlock.
19. Dock.	41. Pastern.
20. Flank.	42. Coronet.
21. Belly.	43. Foot.
22. Point of shoulder.	44. Lower thigh.
	45. Point of hock.

take a little time before he knows what is expected of him, but persistency and patience on the part of the driver will soon overcome its natural awkwardness.

If a horse balks the best thing to do is to let him stand until he concludes that balking is tiresome. Striking the horse, or unhitching him, will only perpetuate the evil. Balky horses are almost invariably made so by thoughtless or rough drivers. You can teach a horse to be useful and trustworthy; but remember, it will not do to teach anything new until the previous lesson has been well learned. The same rule applies to children.

The height of horses is expressed in hands. A horse 13 hands high or less is a pony; one 16 hands high is large. From 15 to 15½ hands is a good height for a farmer's horse, but if horses are raised for sale those 16 hands high will bring the highest prices, other things being equal.

In the accompanying illustrations the first shows the outline of a well-shaped horse fit to do good service on the farm and on the road. The names of its different parts are indicated by figures.

The other illustration shows the composition of the hoof, all the parts being named and numbered.

Fig 11—The Foot of the Horse.

- A. The pastern.
- B. The lower pastern.
- C. The navicular bone.
- D. The coffin bone.
- E. The wall of the hoof—the part on which the shoe is nailed.

The two following illustrations show a well trained horse of a superior breed.

Horses that have been kept inactive in a warm stable for some time are very sensitive to cold winds. These will do no harm as long as the horse is in motion, but

Allerton, one of the finest American Stud Horses, that made a mile in 2:09 $\frac{1}{4}$.

the danger begins when it stands at rest. The horse is liable to attacks of colic, particularly after hard work on the road or in the field, when it is exposed to a draught, or made to cool off in an exposed place. Little or nothing can be done by medicine in such a case. The best treatment is a wet pack. A cloth or blanket

dipped in cold water, wrung out and folded several times, should be placed on its belly and well covered with one or two dry blankets, which should be securely strapped on to prevent slipping off as the horse throws

The same horse, when three years old, with a record of 2:12.

itself. The application will soon produce warmth at the parts covered and thus relieve the pain.

Heat may be applied by hot blankets, but this method is apt to make the animal tender and more liable to a repetition of the attack. The essential point is that

heat, in one form or another, outwardly applied, is the specific remedy for colic. The horse should be placed where no draught can strike it, but where the ventilation is good.

To turn a horse into a pasture, after a drive, may often bring on colic. It is safer to rub it down well and allow it to cool off in a sheltered place before it is turned loose. Even on a summer's night the cool breezes may affect injuriously the bowels of a horse that is turned loose before it has had time to cool off in its stall.

In extreme cases of colic it may be necessary to administer an injection of warm water and soap, but this should be undertaken by some experienced person, or by a veterinary surgeon.

If medicine must be given the most convenient way is to mix it in some liquid, take hold of the animal's tongue and pour the liquid down its throat from a bottle.

Overdriving and quick cooling off may bring on stiffening of the joints of the horse's legs, especially the forelegs. It is a safe rule, when a horse has been hard driven, to give its legs a thorough rubbing down with a wisp of hay or straw, and keep it in a warm stable for several hours. This rubbing process should be continued for not less than ten minutes, fifteen or twenty minutes would be better. The process may have to be repeated if the case is a severe one.

Starting in the center of the sole of the foot, and running back to the heel, fork-shaped, there is an elastic horny part, the *frog*, on the healthy condition of which the free and elastic movement of the feet depends.

For ordinary farm work horses rarely need shoes, but if they are used on the road shoes may become a necessity. Good blacksmiths are now found everywhere—none but a good one should be employed. The danger from not shoeing at all is not so great as from improper shoeing.

Saddle Stallion MONTE CRISTO, of Kentucky.
A Prize Winner.*

The shoes should not be kept on the horse's feet too long, as they interfere with the growth of the horny matter of the hoof and may injure it by crowding. This is particularly important in the case of young horses.

If a horse gets hurt so that a wound or a swelling is the result, the parts should be well bathed and cleaned. In the absence of anything more suitable strong soapsuds may be used. But it is better to be provided with some disinfectant like borax (in the

Morgan Horse HILLSIDE.

form of boracic acid) and carbonate of soda. One-half pound of each in a gallon of water will make a good cleansing mixture. Carbolic acid may answer as well or better, but it must be greatly diluted, a five per cent solution being as strong as it is safe to employ. Frequent applications are necessary.

Large wounds should be sewed up by a veterinary surgeon. It goes without saying that the general rules of feeding and cleaning apply to the horse. It should be fed with great regularity, and receive a thorough currying and brushing every day. Very old horses should have their oats or other feed steeped in hot water for from ten to twelve hours. In this way they may be kept in good condition for a long time and prove serviceable for all ordinary work.

CHAPTER II.

THE HOG.

An enthusiastic breeder has called the hog "the sheet anchor of our prosperity." We may say that the hog is the best agent to convert our immense and bulky crops into a less bulky form, and to enable the farmer to market his corn in this form with but a small expense for transportation. The corn converted into hogs has the advantage that it can be driven to the market, whereas the corn in the ear, or shelled, must be hauled many miles and loaded and unloaded at a great sacrifice of time. And last, not least, while a thousand pounds of corn sold in its original form will take from the farm a large amount of fertilizing matter, the same quantity, put into a hog, will remove scarcely one-fifth as much.

The hog makes more weight of body out of a given quantity of feed than cattle or sheep. This is due to its much longer intestines, as long as those of cattle, which makes possible a more perfect absorption of all nutritive elements. It is easily raised and need not be kept over winter (except the breeding animals, of course) if the proper treatment has been given to it throughout the time from March to November or December.

Pigs should be farrowed early in March and weaned in June when they may be turned into a clover pasture, the cheapest food for them at the time, and on which they thrive best. As sucklings they should

have sweet skimmed milk with wheat middlings. Some ground corn, and finally corn in the ear, may be added later on. While feeding on clover the young pigs should also be given some of the slop they were fed on at first, and as much corn as they will eat up clean. With such a variety of food they will make muscle fast and grow to a good size. Anything that will make their food more digestible, as soaking the corn feed from twelve to eighteen hours or longer, will be a saving in the long run. Good shade and good water must be furnished whenever needed. When from 7 to 8 months old they will have attained, under such treatment, a weight of from 200 to 250 pounds, and command the highest price in the market. Too much corn should not be given at first, but rather a variety of food, slop, middlings, oats and rye in combination. In this way their health is more apt to remain good. As cooler weather approaches corn may be more abundantly fed, and in the last months it may be the only feed.

Clover may be relied on as an almost exclusive feed until the time of special fattening. The experiment has been repeatedly made of limiting young pigs during the summer to red clover alone, then gradually feeding on corn, with the most satisfactory results. The reason for this lies in the fact that the starch so abundant in corn produces fat, and that in the warm season an over supply of fat is too heating. When colder weather comes the system needs a larger part of the fat to supply warmth to the body by the more liberal supply of oxygen due to the more energetic breathing. In this way the danger of an over supply of fat is

avoided. Such pigs keep in better health and are less liable to succumb to cholera.

New corn is not to be recommended. It has a tendency to injure the digestion of the hog, and some think it produces hog cholera. If great weight is desired the hogs may be kept through the winter and spring, but it is a question whether the food they need during the cold season may not seriously diminish the profits which early fattening will secure. If hog cholera ap-

Fig. 12—Carcass of a fat hog showing the division commonly made and the relative prices of the various parts in Chicago market.

pears, nothing is more necessary than at once to separate all animals that are undoubtedly well from the sick ones and give them another place. If the sick ones are separated and removed to another place, there is danger of carrying the disease germs to other parts of the farm. The well ones should be put into a grass lot, at some 80 rods' distance from their former place, and great attention given to cleanliness. The sleeping place should be cleaned every day, and air-slacked lime and carbolic acid and water used to disinfect it. Corn should not be fed, but oil meal, oats and middlings should take its place.

Hogs should have access to a mixture of ashes and salt, which seems to be beneficial in preserving their health.

In raising hogs, as in raising other stock, the progressive farmer will take care that he keeps only the best breeds. His object is to change the raw product of his farm into pork with as little loss as possible. It has been found that to do so most successfully requires breeds like the Chester White, of Pennsylvania, the Poland-China, of Ohio, the Duroc or Jersey Red, of New Jersey, the Yorkshire, derived from the large white swine of England, the Black Suffolk and the Berkshire, which we also got from England. The Berkshire is by many considered the most profitable.

A Tail-Piece.

CHAPTER III.

CATTLE.

Our cattle industry is of immense importance. Cattle are kept for two principal purposes, to produce beef and to furnish milk. Different breeds will do either the one or the other in a superior way. Beef cattle are square built, heavy in the haunches, very full in the breast. The best varieties came originally from England, as the Shorthorn, or Durham, the Hereford, the Aberdeen-Angus of Scotland and the Galloway. Dairy cattle are thinner in front, not so square built, but show

Fig. 13—Hereford Cattle. Three Prize Winners.

great size of the udder. The best varieties are: The Jersey, from the island of Jersey, near the north coast of France; the Guernsey, from the island of that name, near Jersey, and the Ayrshire, from Ayrshire, in Scot-

Fig. 14—Models of Beef Cattle.

1. Mouth.	17. Shoulder Point.	33. Plates.
2. Nostrils.	18. Shoulder Vein.	34. Rumps.
3. Lips.	19. Elbows.	35. Hips.
4. Muzzle.	20. Arm.	36. Thighs.
5. Face.	21. Knees.	37. Hocks.
6. Eyes.	22. Shanks.	38. Hind Leg.
7. Cheeks.	23. Hoofs.	39. Brisket.
8. Jaws.	24. Crops.	40. Bosom.
9. Forehead.	25. Fore Flank.	41. Chest.
10. Poll.	26. Fore Ribs.	42. Loin.
11. Horns.	27. Mid Ribs.	43. Hooks.
12. Ears.	28. Hinder Ribs.	44. Purse.
13. Neck.	29. Barrel.	45. Twist.
14. Throat.	30. Belly.	46. Pin Bones.
15. Dewlap.	31. Spine or Back.	47. Tail Head.
16. Shoulders.	32. Flank.	48. Tail.

land. When butter is the main object, the pure Jersey is generally considered superior to all others. A breed which yields much milk, though not of a superior grade for butter, and is at the same time capable of producing much beef, is the Holstein, or Dutch Friesian, from the northwestern coast of Germany.

Fig. 15—Best Type of Dairy Cattle.

As in the case of hogs, the advantage of raising cattle is in thus saving the cost of moving bulky farm crops to the market. Fed to cattle, the farmer's grain and hay will walk to the market. As the manure stays on the farm, the loss to the soil is not so great and there is of course profit in the beef and dairy products.

Cows, to give the best results, must be treated with great patience and kindness. A rude word, a kick or a blow is a loss to the farmer, for it is only the perfectly contented cow that yields her best in milk and butter.

Regularity of feeding is of importance with all animals, but more particularly with cattle. Hence, the business is very confining if it is to be made profitable. Perfect cleanliness is of great importance. It pays to curry cattle as well as horses. Their stalls should be regularly supplied with clean straw. This also saves the droppings and the liquid manure, which is of great value. Cattle have no upper front teeth. They tear the grass by means of their tongue and the lower teeth.

Fig. 16a—Red Polled Cow. A Prize Winner.

This is the reason why they do not crop a pasture so closely as horses will. Their four stomachs enable them to take a great quantity of food at a time. This is returned to the mouth and chewed again, an act known as "chewing the cud."

As horns are not of any use it is the custom of many farmers to dehorn their young stock. It must be done quickly and with care, to avoid injury to a delicate part of the head. There are some breeds of hornless cattle which are now pretty common in this country. They are called "Polled Cattle," such as the "Polled Angus" and the "Red Polls."

Fig. 16b—Shorthorn Bull Cupbearer, a leading Prize Winner.

CHAPTER IV.

SHEEP.

Sheep are raised for their wool and also for their flesh, which has the name of mutton, from the French word for sheep. They need a dry place to sleep, and prefer upland and hills for feeding. There are a large

The market classifications of wool. In the plate on the left hand samples of clothing wool are shown. A clothing wool has a fiber up to two inches in length that is sound; if the fiber is over this length and is unsound it becomes a clothing wool because of this fact. The sample shown on the extreme left of this plate is long enough to be a Delaine, but it was unsound at the place where the fiber shows an irregular crimp. The two samples shown in the center plate are fine and medium Delaines. The fiber in these instances is sound, fine and from two to three inches long. The three samples in the plate to the right are combing wool; they range from three inches upward in length and are also sound. The shorter sample is medium combing, the center sample is coarse combing, and the third sample on the right hand is the coarsest kind, known as braid combing.

number of breeds. The best for fine wool are the Merino; for medium wool, the Southdown, Shropshire, Hampshire, and several others; for coarse wool, the Leicester, Lincoln and Cotswold. The Merino pays best when a protective tariff keeps out the cheap wools of South America and Australia. No American farmer can afford to raise wool in competition with the people of these parts of the world. Sheep require particular attention at the time when the lambs are dropped. It is important to watch the latter that they may not stray from their mothers during the first days of their life. A ewe will not own its lamb after an absence of a day or two.

Imported Shropshire Ewe Lambs.

The sheep is a hardy animal and not much subject to disease, unless exposed to moisture. It endures cold well, but must be provided with a dry stable. Some

Hampshire Down Sheep.

succulent food, beets, turnips, etc., is desirable, especially in the winter, but it thrives well on the same feed that is suitable for a cow.

A Lincoln Sheep. A Prize Winner.

The importance of breeding only thoroughbreds holds good of sheep as it does of any other stock. It is a great mistake to suppose that by mixing breeds the good qualities of each will appear in the offspring. It is just as likely that the bad qualities appear. New races are produced by in-and-in breeding, but it requires great experience, much time and necessarily much money to repeat in this line what others have already done for us.

Therefore the rule should be: Breed only from pure stock. If you wish to improve the stock you have, use only thoroughbred sires, and always the same breed. In this direction lies success.

CHAPTER V.

THE DAIRY.

The cow is, in a certain sense, a machine to produce milk, and through the milk, butter and cheese. As a machine she ought to be of the most approved kind. There are still many poor cows in the country. Any cow that is not able to yield 300 lbs. of butter, or an equivalent, during the year, may be put down as unprofitable. Poor cows eat up the profit yielded by the others.

A cow that eats more than her milk is worth is jokingly called a boarder. This fault often exists where it is not suspected; but it is no longer excusable. Milk is now tested by an instrument called the *lactometer*, which shows the proportion of cream. At a well-known creamery it was found that during the month of November the patron whose milk showed the highest proportion of cream received \$1.42 per hundred pounds of milk. The patron whose milk showed the lowest proportion received only 89 cents, a difference of 53 cents per hundred pounds.

In December the difference was \$1.59 for the highest, 99 cents for the lowest, a difference of 60 cents.

The milk of different breeds has been accurately tested at the agricultural stations of Iowa, Minnesota, Wisconsin, Illinois and other states, and a great waking up among the farming population has been the consequence. But these experiments have also shown that

the best results cannot be obtained unless some necessary conditions are complied with.

In order to make a good cow do her best she needs (1) suitable food at regular hours; (2) good water to drink; (3) a warm and comfortable stable during the cold season and shade and good pasture in the warm; (4) kind treatment. "Treat a cow as you would a lady" is the rule of a successful dairy farmer.

On each of these points a great deal might be said or written, but it is perhaps sufficient here to remind

A MODEL DAIRY COW.

Jersey Cow DOLLY'S VALENTINE. Yearly test, made by Kentucky Experiment Station, 679.5 pounds butter.

the reader that the object is to turn as much feed as possible into as much good milk, butter or cheese as possible. This is the object, and whoever wishes to gain this object must not fail to apply the means to obtain it. But this is not all. The milk, butter, cheese produced must be palatable, inviting and salable, and

ANOTHER MODEL DAIRY COW.

to that end it is necessary that the greatest care be exercised in the matter of cleanliness and in the proper observation of certain rules. Boiling water should be freely used for the cleaning of pails, cans, separators and churns after every use of them. Cold water is needed for other purposes. The use of the separator, a machine which separates the cream from the milk,

is strongly recommended. It leaves both cream and skim milk sweet. The former commands the highest price in the market. The latter can be used for feeding pigs, as it contains the most valuable parts for feeding purposes and is greatly superior to sour milk; it may also be used in the household for the preparation of various dishes. If set in cans or pans the cream will rise and may then be taken off. But by this time the milk will frequently be found to have soured. The souring is due to the change of the soluble sugar element in the milk into an acid which has received the name of lactic acid (acid of milk), from the Latin word *lac*, which means milk. A part of this acid enters into the cream so that this also will be sour. Its effect on the casein or curd in the milk is to harden this into an insoluble substance, the process being known as curdling. This souring process is due to very minute plants called ferments, such as are also found in yeast. They increase very fast and produce changes in the substance in which they are found, in bread dough, in the milk, in cheese, and in others. They are always present and ready to settle upon any object that is not perfectly clean, and, if there be moderate warmth and moisture, they develop with fabulous rapidity. A milk pail, not cleaned after use, will be infested by large numbers if it is allowed to stay uncleaned for a few hours. They are the cause of the bad taste of many liquids after they have stood a while exposed to the air, of milk, wine, beer and the like. Cold will check their growth, hence cold water is necessary in butter-making and in the dairy generally.

Whether to use shallow or deep pans or cans must

depend on circumstances. If the cans can be kept in flowing water of a temperature of from 40 to 50 degrees for rather more than 12 hours, good results will be obtained with deep cans. Shallow setting requires a room well ventilated, the temperature of which is 60 degrees or less. It should never be higher. The churn used for making butter of cream thus collected will not do for fresh and sweet cream. A special machine, called an extractor, is used for this purpose. The cream obtained by setting in cans should have a certain quality, it should be *ripe*. This again is produced by ferments. It requires care and experience to know when the cream is just fit for churning. To arrest fermentation it may be first warmed to 140 degrees Fahrenheit for a few minutes. This will kill the ferments, and the milk or cream will be *pasteurized*. The name is given to the process in honor of the celebrated chemist, Pasteur, who studied subjects of this character for a long time and suggested the best remedies. In that case the proper ferment must be added to ripen the cream, and in this way butter-making is removed from the haphazard condition and placed under the control of the buttermaker.

The particles or globules of fat in the milk, which form the cream, are not transparent, and being lighter than water they rise to the top. These globules differ in size in different kinds of milk, though they are always so small that a microscope of great power is required to see them. Large globules will rise more rapidly than small ones. Milk that contains mostly large globules of fat will suit best where butter is the

object. For cheesemaking the milk with small globules is suitable.

Whether there are more or less of such globules in the milk can be ascertained by an instrument called the lactoscope, which enables us to determine how much water must be added to the milk to make it transparent.

While there is great difference in the milk of different breeds, it is a rule well understood by good managers that the milk richest in cream is in the "stripings." A cow should be milked completely; no milk should be left in her udder when the milking is done. Careful milking will gradually increase the yield, provided the feeding is properly attended to.

Fig. 17—A Jersey Cow.

The churn separates the butter from the cream. As soon as the little grains of butter appear the churning should stop for a few minutes to allow these grains to come together, and finally the buttermilk is drawn off. The butter is then washed in cold water and worked in such a way as to free it from all traces of buttermilk. Too much working destroys its fine quality and may make it oily. Salt is added for its keeping qualities. It attracts the moisture in the butter

Fig. 18—A pair of Holstein Calves bred by the Iowa Agricultural College.

and thereby prevents spoiling from the buttermilk it may still retain. If any other element than pure butter be left in the mass, such as sugar, or lactose, or casein, the ferments will soon be at work and make the butter rancid.

It is now a pretty general custom of farmers to send their milk to a large dairy or butter factory of which there are now a great number. These factories weigh

the milk they receive and pay by weight instead of measure. This is proper, and it encourages the raising of cows that give rich milk rather than much milk. The best breed for the production of butter is the Jersey. The greatest milker is the Holstein, and its yield in butter, with proper feeding, is claimed to be satisfactory.

Milk also contains the element which produces muscle. This is called casein. Like all muscle formers *casein* is essentially nitrogen, as is also albumen, found in the white of the egg and also in milk. Casein and albumen combine with the fat of the milk in making cheese, which therefore contains these elements along with water and some mineral matter. The following table will show how these elements are grouped in a hundred pounds of milk, butter and cheese.

	Casein and				
	Water.	Fat.	Albumen.	Sugar.	Ash.
Whole milk	87.0	4.0	3.5	4.8	0.7
Skim milk	90.0	0.5	3.0	5.0	0.7
Butter	10.0	86.5	1.0	0.5	2.0
Cheese	35.0	33.0	28.0	0.0	4.0

Cheese-making is a particular business which must be specially learned to be successful. Fresh cheese or curd cheese is simply milk curdled and deprived of a part of its water. Cheese-making begins with causing the milk to curdle and its fat to join in one mass with the casein. This is done by means of rennet, an extract taken from the calf's stomach. The water is then poured off. This fluid contains the sugar of the milk, and some of the other elements. It is called whey, and while fresh will answer a good purpose as

a drink for pigs. The curdled mass is properly salted and run through a mill. It is then put up in packages and taken to the curing room, which is kept at a warm temperature. Now a variety of ferments begin their work in the cheese and finally give it the peculiar flavor which makes it acceptable to consumers.

Cheese contains more muscle-forming elements than any other food. These elements, albumen, casein, etc., are sometimes embraced in the title of "proteins." Lean meat comes next to cheese in this respect, and the legumes (beans, peas, lentils) follow closely. But cheese is not easily digested, which detracts from its value as a general food.

We have called attention to the necessity of cleanliness. This is understood by the dairyman when he filters all milk as quickly as drawn from the udder through fine cotton cloth. Clean cheesecloth or some suitable paper should be used in which to wrap the butter before it is offered for sale. It is not enough to do every part of the work neatly; there should also be the outward appearance to give the impression of perfect cleanliness and neatness. Butter, well made and nicely packed, will command a price sufficiently higher than that paid for the common article to offer a strong inducement for the extra trouble. As so much depends on the cow, a few words as to the kind of feed for cows must be added. There is nothing better than clover-hay, cut in the blossom and well cured, though any other well-cured hay will do quite well. As a rule hay is cut too late. The grass should be cut when it is in bloom. It then contains the largest proportion of foodstuff in its stalks, and especially in its leaves or

blades. Middlings and bran are first-rate, but a change now and then is always advisable to keep up the appetite. Corn is too heating in summer, but will do very well in winter, especially if first ground and mixed with bran or middling.

The animals ought not to have their mangers full all the time. A period of rest is necessary, but whenever feeding takes place it should be at the same hour, if possible at the same minute. And so with watering. In the winter the water should have the chill taken off. Warmth saves food and increases its effect. Keep your cows contented, avoid everything that may cause restlessness or irritation. Unless you are very gentle the business does not pay.

CHAPTER VI.

POULTRY.

The "American Hen" is a very useful bird, as everyone knows. But everyone does not know how useful she really is. The poultry business of the country has assumed enormous proportions. The facilities for sending eggs, poultry and fowl to a good market have been vastly increased, and in many parts of the country there are now cold storage houses which keep eggs in good condition for a considerable time. The result is that poultry raising has become a profitable industry.

Among the advantages and improvements gained the poultry raiser will readily count the incubator. This instrument is now made in such satisfactory shapes and conditions that one may count on nearly every sound and fertilized egg to be hatched by it. The incubator enables us to hatch our first chicks any time from January to March and to get them to market in good condition while prices are yet high. Chicks raised late in April or during May must be extra well fed to make them nearly as profitable. But it is not the business of the regular farmer to make a specialty of poultry. He raises as many chickens as he can for the purpose of having fresh eggs and fried or roast chicken on his own table and only sells what he cannot thus use.

Chickens are unwelcome in the garden, hence either the chicken yard or else the garden must have a tight fence around it. They also injure the grapes and take

some of the small fruit. It is therefore not always possible to allow them to run free at all times.

The place chosen for a chicken yard should have good drainage; it should be naturally dry. House your chickens in a house as warm as you can afford to build. If built of boards, use building felt or tar paper or double walls to keep out the cold. The south side should be all windows. A door may be at the east side. Put a layer of dust (that gathered on the road when the weather is very hot will do first-rate) about a foot thick on the bare floor, and renew it as often as it becomes foul. Breed only pure stock. If you have any scrub stock dispose of it at once. Buy a setting of eggs from a reliable person, or several settings if you like. A quicker way is to procure a trio of birds of a desirable pure bred kind. If you don't wish to sacrifice the stock you have, kill all the roosters of the non-descript varieties and breed your hens to a pure bred male of the desired variety. This will give you in a few years a superior race of fowls.

Some believe that the best breed thus far produced for the purpose of getting both chickens and eggs is the *White Wyandotte*. Next to this stands the *Plymouth Rock*, and some may rank it higher. If the object is to have eggs in winter and to raise very fat, showy and heavy chickens, the Asiatic breeds, *White Brahma*, *Cochin China*, etc., are the most desirable. Merely for eggs the Mediterranean breeds do best—the *Leghorn*, *Black Spanish*, etc.—but these breeds are so small that there is little or no profit in selling the birds. As it does not pay to keep hens beyond the second year, and as one-half of the chicks are males, which must be disposed of in the first year, it follows

that, unless eggs sell for a high price all the year round, it is better to keep a heavier kind.

From the most recent experience of practical poultry raisers we gather that the results obtained from the incubator are not so extraordinary as is sometimes claimed. One-half the number of good strong chicks of the total of eggs placed in a machine is considered a good average, and this is no more than may be obtained where a good many hens are employed.

The loss by infertile eggs is from 25 to 40 per cent in winter, and from 10 to 15 per cent in spring months. While the incubator and brooder are necessary aids to the professional poultry man, they cannot be recommended for use by the farmer.

Among the reasons why the White Wyandotte is preferred by many as the best general purpose fowl, the following are mentioned: The fowls of this breed mature a month earlier than the Plymouth Rock, have more breast meat; in fact, are fat, plump and ready for the table any time after they are twelve weeks of age. They should then weigh at least three pounds, and with good care will gain a pound per month, up to six or seven months of age.

For eggs alone the year round it is now claimed that the most profitable are the Minorcas. They are one to two pounds heavier than the Leghorns and lay eggs one-third larger. They are considered just as hardy and prolific as the Leghorns.

Chicks need no food the first twenty-four hours. They should then be fed coarsely ground wheat, mixed with one part of cornmeal, cooked and moistened with milk. Cooked cornbread and milk will be even better, especially if early fattening is aimed at.

Use a trough for feeding. This should have an upright board at the back in order to prevent the chicks from fouling the food with their feet. An abundance of fresh water is important, and there should be a supply of some kind of grit always within reach of the chicks. As in all other cases, the best results are obtained with regular and proper feeding.

Where circumstances are favorable, turkeys are the best paying birds to raise. The bronze turkey is recommended. Keep only the most promising young birds for breeding purposes. The male should be at least one year old, but two years is better. These precautions are necessary to secure hardy poults, the risk from the loss of young birds being very great. The young poults need close attention during the first few weeks. They must be protected from vermin and from cold and wet weather. They should have wheat bread soaked in milk twice a day at very regular hours for the first week. Onions or clover finely chopped are valuable additions. Later the feed should consist of a bread made of ground wheat and cornmeal in equal proportions, mixed with sour milk and soda and well baked. Curds may also be fed, and sweet milk is always safe. As soon as they "shoot the red"—that is, show the red growth about the neck—they may be allowed freedom to seek their favorite food, insects. They may wander far from the place, and in order to secure their return it is necessary to feed them at home at least once a day, in the evening. If this be done regularly they will not fail to put in an appearance. Sometimes, however, it may be necessary to feed them twice a day. All young turkeys should be marked

with a marker (the cost is 25 cents), in order to prevent loss from mixing with other flocks.

Ducks are very desirable. The White Pekin are preferred, as they are large and hardy, and on account of their white feathers, which bring a good price in the market. They are easily kept in any low shed and grow well without water for swimming. They should be well fed, as they will grow to a good size in from five to six weeks and can be then sold at a good price. Fowls for marketing should always be well fattened in order to bring the best price. They should be kept in close, somewhat darkened quarters, which must be kept scrupulously clean. They should be provided with charcoal and with as much rich food as they will eat up clean. Feed three times a day. Corn should be the main feed, but a mess of bran or ground soja beans with milk, fed once a day, will furnish a desirable variety.

Chickens and other poultry are often greatly troubled with lice. Coal oil is probably the best remedy. Their roosting poles should be kept clean and often washed with coal oil. The dust bed in the chicken house and wood ashes outside will help to subdue the nuisance. The roosting poles should be all on the same level. For nests boxes may be used, each one marked with a peculiar color to induce the hens to use always the same box. Conveniences for access to these nests easily suggest themselves. Much can be learned from successful breeders by visiting their poultry yards.

If a chicken cholera or any other infectious disease kills a fowl, it should be at once buried out of sight and possible reach to prevent the spreading of disease germs. Destruction by fire would be even safer.

We have mentioned the WHITE WYANDOTTE as the best general purpose chicken, but as there may be a difference of opinion on the subject we will quote what the American Agriculturist said a few years ago about this breed: "All varieties of Wyandottes are of great practical worth, but the white variety is accepted everywhere as being the practical fowl *par excellence*. It is being adopted by the great market poultry men more universally than any other fowl. Its white plumage makes it dress off in a very handsome shape, while its dressed shape is almost ideal for market purposes."

A successful poultry raiser, Mrs. Carter, of Hammond, Ill., lays down the following rules for the care of poultry:

"A good insect powder should be plentifully used in the nests of setting hens once each week. The coops should be painted with coal oil, black oil, turpentine and carbolic acid once every ten days, also the roosts of the poultry houses should be kept well painted with liquid lice-killer, composed of two gallons of coal oil, one half gallon of turpentine, one gallon of black machine oil and one-half gallon of crude carbolic acid.

"Give regular feed and water. Always feed grown fowls corn at night. Feed some bran, corn-meal and shorts well mixed with warm water first at morning in cold weather. Put sheaf oats and wheat in the scratching shed every day in the winter time. In the fall put away sheaf oats to feed to the chickens in the winter time.

"Sell all hens before the first of January that are two years old.

"Feed parched corn once a week in winter. If possible have a patch of sunflowers for the fowls to run to in summer.

"Keep feed always where the young chicks can get it; millet seed is the best for growing chickens.

PART IV.

FRUIT.

CHAPTER I.

THE USES OF FRUIT.

To be a farmer and not to have fruit and vegetables in abundance is to deprive one's self of one of the greatest privileges of country life, and of the best means to secure health and enjoyment on the farm. A baked or raw apple is a more suitable article of dessert than a piece of pie. Cherries, plums, grapes, strawberries, raspberries, blackberries and even gooseberries and currants are delightful in their season and may be canned for use later. The farmer ought to have the best of everything that his farm can produce, for the good of his family and for himself. And why should he not? Why is it that so many farmers seem to look upon salt pork and potatoes as the all-sufficient articles of diet the year around? How many farmers' wives, in order to have some variety on their tables, gather and preserve the harsh and woody crab apples of the woods? It is all very well to pick the wild plum, which in some localities makes very fine eating, and also the wild strawberry and the wild grape, but how much superior are the cultivated varieties! Plant the

early Richmond cherry. There is nothing nicer to eat fresh from the tree, provided the cherries are thoroughly ripe. And what a splendid fruit it is to put up in glass jars, so refreshing, so nice to eat, so handy when there is company for supper, and so healthful at all times! Almost as much can be said of the humble gooseberry. Of plums we can raise the Miner and the Wild Goose varieties in most of the States, though destructive insects may destroy all others. Pears succeed here and there, but the fireblight is their terrible enemy. So do peaches in favorable years when spring is late and winter has not been too severe. Grapes do well with proper attention to pruning.

But the apple, in some of its many varieties, can be raised almost anywhere in all our States, and what is there better than well prepared apple butter or a delicious baked apple? There are few farms that have not some specially well adapted soil to raise strawberries, and who that has ever eaten strawberries fresh from the vines, and, perhaps, if such be his taste, with some of the rich cream that the farm can give, would want to be without a strawberry bed? After these berries come the raspberries, and finally blackberries, so that, if only a few kinds of fruit should succeed, there are enough varieties of delicious fruit to supply the farmer's table the year around. A successful fruit raiser, Mr. Dunlop, once said at one of our farmers' institutes: "The farmer who fails to take advantage of his opportunities in this line fails utterly to appreciate what a life upon the farm means, and ought to move to a coal-mining town and go to work in the

mines. The grass, the trees, the sunshine, the vegetables of the garden, the fruit of the orchard are all wasted on him. Believing that salt pork and potatoes are 'more fillin',' he has no time to waste upon a fruit and vegetable garden. Should the children become sick on such a diet he has recourse to the bottle of patent medicine, and when through their perversity, or lack of appreciation of life upon such a farm, the sons and daughters seek the city, he wonders why the children leave the farm."

A boy used early to fruit is not apt to learn to relish alcoholic drinks, fruit eating being a natural antidote for that depraved appetite. The effect on the body is extremely wholesome. For some kinds of sickness apples and grapes are specifics.

Extensive fruit culture is not the proper business of the farmer, but this is no reason why the farm should not produce all the fruit and vegetables the people on it can consume.

CHAPTER II.

THE APPLE.

For apples a northern slope is preferable, as in such a position the trees do not bloom so soon, and thus escape the injurious effects of late frosts. Plow the ground as for corn; running a subsoil plow after the first plow will deepen the soil and prove of great advantage to the growing tree. Set your trees not less than 30 feet apart, or about 50 to the acre. Late keepers should be chosen, with only a few specimens of earlier kinds. Among the latter the Duchess of Oldenburg should have the preference; among the former the Jonathan, Winesap, Gano, Minkler, and for an extra late keeper that bears well in many localities, the Willow Twig. Wherever it has been known to do well a few specimens of the Bellflower, our finest apple, may be planted, but it is a late and somewhat shy bearer. Of the other varieties, plant only such as have been tried in your neighborhood. The Ben Davis is widely grown and bears abundantly, but its fruit cannot satisfy anyone who knows what is meant by a good apple. It is greatly inferior to almost any other apple, but is a good seller on account of its bright red color.

As to cultivation, it should be the same as for corn. You cannot profitably raise two crops, one of apples and the other of weeds, grass or whatever else, at the same time and on the same piece of ground. The apple tree quickly extends its roots in every direction.

While the trees are very young, from one to at most five years after planting, crops of potatoes, tomatoes, cabbage or small fruit may be raised between the rows at some distance from the trees. Later on a good disk harrow, followed by a smoothing harrow, should be persistently used to keep the soil in a mellow condition, thus preparing the same kind of earth mulch that is so useful for corn. Under no circumstances allow grass to grow in the orchard. It is not objectionable, and possibly useful, to sow clover late in summer, but on condition that the crop be plowed under early in the spring.

Soja beans, or cow peas, being of surer growth, may be sown instead of clover. Great care must be taken not to injure the roots of the trees during cultivation. The roots are apt to be near the surface in good soil. It has been suggested that rather deep plowing between the rows from the very beginning will force the roots to form at a greater depth; but once they are formed any injury to them means loss to the tree and to the owner.

In order to be able to run a plow as near as possible to the trunks of the trees, it is necessary that the trees be trimmed up several feet, so as to enable a horse to pass. The objection is that trees do better if their branches start near the ground, hence a middle course will probably answer best.

Cultivation ought to stop early in August in order to avoid a late growth that might be hurt by the cold of the winter. As all cultivation should come as near to the trunks of the trees as possible, the harness should be without hames and singletrees. Sometimes

it may be advisable to apply a mulch of some kind to prevent grass and weeds from growing near the trunks. Grass may be taken from meadows near by and spread as a mulch for this purpose.

As to the age of trees to be planted, it is now pretty generally agreed that trees three years old give the best satisfaction. Older trees should not be planted, but trees two years old will do very well. The trees are generally greatly mutilated in their roots when they come from the nursery. The tops should therefore be shortened in by cutting off enough to match the size of the roots. All pruning should be done either before the sap begins to move in the spring, or when it is

Fig. 19—A Section of an Apple.

- A. The seeds.
- C. The calyx end.
- E. The core (or seed box).
- T. The pulp.

Fig. 20—Section of an Apple Blossom, showing how the apple begins to form.

descending after the terminal buds have formed. If old trees are pruned, it will be necessary to cover exposed surfaces with grafting wax or paint, to prevent evaporation.

When an orchard is set out it is advisable to mark the varieties on a map, as the wooden labels on the tree will drop off and the names will be forgotten by the time the first fruit is produced.

The trees should be pruned so as to give them an open head by cutting out central branches that would, in growing up, make a dense mass of top growth. Aim at having the main limbs spreading, and rub or prune off all water sprouts as soon as they appear. By this name we call those quick growing, succulent shoots that start directly from a big limb or the trunk.

Apples, to keep well, should be hand-picked, packed in barrels and kept in a cool place where frost cannot hurt them. The apple has many enemies, the most serious ones being the "borer" and the "codling" moth. The former is a beetle that lays an egg in the trunk near the surface. A grub develops and burrows under the bark in a circling movement. If there are several of them they will often break the connection between the bark above it and the bark below so that the tree must die. Frequent examination and cutting out (the use of a sharpened wire is recommended) will be necessary. A preventive that has been tried with success

is to tie a piece of heavy paper, building felt, tar paper or manilla paper, around the trunk (which should have been first carefully examined and thoroughly washed with whale oil soap), making sure that it goes down as far as possible and fits it tight. It is of course necessary to repeat this every year, and in time to be ahead of the borer.

Fig. 21 — The Flat-Headed Borer. *a.* the larva; *b.* the pupa; *d.* the perfect beetle.

The codling moth lays its egg in the calyx of the young apple while the latter has still its up-

right position. The grub enters the fruit and works it way to the core. Many apples so attacked drop. They should be gathered and fed to the pigs to prevent the spread of the pest. The canker worm feeds on leaves and often destroys the greater part of the foliage. Both can be held in check, if not entirely destroyed, by thorough sprayings with a mixture composed of:

Copper sulphate (or bluestone) ..	4 pounds.
Fresh lime	4 pounds.
Water	40 pounds.
Paris green	4 ounces.

Instead of Paris green many use London purple, both containing arsenic. Without the latter the mixture may be applied to prevent the scab on leaf and fruit in the apple, and the rot and other fungous dis-

eases in peaches and plums. Sucking insects, that injure the tree by sucking the sap of the leaves, etc., may be killed by spraying with an emulsion of:

Hard soap, $\frac{1}{2}$ lb. (or soft soap, 1 lb.)

Boiling soft water, 1 gallon.

Coal oil, 2 gallons.

In spraying a force pump should

Fig. 22—The codling moth. *a* is the burrow; *b*, the entrance hole; *c*, the larva; *d*, the pupa; *e*, moth at rest; *f*, moth with wings spread; *g*, head of larva; *h*, cocoon containing pupa.

be used and particular care taken to reach every part of the tree. It requires practice and close attention both in mixing the material and in applying it, to secure the best results, which are such as to pay richly for the trouble.

The following remarks on "Spraying and Spraying Mixtures," by practical farmers and fruit growers, may be profitably read in connection with what has been said here.

BORDEAUX MIXTURE.

In order to prepare Bordeaux mixture suspend as many pounds as you need to use of the sulphate in a gunny sack in a barrel containing a gallon of water for each pound of sulphate. The sulphate will be ready for use in a short time and will remain in solution and keep during the summer.

The next step is to slack in a long box as many pounds of lime as you have sulphate—you can divide your lime by measuring its surface. Your lime and sulphate is now ready for mixing, but do not mix until you are ready to use it.

If you wish to make forty gallons of Bordeaux, fill your barrel or tank partly with water, then from your sulphate barrel pour in four gallons, and take from your lime enough to equal four pounds of unslacked lime. Dissolve the lime in a vessel of water and pour it off through a strainer

Fig. 23—Canker worm. *a*, *b* and *c* are eggs; *e* is a mass of eggs; *f* is a larva dark brown in color. Larvae can drop from tree by silk thread.

into your barrel or tank, then add water enough to make forty gallons. When it is thoroughly mixed use as soon as possible.

To meet the ravages of the codling moth, use Paris green or London purple, about one pound to 150 pounds of water.

Spray just before the buds open in the spring with a mixture of one pound of sulphur to fifty gallons of water, to destroy any fungous growth that may have started during the warm days of winter, or eggs of insects that may be deposited upon the branches or body of the tree.

The next spraying should be done as soon as the blossom falls, using Bordeaux mixture for blight, and adding to each fifty gallons of water one-third pound of Paris green or London purple to destroy the worms.

Spraying in same manner should be done in a week or ten days, then try to get a little poison in blossom end of each apple.

We should try to do our spraying *after* rather than before a rain, and the best results will be obtained by spraying even a fourth time.

To make fifteen gallons of an emulsion for the destruction of lice, boil in two gallons of water one pound of soap until you have suds, then add to your suds one gallon of coal oil and mix thoroughly with your pump. When the oil is well mixed with suds, you can add water to make fifteen gallons.

In mixing Paris green the proper way is to use just enough water to make a paste at first. You can then easily dissolve it. Never put it into your barrel when it is in powder form.

Spraying should be done thoroughly. Leave nothing untouched, from the ground to the topmost twig. Don't be afraid of overdoing it. Where you do your most work you will get the best results.

(L. BERRY FORD.)

"The eggs of the apple tree borer are laid during June and July, and during this period the trunks of the trees should be kept well washed with soft soap, diluted with a solution of tobacco.

"A friend reports that he has, while spraying, thoroughly wetted the collars and trunks of his trees with the Bordeaux solution and has never found a borer in his orchard.

"Twenty peach trees were each wrapped with a leaf of tobacco near the ground, and although in a badly infested locality, were not attacked."

(WILLARD D. BARR.)

CHAPTER III.

CHERRIES, PEARS AND PLUMS.

All of these trees may be planted at a distance of 20 feet by 15 feet apart. The early Richmond cherry is the best. The English Morello does well for a late sort. Cherries are apt to throw up suckers, hence cultivating is not to be recommended except while the tree is young; but the grass or clover that may be allowed to grow between the rows should be frequently cut and used as a mulch. Manure may also be spread, both as a fertilizer and as a mulch.

Of pears it is advisable to plant only such as have been tried in the neighborhood and found capable of resisting the attack of the fireblight. If this blight once appears every branch affected, and if necessary the whole tree, should at once be burned, in order to kill the germs that will spread from the diseased parts to other trees. Dwarf pears—that is, pears grafted or budded on quince stock—have been generally found more blight-proof than the standard varieties.

Plums are often a failure on account of a tiny beetle, the curculio, which puts an egg into the skin and then cuts a half-moon shaped mark into the young fruit to prevent the skin from closing up over the grub, which is soon hatched. This grub eats into the fruit and causes it to drop. Plum trees should stand near the chicken yard, so that the chickens can fre-

quently be allowed to get the fallen fruit and its destructive enemy. In this way a check is put upon the propagation of the pest. Spraying with the mixture recommended in the case of the codling moth for the apple tree, as soon as blooming ceases and the young

Fig. 24.—The plum tree curculio. *a*, the larva; *b*, the pupa; *c*, the beetle; *d*, curculio, natural size, on young plum.

Fig. 23.—Reproducing plants by layering. *A* is branch bent over and buried, held down by stake *B*. New shoots *C* start up, which are then cut off from parent plant at *D*.

fruit begins to show, is the best thing to be done. Plum trees suffer also from a species of blight. If this appears the only remedy is to cut out and burn all affected parts. Spraying in time with the emulsion of hard soap and coal oil may do much to prevent it.

In favored localities the peach is a most desirable fruit. It is easily grown from good stock.

CHAPTER IV.

GRAPES.

Grapes are a most delicious and healthful fruit. The Concord is still the most popular variety. It furnishes excellent eating when fully ripe. It is too often picked and eaten while yet immature. The Niagara is a superior white grape which has given good satisfaction. The Delaware, small and sweet, does very well, but is liked too well by the robin and catbird. There are many other varieties, but they cannot be depended on for general cultivation.

Plant grapes (one-year-old vines from a good nursery are best) 8 feet apart each way in fertile soil. If the soil is poor it will pay to enrich it, but keep fresh manure from the roots. Grapes grow only on the wood grown the year before, and each bud may produce two clusters. As there are so many buds, it is necessary to prune severely in order not to weaken or kill the vine by overbearing, and to get good-sized clusters. Pruning should be done in the fall, as in the spring it is difficult to do the work before the sap begins to move. Train at first to one cane, rubbing off all other shoots as they appear. This may be tied to a stake and allowed to grow its full natural length; but nip off the side shoots, leaving, however, a few leaves to prevent the breaking into growth of the bud at the place where these shoots start. Early in September nip off the tips of the cane to insure perfect ripening

of the wood, and in October or later cut off fully two-thirds of the cane, leaving one-third to bear fruit the next year. If the growth was not satisfactory no fruit should be expected the year after planting, and but little the year thereafter.

The following year cut the cane that has borne fruit down to within two feet or less from the ground, allowing two strong canes to grow; rub or prune off all other shoots. These canes should be cut back in the fall. They will bear fruit the following summer.

In order to check the tendency of the vine to send its sap too vigorously upward and develop the top clusters at the expense of the lower ones, the bearing canes should be bent and their tips tied below. For this purpose two stakes will be found more satisfactory than one. The vine needs the sunlight, and if tied to one stake there would be too much crowding. If the expense is not an objection, from three to five wires may be drawn along the rows for the bearing canes to grow horizontally on them. The canes should be firmly tied to the wires or stakes to prevent the wind from tearing them loose. Grapes may be protected in winter by laying the canes flat on the ground, holding them fast with clods and then plowing against them on both sides of the row. If there are not many vines the spade alone may be sufficient.

Fifty vines, if well grown and kept, may yield from 500 to 1,000 pounds of luscious grapes year after year, more than enough for the average family.

Grapevines should have the best chance for sunlight, and the ground should be very perfectly drained.

Grape canes of the season may be cut into pieces in autumn, each having an uninjured bud, preserved during winter in boxes filled with sand, and stuck into the ground in spring. They will grow for the most part the same season and make good plants for planting the next. Growing vines may be layered—that is, a cane is bent to the ground and held there with pegs. From each bud a plant will start. In the fall the cane should be severed from the parent stock and each of the separate growths cut off from the other. These will also make good plants and come into bearing a little sooner than vines grown from cuttings.

CHAPTER V.

SMALL FRUIT.

Strawberries should be set out in spring, in rows four feet apart and plants eighteen inches to two feet apart in the row. The ground should be as rich as possible and in the highest state of cultivation. It is hard to keep the blue grass out of a strawberry bed, and as close weeding by hand would be tedious, it is best to cultivate well between the rows by horsepower, using a pronged hoe in the rows and around the plants; take off one crop the following year and then plow under the first planting; relying on "runners," which by that time will have invaded the space between the rows, for the crop of the third year. This process may be repeated, the original rows being again established, but by this time the grass and weeds will be very annoying, and it may be best to plow under both them and the strawberry plants and sow clover for a rotation, with vegetables and again strawberries to follow. During the early part of the season the growth of runners must be checked as much as possible. The best method is to grow each plant in a hill by itself, but few farmers can do this, as it takes too much time to keep the runners down.

Raspberries may be planted on any good land. For a few years the space between the rows of the apple orchard would offer a good opportunity. Each plant

should be pruned back to a few shoots and the tips cut off before a crop can grow to secure ripe wood and good sized berries. The fewer shoots the finer and larger the fruit.

Fig. 25—A strawberry plant reproducing by a "runner."

Fig. 26—A strawberry plant properly set out.

The same is true of blackberries. As to choice of varieties of these and all other kinds of fruit, the advice of the nearest nurseryman should be taken, or the reports of the various farmers' institutes may be consulted. In a certain locality certain varieties will give satisfaction, while others may fail.

CHAPTER VI.

GENERAL REMARKS.

Strawberries are either *pistillate* or *hermaphrodite*. The blossoms of the former lack the *stamens*, which bring about fertilization; the latter have both stamens and pistils.

Some of our best varieties of strawberries are *pistillate*. If such are planted it is necessary to plant with them some of the other kind, otherwise but little,

Fig. 27 —A perfect strawberry blossom having both pistils and stamens.

Fig. 28 An imperfect strawberry blossom having pistils, but not stamens.

if any, fruit will be produced. The advice of the nurseryman should therefore be taken in all cases of doubt, though inspection will easily enlighten anyone when the plant is in bloom.

As for planting trees or vines, the rule should be to dig a hole several times larger and deeper than the root requires, then to throw in part of the dirt taken out, heaping it in the center.

On the top of this heap set your tree or vine, taking

care to spread out the roots well, after cutting off smoothly any bruised ones. Then fill in with the best soil, using water to settle the ground thoroughly around the roots and make it cling firmly to them. No vine or tree should be set deeper than it was before, nor less deep.

After planting, which in the Northwestern States is most safely done in the spring, the ground should be kept from baking by frequent stirring. It is best not to mulch at first, but to allow the sun and the rain to stimulate root growth. Later in the season, when rain is scarce, a mulch of grass free from seed, or bright straw may be applied to keep the weeds down. The danger of gathering a lot of weed seed in this way is, however, so great that cultivation is the safer plan.

As in the case of apple trees, cultivation ought to stop in August, and then is the time to apply a good mulch.

In the case of cherries and plums it has been found that cultivation is less necessary, and may even prove injurious. It will be preferable, therefore, to keep the ground mulched and thus prevent the growth of grass and weeds. If grass or clover has once started it may be as well to mow frequently and leave the stalks on the ground. The cutting must be repeated as often as possible.

An important word of caution may yet be necessary. Never allow slops to be emptied near a tree or vine. Keep horses and cattle from your trees and out of your orchard. The salt in slops and in the urine of animals will infallibly ruin the healthiest tree in a short time. Slops should be emptied at different spots, never twice

on the same spot within a year at least. No harm will be done if this precaution be used.

An acre of ground devoted to orchard purposes may be planted with 30 or 35 apple trees, with the addition of 5 cherry trees, 5 pears and 5 plums.

Plant your trees as near to the house as possible. This will be appreciated by the female portion of the family, as it will save time and trouble, and also by the male portion when the fruit has been prepared and is presented to them at mealtime.

In addition to the fruit garden there should be, of course, a vegetable garden. Asparagus is a desirable vegetable, requiring but little care, except at planting. A bed should be dug as deep as possible and filled with well rotted manure and rich black soil. The young plants are then planted in rows about two feet apart. They must be kept free from weeds. In the fall it will be well to cover the bed with a coat of manure. This will secure an early crop. The growing plant should not be allowed to bear seed. Cut the tops after the flowering season is over.

Tomatoes are a very valuable crop. Plant only the best varieties and provide for a support of the vines. Laths nailed on sticks about two feet above the ground will answer for this purpose.

Cucumbers, pumpkins, squashes, melons, etc., should be planted in rich garden soil, but it will be necessary to have your melon bed at a considerable distance from the former vegetables to avoid fertilization from their pollen, which would spoil the melons for eating.

The insect enemies of all these vegetables are numerous and must be fought by hand picking. Birds will destroy many of these insects. No farmer will wish to be without early peas, and a variety of beans, including the Lima bean.

The directions for planting and cultivating these are found on the papers in which the seed is sold, hence none are given here. Lima and other tall growing beans need poles to climb on. A supply of such should be provided for in winter or early spring before the regular field work begins.

No garden will be complete without some sweet corn of the best varieties. To keep the seed from being spoiled by the field corn, care should be taken to plant it at a distance from the latter.

Celery may be readily grown in good soil, but it needs attention when the plant has attained its growth to secure the desired whiteness. The rows must be well hilled up on both sides so as to almost cover the entire plant.

There are other delicacies which are welcomed on the table and can be raised with but little trouble, such as the oyster plant, cauliflower, Brussel's sprouts, together with the more common spinach, lettuce and several varieties of cabbage. The boys and girls should be encouraged to take an interest in planting these and attending to them, by being allowed to sell what is not needed at home. A part of the garden may be given up to sunflowers, the seed of which is much liked by chickens, and benefits their health.

A garden, to be productive and satisfactory in the choice quality of its vegetables, should be plowed and subsoiled and abundantly manured. If at all possible, an arrangement should be made to supply it readily with water in the dry season. Narrow boards, nailed together, may be used as troughs or pipes to convey the water from a distance where it is not feasible to use ditches. At the same time it has been found very useful to underdrain garden soil. The ground should be kept mellow and not a weed allowed to grow on it.

PART V.

SCIENCE AND AGRICULTURE.

CHAPTER I.

THE DIVISIONS OF SCIENCE.

Who has not often looked at the starry sky and admired this grand spectacle? What a multitude of stars, —all in motion, but none in a hurry, not one keeping the other from following its course through the night and the day, through the weeks, months, years and centuries! They are so far away that it takes the light of some of them millions of years to reach the earth. For all we know they may have ceased to exist millions of years ago, and yet their light keeps on traveling, and countless human beings are meanwhile born and live and die.

And our earth itself is a star, a very little one, it is true, compared with those distant stars each one of which is believed to be a sun around which such small stars as our earth may be circling. Wherever we turn we are in the presence of an astonishing movement. Nothing stands still. The very heavens move. Change is the law of the universe.

The study of the movements and changes, not only of the stars, but of all matter, is the work of science.

Matter is indestructible. We cannot create it; we can only cause the particles of which it consists to change their places and enter into different combinations. And these particles are exceedingly small—so small that they can be seen only when thousands of millions are joined together. The name for the smallest particle of matter is *molecule*, but a molecule is believed to exist of several distinct parts, each of which is called an *atom*. What, then, is an atom? We can only answer that it is the smallest thinkable part of an element. Scientists believe that such atoms are always or mostly in pairs, and they make their calculations of the movements of these atoms on the basis of this belief.

In a molecule we have all the elements which we find in the larger mass of any *substance*. In an atom we have only the smallest part of *one* distinct *element*.

C h e m i s t r y deals with atomic changes which result in new substances. P h y s i c s is occupied with molecular movements, the molecule itself remaining unchanged.

How are the atoms placed in a molecule or in any part of matter? We know that gold is heavy and air is light. If all matter consists of atoms, what makes the difference in weight? It is believed to be due to the greater or less distance between the atoms. We may imagine them to be close together, as in this illustration—:::—and again wide apart, as in this:

The former would represent the gold, the latter the air or any other light substance. When we examine

the sky at night, we find parts of it where the stars are close together, as in the Milky Way, and others where they are far apart. We might see something similar in the atoms of different substances if our sight were fitted to behold them.

As long as the atoms in a molecule stay united there is no chemical change. But molecules may undergo many changes of *place*, and such changes belong to *Physics*.

Water contains in every one of its molecules two parts of the element called hydrogen and one part of oxygen. If we heat water so as to form steam we do not change its molecules, for the steam has all the essential elements that water has, and in the same proportion. All that has changed is the place of the molecules, or, let us rather say, the distance between any two molecules. If we could see their movements we should find that they fly apart as heat is applied. Thus water is changed into steam. When these molecules strike a cold surface they come nearer to each other again and appear as water. Hence the production of steam belongs to the department of physics. If we mix sugar in our coffee the molecules of the sugar are not altered; they are only separated.

But let us burn a quantity of sugar. We now get carbonic acid—that is, a gas which contains the element *carbon* and the element *oxygen* in every one of its molecules. Where is the change? To answer this question we should know the composition of a molecule of sugar. It consists of carbon, hydrogen and oxygen. In the carbonic acid the hydrogen is absent and a part of the oxygen is also gone. Each molecule of sugar

is composed of 44.92 parts of carbon, 6.11 parts of hydrogen and 48.97 parts of oxygen. In each part of carbonic acid we have 72.73 parts of carbon and 27.27 parts of oxygen. There has been a loss of hydrogen and oxygen, the elements wanting having passed into the air of the atmosphere. But as they are still there, we would better speak of their disappearance as a *change*. This change was due to *chemical action*. But the chemist, by another process, can separate the three elements of sugar and *retain each by itself*. He can *weigh* each part and thus find that *the three parts weigh exactly as much, taken together, as did the sugar*.

If all matter on earth consists of these infinite particles, may not the same be true of the sun and all the other stars? As heat expands matter, making the molecules fly apart, is it not likely that at some time or another, when all matter was in a condition of fiery vapor, there was no sun and no earth?

It is believed that this was so. When a belief is expressed in scientific terms it is called a theory. At the end of the eighteenth century the German philosopher K a n t made known a theory which was afterwards adopted by a French astronomer, L a P l a c e, and is known as the *nebular theory*, or hypothesis. It is about as follows:

There was a time when our sun and all its planets, our earth included, were one mass of vapor or gas. In the course of time this mass, in its swift movement around its center, would throw off portions that kept up that movement at a greater or less distance from it, and thus this center became the sun and the parts

thrown off the *planets*, the whole making up what is called the *solar system*.

After untold ages the earth cooled off enough to form a coat of watery vapor around its fiery kernel, and when this kernel hardened on its surface a crust was formed which gradually changed into soil for the growth of plants.

Below this crust the former heat continued for a long time, and it is believed to be great enough even now to keep the center in a molten condition. From time to time the pressure of the gases produced within would break the crust, allowing this molten mass to rise and spread over parts of the surface. Thus arose our highest mountains. They are of very hard stone, known as granite, gneiss, etc. From their disintegration (crumbling) are derived some of our best soils.

The vapor around the earth gradually separated into water and gases, as the crust cooled off more and more, and this water held in solution many minerals; for instance, *calcium*, which, in combination with oxygen, forms *lime*. Numerous small animals arose, which, like oysters, snails and mussels, formed a solid covering for themselves from the lime in the water. As they died these shells sank to the bottom and others followed. In this way vast deposits of carbonate of lime, etc.—that is, *limestone* and *chalk*—were formed. Most of these animals were so small that their tiny shells can be detected only through a microscope. Then came various changes. Immense fishes filled the vast sea; and gigantic amphibia (creatures able to live both in the water and on land) the forests of quick-grow-

ing ferns and other plants that grew to an immense size. These were buried later under vast seas and changed into coal. The age of man came last.

From the atomic night to the sunshine of the age of man—what a stupendous change!

This theory has been generally adopted by scientific men, because all scientific investigations (searching) have strengthened the arguments in support of it.

The science that deals with the crust of the earth and its formation is called *Geology*. Plants and their structure are the subject of the science of *Botany*; animals the subject of *Zoology*. *Chemistry* is needed for a proper understanding of the changes going on in the plant and the animals, and it is no less important in the work of the physicist. The latter teaches us why a well prepared soil, plowed and subsoiled and tile drained, furnishes the conditions for a healthy and vigorous growth of field crops. It is because the roots must seek for proper food in the soil. The soil must be porous (open) so as to allow water and watery vapor to enter, and also to arise from the lower part of the soil, holding in solution the necessary minerals and nitrates. *Agricultural Physics* examines the soil and shows how it was formed from the original mountains and the hard crust that at one time covered the earth, even where there were no mountains.

Physiology is occupied with the bodily functions of the various living creatures, plants and animals. It is closely dependent on chemistry and physics, and is, in a sense, a part of both botany and zoology.

Closely allied with geology is the science which deals with plants and animals buried in the past, thou-

sands or hundreds of thousands of years ago, in the deposits which produced coal, limestone and other parts of the earth's surface. It is called *Paleontology*.

An important branch of zoology is the science of insect life, *Entomology*, which is of special interest to the agriculturist and horticulturist. There are a number of other sciences closely connected with part or all of the preceding ones, such as *Optics*, the science of sight; *Mineralogy*, the science of minerals; *Crystallography*, of the crystallic forms of minerals; *Meteorology*, the science of the weather; the sciences of *Hygiene*, of *Sanitation*, and others.

It is a tendency of our times to arrive at scientific certainty in every line of pursuit. This is the case in agriculture, which is rapidly becoming a scientific pursuit, as shown by the work done at our agricultural colleges and experiment stations, and especially in the various departments or *bureaus* of the Department of Agriculture in Washington. The field of work is large, covering as it does the lines of vegetable and animal industry; the many lines of productive industry carried on by the farmer, the horticulturist, the orchardist, florist, the truck gardener, poultry breeder, dairy man, horse and cattle breeder and others.

CHAPTER II.

THE TESTS OF SCIENCE.

In the seventeenth century there lived in Flanders a distinguished man by the name of *Van Helmont*, who made a great many experiments in order to learn about the nature of plants and animals. He did not know why it was that a small tree would grow big and heavy in the ground where it was planted; whether it drew its nourishment from the ground or from the air, or from both; and therefore he made the following experiment:

He took a young willow tree weighing five pounds and planted it in a pot filled with 200 pounds of soil which had first been thoroughly dried in an oven. He placed the pot into the ground, in his garden, covering it in such a way that no dust could collect on it, and using rain water to keep the soil moist. He kept the willow in this pot for five years. Then he took it up and found by weighing it that it had increased to the weight of $169\frac{1}{4}$ pounds! Whence, then, did the tree get this additional weight? It was impossible, so he argued, that anything could have come to it from the air, for rain water only was used, and was not rain water absolutely pure water? Nor could anything have come from the soil, for were not the roots confined in a pot so that no part of the soil of the garden could touch them?

This puzzled a great many people. Some of them repeated the experiment with *glazed* pots (Van Helmont had used one that was not glazed) and watered the tree with *distilled water*—that is, with water which was *chemically pure*. And what was the result? *The tree wouldn't grow!* It became now clear that the moisture from the garden soil must have entered Van Helmont's unglazed pot, holding in solution nitrates and minerals which the tree needed for its growth. And further, it was found that rain water was not chemically pure; that it contained some ammonia, a nitrogenous element of great importance for plant growth, and sometimes, especially in the neighborhood of cities, also some of the mineral matter needed by plants. Thus the mystery was explained by *properly conducted experiments*.

Such experiments are the test of scientific truth, and it should be noticed that it is only when *all* experiments, provided they were carefully made, *confirm* such a truth, when *none, not a single one, contradicts* it, that such a truth is finally accepted as scientifically demonstrated.

Hence it is that science, in the true sense, is thoroughly practical. It is the most practical thing in the world, and those err greatly who make a radical distinction between science and practice. Scientific agriculture is *true* agriculture. It is the highest and noblest type of it, provided only it be rightly understood. Mistakes are no doubt made even by specialists. Cases of chemical examination of the soil have been known that led into error, simply because the chemist did not know that some of the elements he

found in the soil were insoluble in the water of the soil. Had he known this he would possibly have recommended, in such a particular case, gypsum to be used on a clover field, salt on wheat and other grains, in order to furnish the necessary conditions of *solubility*. But such mistakes are gradually avoided. For science reaches out farther and farther, so that exceptional conditions are rarely left unnoticed.

We have spoken of the elements that are found in matter and of their smallest parts—atoms. No one has ever seen an atom. But it may be truly said that all our modern science rests upon this theory of atoms, and that this theory is accepted as true simply because all experiments thus far made confirm it, and not one has yet contradicted it.

A very important experiment was made by the French chemist Lavoisier in the latter part of the eighteenth century which shows the importance and the character of a truly scientific test.

Until then it was taught in textbooks, and believed to be a fact by scientific men, that the cause of fire was a *substance*, a principle, or something which contained the fire, and would burst forth when conditions were favorable. The name of *phlogiston* was given to this peculiar something, and it was said that all substances contained it, even the flint, as sparks would come from it when struck with a piece of steel.

But by this time Priestly, an English chemist, had discovered the gas called *oxygen*, which forms nearly one-fifth of the air we breathe. Lavoisier, wishing to find out more about this gas, burned a quantity of wood and carefully saved and weighed the products

of the combustion (burning). He found that *these products weighed more than the wood he had burned*. Whence came the additional weight? He examined carefully what he had saved, and found that all the elements of the wood were there, and besides them a *quantity of oxygen!* The additional weight was due to this oxygen, and now it was plain that burning takes place when oxygen combines with carbon, the principal part of wood, under specially favorable circumstances which make possible a very energetic combination of the two elements. When we observe that certain acts are always followed by certain consequences, we are in the presence of a law.

A ball thrown towards the sky will fall back to the earth, and as it falls its movement will be quicker the nearer it comes to the earth. If we throw up a feather it will stay in the air much longer. Is there, then, a law for the ball and another for the feather? It was believed that a large mass of lead would fall faster than a small one. The Italian scientist, Galileo, in the seventeenth century, proved that this was a mistake. He took bullets, large and small, went up on a high tower and dropped them to the ground. They all came to the ground at the same time.

If we take a suitable vessel and place it on a smooth plate of glass to keep out the air, then apply an air pump and pump all the air out of the vessel, a leaden bullet and a feather or piece of paper will fall to the bottom of that vessel with equal rapidity. Why? Because the air no longer hinders the movement of the feather. The round ball can overcome the effect of the air more easily, but in an airless space (in a

vacuum, as it is called) it has no advantage in this respect over the feather. This proves the universal truth of the law of falling bodies, the law of gravitation.

In this way, then, omitting all details, we see that the scientific observer proceeds to arrive at the truth. He discovers the laws which govern the *changes of matter*. The knowledge of these laws is *science*.

What an immensely suggestive and inspiring thought that all the wonderful variety of earthly things, and all that we see in the heavens above: the sparkling diamond, the enduring granite, the towering mountain, the shining gold, the infinite number of animal and plant forms—nay, the brilliant sun itself and all the glory of the stars—are the outcome of the changes of matter which started in what was at first a vast mass of vapor, thin as air and probably much thinner, and that they all assume their varied color only for the mind through the human eye! The atoms of which they consist are invisible, they have no color. It is only as they combine in various proportions that their forms produce the effect of color under the influence of light, the rays of which are either reflected (thrown back) or absorbed, according as these forms may make possible or require the one or the other.

What a mystery there is in this! What a power in the human mind that feels this mystery! And how grand beyond all human conception the source of this mystery and of this power!

CHAPTER III.

THE CONSERVATION OF ENERGY.

There is in all matter a certain force for which we use the general term of *energy*. Force is shown in action; energy may be inactive, and yet exist. It has been proved by close observation and experiment that the sum total of all the energy in the world never grows less. It is the same all the time. All the natural changes we see (the name *phenomena* is used for them) are due to the motion of atoms; but what is it that makes these atoms move? In chemistry the term *affinity* has been used to explain why, for instance, oxygen combines with phosphorus or carbon. Affinity means relationship. It is as though these atoms were related and wished to meet. But a word is not an explanation or a reason. All we know is that, no matter what takes place, all phenomena are due to the motion of the smallest particles of matter, and that the energy used or displayed in these movements is always in existence. This is shown in the phenomena of heat. Heat is a mode of motion. Motion produces heat, and heat in its turn produces motion. The energy at work which heats the axle as the wheel turns upon it is exactly equal to the heat produced. When this heat enters into the air—that is, when the axle cools—it is not lost, but taken up by the air, and used to produce some

effect which is exactly equal, as energy, to the force which was required to produce it.*

We burn coal, heat the water in the steam boiler, and thus move a railroad train, a ship, etc. Here is energy. It comes from the coal, you say. But how did this coal get it?

The answer is this: The source of all energy on our earth is the sun. It caused the growth of those masses of vegetation in the dim ages of the past which were afterwards buried under water, pressed together and formed into coal. The force expended while this took place was buried and fixed in the coal. To-day we dig the coal from the depths of the earth and use the force that made it. The energy expended in its production is exactly equal to the energy that now comes from the coal, heats the water and drives the train or the ship. *Thus we live not only by the sun that shines to-day, but by the sunlight that warmed the earth millions of years ago!*

It is the sun that makes the rain and the snow. It acts on the plant, makes it expand and lose part of its moisture. This stimulates the roots. They absorb and send up more moisture and, dissolved in it, the elements the plant needs for its growth. The plant condenses the energy which called it forth and made it grow into a tree, and returns all it received in the

*This was proven, at the beginning of this century, in the cannon foundry of Munich, Germany, by a clever American, a native of Massachusetts, who was made a count by the King of Bavaria and is known as Count Rumford.

wood of the tree as fuel, or in the wheat as food for the body. There is unceasing movement everywhere, a constant expenditure and storing up of energy in all nature, a most wonderful circle of change and motion, always the same and yet always different!

The discovery of the law of the conservation of energy is one of the most important ever made. On the basis of the experiments of Count Rumford and many other scientific experimenters, J. ROBERT MAYER, of Heilbronn, Germany, formulated this law as the first discoverer of it. Professor JOULE, a Scotch scientist, proved it correct by a series of special and very ingenious experiments. Many other scientific men contributed important work which showed the bearing of this new law on scientific pursuits in physics, astronomy and chemistry.

A most interesting book by one of the most thorough British scientists, Professor Tyndall, "Heat Considered as a Mode of Motion," admirably proves and illustrates its working.

CHAPTER III.

AGRICULTURAL CHEMISTRY.

All chemical changes in the soil and its products come under the head of *Agricultural Chemistry*.

The elements contained in the soil are, in the first place, those found also in the rocks from which all soil was formed by disintegration; secondly, those produced by the decay of vegetation in the product which we call humus, and, finally, those which enter the soil directly from without, as air and water. The air consists of about 20 per cent of oxygen, diluted by about 80 per cent of nitrogen. It contains a small percentage of carbonic acid-gas, enough, however, to amount to several thousand tons over each acre of ground.

If we burn a plant and weigh the products of this burning, we find that different plants require the same elements, but in varying proportions. There are less than twenty elements which are known to enter into the body of a plant. These are: Oxygen, nitrogen, carbon, hydrogen (in water), calcium (in lime), phosphorus, silicon (in sand), magnesium, aluminum, sodium (in salt), potassium (in ashes), manganese, iron, chlorine, fluorine, sulphur, boron. *Aluminum, calcium, magnesium, manganese* are as much *metals* as *iron* is. They form compounds with oxygen called *oxides*. The oxide of calcium is lime, of magnesium, magnesia. Oxygen combines with all the elements named except fluorine. With silicon it forms silica or quartz, from

which we get sand and pebbles, also the carnelian and jasper stones. Aluminum is the principal element of clay, but not a plant food. Lime and magnesia are plant foods of great importance. The *non-metals* enter more largely into the composition of a plant than the metals.

Oxygen, a heavy element, is a gas, but readily combines with other elements.

Oxygen is the absolutely necessary element to bring on combustion with or without a flame. In combination with other elements it forms nearly one-half in weight of the solid earth, and 8.9 by weight of water.

Silicon is not found in a free state, but is frequent as an oxide. It forms an essential part of many minerals. It is that element which gives stiffness to the stems of plants, of corn, wheat, grass, etc. Quartz is a very pure oxide of it; silica contains aluminum. Lime of silicon and magnesium of silicon are also forms of it.

Carbon, found perfect in the diamond and in graphite (the substance used in lead pencils), is the principal element in the plant. It is the characteristic element of wood, starch, sugar and all oils and fats. Acted upon by the oxygen of the air, the fat and other parts in the animal body, which contain carbon, are burned. The oxygen forms an oxide with the carbon, and this is breathed out by the lungs as dioxide of carbon. This mingles with the atmosphere and is available for the use of plants, which absorb it and draw it in by means of their leaves.

Limestone, marble and dolomite are carbonates, that is, compounds of the metal *calcium* with *carbon*.

"The influence of the carbonates on the soil is very useful. They favor the process of converting nitrogenous compounds into forms suitable for plant food and exercise a great influence on the physical state of the soil, increasing its capacity for holding water and enabling it to reach easily the roots of plants."*

Experiments have proved that plants take the greater part of carbon from the atmosphere. On an acre of the following crops, raised in rotation: potatoes, wheat, clover, oats, it was found that the soil furnished 2,513 pounds, the air 5,031 pounds, the total being 7,544 pounds.

Sulphur is found both free and in combination with metals. In gypsum (plaster of Paris) it is combined with oxygen and calcium.

Hydrogen is the lightest of elements, and is therefore chosen as a standard to compare the weight of others. It is entirely colorless, has neither taste nor smell. It is found free only in small portions in some volcanic gases, but the form in which it is most usually found is water, of which it forms 11.3 per cent by weight. It constitutes 74 parts in ammonia which are joined to 26 parts of nitrogen.

Chlorine occurs free in small amounts on volcanoes. Its most common combination is with hydrogen, as *hydrochloric or muriatic acid*; with the metals it forms *chlorides*, and with *sodium* it combines to form our common salt. Chlorine is found in all plants, but in the soil it is found only in the proportion of .1 per cent.

*Wiley.

Phosphorus is found only in combinations and is never absent in any natural soil. It is one of the absolutely necessary elements in animal and plant food. It is needed in the brain, and constitutes almost all the mineral matter of the bones. In the seeds of plants it is the principal part of the ash.

The importance of phosphorus may be inferred from the fact that cereal crops (wheat, oats, etc.) take from the soil about 20 pounds of phosphorus per acre, grass about 12 pounds. According to an estimate of the agricultural department in Washington, the cereal and grass crops in the United States remove annually from the soil nearly four billions of pounds of phosphorus.

As phosphorus is mainly found in bones, the English farmer buys bone meal (ground bones) freely. British ships have carried the bones of the vast battlefields on which the first Napoleon caused the slaughter of so many men from the shores of Germany to England, for the use of the English farmers. A country that keeps sending abroad heavy crops of wheat, corn, etc., sells a most valuable part of its very soil, that must be re-imported sooner or later if the agriculture of that country is to be maintained in a thriving condition.

We have stated before that nitrogen makes up over 80 per cent of the air we breathe (the atmosphere), the remainder being oxygen. The two gases mingle as air, but do not enter into a chemical combination in the atmosphere. In the soil nitrogen is found in *nitric acid*, a compound of oxygen and nitrogen, and in this form it is taken up by the roots of plants. The process by which nitrogen is changed into available plant food, into nitric acid and nitrates, is called *nitrification*.

Humus contains nitrogen. By the action of ferments, tiny plants, invisible to the naked eye, which are similar to those which exist in yeast, this nitrogen is changed into *nitrates*, for instance *nitrate of lime*. But they do this only where the soil is warm and moist without being sour. The air must circulate through it. Hence the importance of cultivation and draining. The same process goes on in the manure pile.

Agricultural chemistry is largely concerned with the measures and means to retain and increase in the soil the stores of available nitrogen. "The importance of nitrogen as a plant food," says Prof. Wiley, the chemist of the agricultural department in Washington, D. C., "cannot be too highly estimated. It is as necessary to plant growth and development as water, phosphoric acid and potash, and far more costly."

The nitrates are easily dissolved in water and therefore apt to be washed from the soil by rains and the action of water in general. They find their way to the sea, hence the value of seaweed, which is rich in nitrates, as a manure. Fish are rich in nitrate and are sometimes used for the same purpose. The feathers of birds are very rich in nitrates and the peculiar value of guano is largely due to them.

Nitrogen is the valuable part of the *albuminoids*, that is, the food element which forms the flesh of muscles and is found in peas, beans, meat, etc. It is also the essential element of *casein* in the milk and cheese, and of *gluten*, that substance which remains when all the starch has been removed from the flour of wheat, oats, etc.

In Chili large deposits of a nitrate, called *Chili salt-*

peter, are found. This saltpeter forms a large article of trade. It is transported very largely to England, but the United States import a considerable quantity, in the neighborhood of 200 million pounds annually, and these imports are increasing.

Sodium is found in common salt and in soda. *Potassium* is the essential element of *potassa*, which we find in potash.

Calcium, as already stated, is the essential part of lime. All these are important for plant life and must be in the soil to enable plants to grow.

As the crops raised by the farmer contain these elements, it follows that, as he sells his crop, he sells a large part of his land. In a ton of wheat he sells 38 pounds of nitrogen, 19 of phosphoric acid and 13 of potash. Even if he condenses his crops of corn and grass by feeding them to his hogs and cattle, these will, when sold, carry away in their bodies about one-fifth of the material in the crops. Hence the absolute necessity of making good this loss before the land wears out. And it will wear out, even while there are large amounts of these elements in the soil, for the reason that it is only the soluble combinations that are useful, and many are not soluble. Barnyard manure alone cannot do all the work of fertilizing, no matter how carefully it is preserved and applied, for it does not contain that part which was sold and left the farm either as hay and corn, or as swine and cattle.

The time must therefore come when the farmer will be compelled to buy fertilizers to make good this extra loss. Agricultural chemistry is largely concerned with

determining what elements of fertility are wanted in the soil, and how to apply them.

As long as it considers the soil and the atmosphere, chemistry is called *inorganic*, that is, *not-organic*; but when it deals with plants and animals and their remains, it is called *organic*. The parts of a plant or animal by which they grow, and which develop as they grow, are called *organs*. If we cut across the stem of a plant and apply a magnifying glass, we see a number of cells from which the sap runs out. These cells (resembling little bags) have thin walls which allow the sap to pass through, which reaches every part of the plant. *Organic chemistry* is applied to the study of these and all similar phenomena.

The force which makes the sap rise in these organs of the plant, the cells, is called *capillary attraction*, from a word meaning hair, as these cells are joined together so as to form very small passages. But these passages are interrupted by the walls of the cell so that the comparison is not a very good one. The action of the liquid in the cell in passing through the cell walls is called *osmosis*; the passing out being called *exosmosis*, the passing in *endosmosis*. The same words describe the action of the blood in the small cells of the animal's body.

CHAPTER V.

AGRICULTURAL PHYSIOLOGY.

Chemistry is on the one hand connected with *geology*, and on the other with *physiology*. All these stand in close relation to *agriculture*, the object of which is to feed and clothe man. It fulfills its high mission in proportion as it does this permanently and, if not abundantly, at least sufficiently.

The improvement of the human race is the ultimate object of all the sciences. Hence the necessity of knowing the laws that govern man in his efforts to maintain himself in good health. Physiology, and its allied sciences of *hygiene* and *sanitation*, treat of these laws. We have already seen that all animals breathe out carbonic acid (or rather di-oxide of carbon). This gas is diffused in the atmosphere, of which it constitutes about the 1-2500th part. This is at a rate of some six thousand tons over every acre of ground. The plant, on the other hand, under the influence of the sunlight, gives off oxygen through the pores generally found on the under side of the leaves. Oxygen, a heavy gas, is present everywhere, often in combination. Nitrogen dilutes oxygen so as to make it fit to be inhaled by man and animal. But we have learned that in close combination with carbon oxygen causes combustion (burning), and that in this way compounds of carbon are formed, such as carbonic acid, which cause nausea

and death if breathed by animals. Now remembering that all fat is essentially carbon (the other part of fat being principally water) we can understand that the oxygen of the air, acting upon the fatty matter in our body, will practically burn up this fat in so far as it is found in the blood. The result is bodily heat, and this explains why in cold weather violent exercise, that makes us take in more air, and consequently more oxygen, will create warmth in our bodies. It explains also why in very cold countries, raw oil, tallow and the like are relished as a regular food by the natives. When tallow candles were still in common use it was difficult for the travelers in arctic regions to keep the people from making a meal of them. But it is not only the fat that is used up. With the exception of the bones and the horny matter, every part of the animal body is changed back during life into the elements of which it was made. New material is constantly formed, and our bodies and the bodies of animals are thus constantly renewed and destroyed in a regular circle of action that has been called the "circulation of life."

Food, after it has been chewed and mixed with saliva, passes into the stomach. In the case of cattle this stomach consists of four parts, and cattle chew their food twice, the second time after it has returned to their mouths from the first stomach. From the stomach, where the gastric juice (from *gaster*, meaning stomach) has been mixed with it, it passes on to different parts of the intestines, after having received the bile of the liver, a peculiar liquid which acts particularly on the fatty part of food. It is then called *chyle*. This chyle is a pretty uniform liquid mass,

which is for the most part changed into blood. All along the small intestines tiny bloodvessels, called capillaries, suck it in and convey it to larger vessels, called veins. These veins contain the bad and imperfect blood. Countless capillaries, meeting other capillaries that conveyed good blood, receive the worn out and spoiled parts of the body that have gone back into the blood from these other capillaries, and convey them, together with the imperfect blood of the chyle, to the veins, and these veins carry all this mass of impure and bad blood to the heart. The heart is a powerful muscle which continually contracts and expands and thereby produces a pumping movement. It consists of four parts, the two upper being called auricles, the two lower ventricles. A partition divides the heart into two halves, the right and the left. Its name is *septum*. The venal blood is discharged by the veins into the left auricle, which sends it through a valve to the left ventricle. The left ventricle discharges it into an artery, a large bloodvessel, which carries it to the lungs. These consist of two parts, the right and the left, each containing many thousands of cells. As the blood spreads through the lungs, it loses its bad element, the carbonic acid, which is breathed out, and receives a new supply of oxygen from the air breathed in. It is then ready to return to the heart, which will pump it into the bloodvessels called arteries, and thus send it into every part of the body. The renewed and healthy blood that comes from the lungs enters the right auricle of the heart, from which it flows into the right ventricle and thence into the large arteries. These arteries, the same as the veins, end in a mass of capil-

laries which join the other set of capillaries, so that the circle of movement goes right on, and continues as long as the life of the body. This entire circular movement requires only one-half of a minute.

FIG. 29.—THE POSITION OF THE LUNGS AND HEART IN THE CHEST.

A, B, C, D.—Heart.	2.—Pulmonary Artery.	6.—Jugular Vein.
E, F.—Lungs.	3.—Aorta.	7.—Windpipe.
G.—Diaphragm.	4.—Superior Vena Cava.	8.—Larynx.
1.—Pulmonary Vein.	5.—Carotid Artery.	9.—Coronary Artery.

Illustration :—

29. The heart, lungs and diaphragm.
30. The lungs, windpipe, larynx and bronchial tubes.
31. Chart of the circulation of the blood.

It is very easy to see that a healthy heart and vigorous lungs are necessary to secure the best results of this renewal of blood. Full, vigorous breathing will

secure the separation of the carbonic elements from the blood, and the mingling of health giving oxygen with it. The heart must be sound to fulfill its work as the great pump to secure an even flow through the system. In order that it may act freely and with the

The lungs, showing the larynx. A, the windpipe ; B, the bronchial tubes.

necessary energy there is needed another muscle, called the midriff or diaphragm, which marks the division between the upper and the lower cavities of the body. It is at the base of the chest, extending across it and bent upward. On its elasticity depends the free action of the heart, and also of the lungs. Ladies wearing

FIG. 31.—THE HEART AND ITS CAVITIES.

(Showing lesser and greater circulations.)

a, right auricle; *b*, right ventricle, communicating through auriculo-ventricular opening; *c*, pulmonary artery, showing branches to each lung; *d*, capillary vessels of lesser or pulmonic circulation; *e*, pulmonary veins; *f*, left auricle, and *g*, left ventricle, communicating through left auriculo-ventricular opening; *h*, aorta; *i*, arteries; *k*, upper vena cava, bringing blood from upper portions of body to right auricle; *l*, arch of aorta; *m*, its descending portion; *n*, arteries of stomach and intestines; *o*, capillaries of intestines; *p*, portal canal; *q*, capillaries of portal system in liver; *r*, veins of liver; *s*, lower vena cava, bringing blood to right auricle from abdomen and lower portions of body; *t*, capillaries of greater or systemic circulation.

corsets hinder the development and action of the diaphragm, and thereby endanger their entire system.

But it is not only through the lungs that the waste material of the body is thrown out or secreted. What passes into the air by the lungs is material that has no value as a fertilizer. It is otherwise with the matter voided in the urine. This liquid contains the most important fertilizer and is therefore the most valuable part of manure. The urine of a cow contains a large percentage of nitrogenous matter, chiefly ammonia, sulphate of potash, phosphate of lime, carbonates of potash, and of ammonia, and a peculiar sub-

stance found only in the urine, to which the name of urea has been given. This also contains nitrogen. The

FIG 32 -RELATIVE POSITION OF THE INTERNAL ORGANS.

urine of cows contains 65 per cent of water, that of the horse 94 per cent; the latter is therefore much less valuable.

A great many impurities pass through the skin, in summer more than in winter. These cannot of course be used for any purpose, but the fact shows how necessary it is to keep the skin clean so that its millions of little openings, *pores*, may be able to do their work. As cold contracts, these pores are partly shut up in cold weather, unless vigorous exercise, developing

heat, brings moisture to the skin. But such exercise is at the expense of food, and it is therefore economical to provide warm stables for stock. A sufficient supply of pure air must, however, be furnished. All stables should be well ventilated.

FIG. 33.—Diagram showing the action of the diaphragm when one is breathing.
A. A.—Diaphragm.

The matter that passes through the alimentary canal as excrement lacks much of the fertilizing value of urine, but is nevertheless valuable. It contains mostly hard and undigested matter which needs fermentation to become valuable as manure.

CHAPTER VI.

FOOD AND FEEDING.

Food, whether for man or animal, is divided into three classes: 1, *muscle-formers* (nitrogenous, albumenoid, or protein); 2, *Fat producers* (*carbo-hydrates*, i. e. compounds of carbon and the elements of water, oxygen and hydrogen), and with these the *oils* and *fat* itself; 3, mineral. Water is found in all food. Straw and grass contain a fibrous substance which consists of silica and carbon. The minerals, as already stated, are found in the ash when the body is burned.

Nitrogenous elements, together with phosphates, are found in the horny part of the body, of the outer skin and the hair with which it is covered, and in the teeth and the bones. The carbo-hydrates are derived from the carbonic acid in the atmosphere through the action of the roots and leaves. The latter absorb carbonic acid directly from the air under the influence of sunlight. The minerals come exclusively from the soil. If we feed to make stock take on as much fat as possible, we rely on the carbo-hydrates, but if we wish for solid meat, nitrogenous food must be furnished. Both are needed and neither could be omitted without serious consequences.

The most essential elements of the bones are phosphoric acid and lime. The two appear in the chemical compound *phosphate of lime*, which is composed of 100 parts of phosphoric acid and 84.53 of lime. Hence food should supply this and also the phosphate of magnesia.

We find in 100 parts of the ashes of the oat plant, of phosphate of lime 39.3 parts; in 100 parts of wheat straw ashes, of phosphates of lime and magnesia 6.2 parts; in 100 parts of ashes of wheat, of phosphates 44.5; in 100 parts of the ashes of bran, 46.5; in 100 parts of pea straw, 17.5 parts; in 100 parts of the seed of barley, 32.5; in 100 parts of the seed of oats, 24. Hence the importance of these for feeding purposes, though it must be remarked that phosphate of lime is found in all plants.

The chemist calls compounds of this kind *salts*. Our common table salt is not a salt in the chemical sense, for it consists of two distinct elements, chlorine and sodium, which can be easily separated by the chemist. Chemical salts are combinations of a *base* (the name given to such substances as *lime* or the *oxide of a metal*) and an acid in the chemical sense, that is, compounds like carbonic acid, sulphuric acid, phosphoric acid, etc. The acid *phosphoric acid*, joined with the base *lime*, forms the salt *phosphate of lime*; *sulphuric acid* and *lime* form *plaster of Paris* (gypsum); *carbonic acid* and *lime* form the salt *carbonate of lime*, such as *chalk*, *limestone*, *marble*. None of these have much resemblance to our table salt.

All fatty matter needs for its perfect digestion the bile of the liver. The bile contains a base which, acting upon the fat, produces a mixture resembling that produced when wood ashes or potash are combined with fat for the production of soap. In this condition these elements are taken up by the fine hair-like veins, capillaries, that receive the bloodforming elements from the intestines and carry them to the larger veins.

The starch in food, such as the solid bulk of all flour, of potatoes, rice and the like, is first turned into sugar in the process of digestion, and finally into fat. It is then acted upon by the bile and other juices and thus fitted to be absorbed by the capillaries. Starch, sugar, fat, mark the changes of the same materials for which we have the general name carbo-hydrates. Below is a tabular statement of the divisions of food that must be supplied to the body in order that it may grow and repair waste :

I.

MUSCLE-FORMERS. NITROGENOUS FOOD.

1. *Albumenoids*, that is, *containing albumen*, a food stuff found in the white of an egg, and also in the lean part of meat, in the nitrogenous parts of seeds, and especially in the *legumes*—*peas, beans, lentils, clover, the cowpea, the soja bean and alfalfa*.

2. *Casein*, which resembles albumen, but is distinct in so far as it is that part of the milk which curdles and thus serves to make cheese.

II.

HEAT-PRODUCERS. CARBO-HYDRATES, OR CARBON-ACEOUS FOOD.

1. *Starch*, found in *flour*, in *potatoes*, in all the *cereals*, in *grass* and *hay*, also in *sago, rice* and in all *fruits* and *vegetables*.

2. *Saccharine* (sugar) matter, in *honey, fruit, sugar*, etc.

3. *Fat*, found in the *fat of animals*, in *milk*, in the *oil* of seeds, in *butter*, and partly in cheese. *Linseed, rape seed*, etc., are rich in oil, and also contain much nitrogenous matter, hence they are very valuable for stock.

III.

MINERALS.

1. *Chlorine, Sodium or Natrium*, in the combination of common salt.

2. *Phosphorus*, as phosphate, in the bones, nerves, brain, etc.

3. *Sulphur*, in the hair, and in horny matter.

4. *Iron*, in the blood and muscles.

5. *Fluorine*, in the outer coats of the teeth, the enamel.

6. *Calcium*, as lime in potash.

7. *Potassium*, in potash.

8. *Magnesium*, in phosphate of magnesia.

This food has for its principal element *carbon* united with hydrogen; this combination slightly varies as to the amount of either in starch, fat, butter, oil.

The following table gives the approximately correct average percentage of organic matter and ash in our common field crops:

	Albumenoids or protein.	Carbonaceous food, fat or oil.	Starch and sugar.	Woody fiber.	Minerals or ash.	Water.
Wheat	12	2	73	2	2	11
Oats	12	5	60	9	3	11
Barley	12.5	2	69.5	3	2	11
Corn	10	5.5	70	2	1.5	11
Peas	20	2	53	12	2	11
Bran	15	4	54	9	6	12
Pasture grass...	4	1	18	9	2.5	65
Meadow hay...	6	2.5	45	29	4.5	13
Red clover....	12	3	39	25	6	15
Corn stalks....	4	1	33	20	2	40
Oat straw....	4	2.3	42	37	5	10
Wheat straw...	3.5	1.3	4.3	38	4	11
Turnips	1	0.2	6.8	1	1	90
Potatoes	2	0.1	17.9	1	1	90
Corn silage....	2	1	10	6	1	80

Compare with the preceding the food values of the following :

	<i>Albumenoids.</i>	<i>Fat or oil.</i>	<i>Starch and sugar.</i>	<i>Woody fiber.</i>	<i>Ash.</i>	<i>Water.</i>
Beef (fat).....	15	32	....	....	5	48
Mutton	13	38	....	....	3	46
Pork	11	44	....	....	2	43
Beans and peas	20	20	*53	12	2	..
Milk (whole) ..	3.5	4	**4.8	....	0.7	87
Milk, skimmed.	3.0	0.5	**5.0	....	0.7	90
Oat meal.....	6	7	*67	10	2	8
Cheese	28	33	....	....	4	35
Butter	1	86.5	**0.5	....	2	10

Notice the high food value in albumenoids of the following: Cheese, 28; beans and peas, 20; beef, 15; mutton, 13; pork, 11. In regard to oatmeal, whole wheat flour, etc., it is doubtful whether all the albumenoid part is digestible, much being found in the outer part of the kernel. This is of similar character to that in the bran of wheat, but this bran is not found to be suitable for human digestion.

We see that our bodies are built up from the elements around us, gases, invisible to our eyes, forming the greater part of them, and minerals the smallest. But these elements do not feed us directly. Our digestive organs are incapable of changing the carbon found so abundantly in nature into human fat, nor any part of the vast mass of nitrogen around us into muscle. These elements and the minerals we need must first be changed by the plant into forms that are digestible by the human and animal body. Nor could we use many plants directly to sustain our life. We could not live on grass and straw, nor on several parts of such plants

*Starch. **Sugar.

as are otherwise acceptable as food, unless we first feed them to animals, and then eat the flesh of these animals. Hence the usefulness of cattle, sheep, swine, poultry and game.

To furnish food for mankind is the business of the farmer, but if this business is to yield him a profit, he must know how to raise his crops, and how to fatten his stock in the most economical way. He must avoid waste in feeding, and he must furnish his stock warm and comfortable quarters. In cold weather we walk fast or work to overcome the effects of cold. Our lungs take in more oxygen and this oxygen burns up more fuel, that is carbon, in our body. This is the reason why fat is relished in winter. But if fat is burned up, it is lost as an article of value that has cost material for its formation. Hence, if animals are shivering, a large proportion of the fat they have laid up in their bodies is lost again, and more must be supplied by feeding.

We use the words *assimilate*, *assimilation* (from Latin *simile*, meaning alike, or similar) to denote the process by which animals and plants change outside elements into parts of their own body. We say therefore that each plant or animal is benefited only by that food and so much of it as it can *assimilate*. In this sense the word *digestion* has nearly the same meaning if we speak of animals and man. But *assimilation* is a gradual process, and must not be rushed. *Overfeeding* is as bad as *underfeeding*, as it results in loss to the farmer. Animals should have enough to eat, but no more. If they do not eat up their food clean, less should be given next time. The proper measure,

moderation, in such as in all other matters, should be a rule that is applicable both to man and beast.

A general inference is the following: As food is useful only in so far as it is digested and taken up into the system, any measure that will help digestion is in so far a saving of food. Hence it is desirable to feed hay and straw chopped fine, to feed grain, bran, middlings, etc., stirred in slightly warmed water, or even after they have been thoroughly boiled or steamed. This is especially desirable for pigs, and in winter. In cold weather a greater amount of food is needed to make fat, solely to be consumed in keeping the body warm. A warm stable will therefore save feed. Chopped food will be more readily acted upon by the saliva and juices of the stomach (gastric juices), hence more easily digested, so that a given quantity of hay will go further. If corn stalks are cut fine on a good machine, they would constitute a valuable addition to useful fodder. Ensilage has been found to be more relished and more easily digested than other fodder.

CHAPTER VII.

HUMAN FOOD.

As to the proper preparation of the human food a few rules may be given. We need a due mixture in our food of nitrogenous and carbonaceous elements. Of the former the greater supply is in cheese, about 28 per cent; in meat from 15-20 per cent; and in peas, beans and lentils, about the same. These articles contain at the same time a large proportion of carbonaceous elements, such as starch, and in the case of cheese and meat, fat, and also the mineral elements needed by the body. They suffice, therefore, for all purposes of nutrition, especially in the case of those who work hard in the open air. In the preparation of meat it should be remembered that the nitrogenous element is largely in the form of albumen (the same substance which is found in the white of egg.) Now, inasmuch as this albumen will harden (coagulate) when exposed to heat, it has been found that in order to keep the juices inside of the meat, it is necessary to expose meat quickly to a great heat, which will harden the albumen on the outside layers of the meat and thus make a coating which will keep the other valuable juices within. Hence it is that steak broiled over a bed of bright coals is much more juicy than one fried in a skillet.

If a skillet must be used it should be made thorough-

ly hot before the steak is put in. An admirable improvement would be *braising*, which is done in a braiser. This has a tight-fitting lid with a standing rim; on this live coals are placed, so that the heat is applied to both sides of the meat at once. It follows that a steak should be thick, for the larger the inside the more juice can be preserved. This is of course also true of roasts. In the case of boiled meat, unless broth is the main object, the water used should be boiling before the meat is put in, and the pot at once covered with a tight fitting lid. The steam boilers, for cooking purposes, to be had in the tinware stores, are prepared on this principle.

Potatoes, carrots, turnips, cabbage, etc., contain very little nutriment, but are liked as an addition to the more substantial food and answer a need of our system. The same is true of fruit, only nuts being rich in nitrogenous elements. Most of us are apt to eat too much meat. It has been found that a quarter of a pound of meat, or at any rate not more than one-half a pound, a day is sufficient for soldiers, who spend much of their time out of doors. It ought to be enough for anyone. Those who overload their stomachs with rich food are punished in various ways. They frequently suffer with gout when they attain mature age, a most painful disease.

Bread has been called the staff of life. It is in itself sufficient to sustain life and build up the body, but as the starchy elements prevail in it, a larger portion must be used than is necessary with meat, cheese or the legumes. Most of the nitrogenous elements of the grain are in its outer coating, the bran, but bran cannot be

digested by the human system. The bran had better be given to cows or pigs. The milk of the former and the meat of the latter can then be taken into the human system with good effect.

Milk, and chiefly cow's milk, is an ideal food, as it contains all the elements of which the body is made in about the same proportion in which they are found in the body. Milk is largely water, the rest consists of nitrogenous and carbonaceous substances, the former in the form of casein, which is the essential part of cheese, the latter as butter. The mineral matter needed by the human body is also found in the milk. Skimmed milk, being deprived of the fatty element, is excellent for the purpose, as the fat is abundantly supplied by other articles of food. Milk may be used at every meal in place of coffee or tea. These two are not specially injurious prepared in a weak form, by merely pouring boiling water on a very little tea or coffee, the latter ground as fine as possible or pulverized, but as a rule they are regularly boiled, or else allowed to stand until the hot water has drawn out their poisonous elements, the caffeine or thein. If tea or coffee must be used, the rule should be observed of never boiling them. The less material used, the better.

Unfortunately the taste of using strong coffee or tea has become so general that it is as difficult to change it as it is to change the taste for liquor. The alcohol in the latter is a poison, hence no one who wishes to keep himself in perfect health can afford to touch it. A melancholy philosopher has said, "These harmful substances seem to have been created to prevent the human race from living too long, for if all

people lived out their natural lives the earth would soon afford no longer standing room for the race."

All feeding, whether of man or animal, should be so regulated as to give the stomach ample time to recover for new work by a period of rest. As to animals, the rule must vary, as the smaller stomachs of the horse and pig require these animals to feed oftener than cattle with their four stomachs.

In regard to man the best results will be obtained if an interval of not less than four hours between meals be allowed for children, and not less than five hours for adults. In some respects the plant is a model for man. Man will crowd everything into his mouth that, for some reason, pleases him. He will poison himself with alcohol and tobacco, and hurt his digestion by drugs, strong spices and unsuitable food. Not so the plant. It is truly wonderful, one of the many miracles that we find everywhere in nature, that a plant will select out of material in solution, with which its roots come into contact, only that part of the solution which contains the material it needs, rejecting the other. It will absorb a chemical salt contained in a solution of water and reject the water, or absorb the water and leave the salt. A solution which contains equal parts of different minerals, all needed by the plant, will be assimilated in such a way that each mineral appears in the plant in different quantities.

From a solution of equal parts of sulphate of soda and of muriate (or hydrochlorate) of soda, there were taken up by a plant (*bidens cannabina*) only 11.7 of the former and 22 parts of the latter. In the case of sulphate of soda and muriate of potash the plant took

only 7 of the latter and 12 of the former. There is a lesson of great importance for us in these facts. What the plant does unconsciously, we should do consciously; take up only what is fit for us, for the up-building and preservation of our bodies, and reject all the rest. And might we not probably enlarge this rule by making it applicable also to our minds and souls? Let us feed our minds only on what is true, let our souls imbibe only what is good, praiseworthy, noble! In that way we shall grow to the full stature of mind and body for which the Great Architect created us.

CHAPTER VIII.

ENTOMOLOGY, SCIENCE OF INSECT LIFE.

“Insect” means literally, “cut into” or “in sections.” Notice, for instance, the wasp. Insects are so called because of their form. A familiar insect is the grasshopper, another the cricket. All moths, butterflies, beetles, bugs, caterpillars, belong to the class.

Some insects are useful, but many are very injurious pests. Of the latter we mention the Colorado beetle, or potato bug; the chinch bug, so destructive to wheat; the Hessian fly, the army worm, the cutworm—all destructive to green crops. The pea weevil, or “Pea bug,” lays its eggs on the outside of the green pod whence the larva, from the eggs, eats its way into one of the peas on which it lives until it enters the pupa state.

Moths, butterflies and nearly all other insects, such as bees, beetles, flies, etc., develop from the egg by the following stages: From the egg is hatched a caterpillar or grub. This is a voracious feeder but changes after a short time, generally several weeks, into a motionless form called pupa, after having surrounded itself with an envelope that resembles a shell. In this condition it may remain all winter. On the approach of warm weather the shell cracks open and the moth or butterfly comes forth to be soon engaged in laying eggs for another set of caterpillars.

The cutworm is a caterpillar, and so is the army worm.

The pupa of a butterfly or other insect is called a *chrysalis*. The chrysalis of a butterfly is almost always rough and angular, while the pupa of a moth is smooth, oval and more or less silk-like on the outside. The butterfly differs from a moth in its feelers, or antennae, which are smooth and threadlike and end in a knob, while those of the moth are generally feathered. Moths fly mostly at night, butterflies only in the daytime. The larva of a beetle is called a grub. Among useful insects may be mentioned the ground beetle, which is very destructive to cutworms; the lady-bird beetle, or "ladybug," which lives on plant lice, and the various parasites that live on plant lice and caterpillars and so destroy them.

Insects are divided into seven classes, according to their wings.

1. Nerve-winged (*neuroptera* — *ptera* meaning wings) as May flies.
2. Straight-winged (*orthoptera*), as crickets and grasshoppers.
3. Half winged (*hemiptera*), as bugs and plant lice.
4. Sheath winged (*coleoptera*), as beetles.
5. Scaly winged (*lepidoptera*), as butterflies and moths.
6. Two-winged (*diptera*), as house flies and mosquitoes.
7. Transparent winged (*hymenoptera*), as ants, bees, sawflies, wasps.

All insects have six legs; moths, butterflies, beetles, bugs, weevils, etc., have four wings.

The insect pest is one that often tires the patience of the farmer and gardener. To guard against the *chinch bug* a thin streak of tar around the entire field will protect a field that has not yet been attacked.

Fig 34 —A ground beetle, one of the "sheath winged" insects, very destructive to cut worms.

Fig 35.—Lady-bird beetles, or "lady-bugs." The straight lines represent the average natural length. These beetles are very destructive to plant lice.

Rotation of crops, and the careful destruction of all vegetation on the field, after the crops have been harvested, will afford no place for the eggs and do much to diminish the evil. Plowing before winter sets in will kill many eggs. There are some destructive insects that infest orchards. The *apple borer* does much damage to the trunk of apple trees.* It is a glossy and

*See page 147.

greenish black beetle about half an inch long. It bores into the tree and along under its bark and remains there one or two years. When several borers attack a tree it is apt to be killed; in all cases it is more or less weakened. Good cultivation, by causing an abundant flow of sap, is said to check the borer by drowning it. Whale oil soap applied to the trunk, after the rough bark has been scraped off, followed by an application of soft soap early in the season, is said to keep the beetle away from the tree. When the larva is in the tree it must be cut out.

The *codling moth* (from codling, the name of an apple) is about $\frac{1}{2}$ inch across its wings.* Its fore wings are gray, its hind wings light brown. The larvae generally enter the young apple from the blossom end while the apple is yet upright, and eat their way to the core. Such apples generally fall before they are ripe, and it is a good practice to feed them to the pigs, in order to get rid of the insect. In the pupa state that insect stays about two weeks. Then the moth comes out and soon a new set of eggs is the result. Spraying the trees with a mixture of Paris green is to be recommended, especially while the apples are still turned upward (that is, while their blossom end is above, and the stem below). It is important to spray at the right time, not too early, while the tree is yet in full bloom, nor too late, because then the mischief is done. Spraying too early will kill the bees that not only gather honey from the blossoms, but also, by carrying pollen from one blossom to the other, fertilize them.

The *pear tree slug* is a black saw-fly. It has

*See pages 147 and 149.

four wings. The female is nearly 1-5 of an inch long. It lays its eggs on the approach of warm weather in June, and these produce the slugs, which are one-half inch long and often longer. They change their skins four or five times while feeding on the leaves. After about four weeks more a new generation of flies will be ready to deposit a new crop of eggs. A kerosene emulsion* should be used for their destruction in June and August. The *plum curculio* is a weevil, dark in color, and 1-5 of an inch in length. In the spring it comes forth from rubbish, hence the necessity of destroying all rubbish in the fall. As the young fruit is setting it punches a little hole in it, lays an egg and cuts a moon shaped slit into the skin near the hole. This slit gives the larva a chance to get out of the fruit when it has grown larger and the hole has disappeared.†

Trees may be jarred to make the damaged fruit fall to the ground. This should be picked up and given to the chickens and pigs. A sheet spread under the tree will collect the curculios, which should then be destroyed in a mixture of kerosene and water. Spraying with Paris green is recommended. It should be repeated several times after the blossoms have fallen.

The *tent caterpillar* is very destructive to the leaves of the trees. The nests are easily seen and should be destroyed; but this should be done while the caterpillars are in the nests. They come out two or three times a day to feed. Spraying with Paris green is the best remedy.

*See page 148. †See page 147.

The science of Entomology is of comparatively recent growth, but it is of great importance. Only re-

Fig. 36.—The tent caterpillar. *a* and *b* are caterpillars on the web, *c* is a mass of eggs, *d* is the cocoon containing the chrysalis or pupa. The female moth is above.

cently it was found out that the peculiar fine taste and flavor of the Smyrna fig is due to the action of a tiny insect. After many futile attempts this insect has at

last been introduced into California fig orchards, and some excellent figs have been raised in consequence.

Among the useful insects bees deserve our special attention.

Of the destructive ones the following illustrations show three more specimens with which we will close this chapter.

Fig. 37 —Bud moth. The larva feeds upon young buds of fruit trees.

Fig. 38 —Midge and larva.
Destructive to clover

Fig. 39 —1. Army worm, pupa of same; 2. Moth into which it changes; 3. Chrysalis.
This is a cutworm.

CHAPTER IX.

BEEES.

Any farmer may have a small stand of bees and all the honey needed for his family. In some seasons an exceptional yield of honey may even enable him to realize a nice little sum of money out of honey sold.

Bees are insects and belong to the order of *hymenoptera*, their wings being very thin and transparent. Their two pairs of wings are spread in flight in such a way that the inner pair hooks on to the outer. In this way they are enabled to carry a larger load than their size might lead us to expect. A bee has a long tongue which it can twist about easily, and at the end of which there is a brushlike part which it uses to sweep up the juices from the flowers. It puts the sweet juice (or nectar) of the flower into its mouth, whence this nectar passes into a little sack called the honey bag. Bees do not fly home until this bag is full. At the same time each bee gathers the pollen of flowers (*pollen* or *seed dust*) on its hairy legs, which have pocket-like depressions on each side. Thus loaded up the bee returns to its home and there puts away the nectar, which by and by changes into honey, and the pollen.

Before any honey can be stored, the bees must have *cells*. These they build of wax, which they make out of honey. Each cell has six sides—we say it is

hexagonal. A little inspection will show that this is the most economical form where a number of such cells are joined, for any other form would yield less room for the material used. Circles would leave open spaces where they meet; squares and triangles would require more material for walls to afford the same amount of inside space.

Bee-keepers now help the bees at this work of cell making which keeps the bees from gathering honey while they are engaged in it. They use ordinary beeswax, which is pressed out into flat sheets showing the beginnings of the future cells. The bees use these as foundations to build on. These foundations are held by a square frame which can be easily put into and removed from the hive when the bees have filled the cells with honey. The hive should be a box with such fastenings inside as will enable the beekeeper to hang his foundation frames on them. There should be enough of them to fill the entire box, leaving only space enough for the bees to get around in.

Bees go through the same stages of growth as other insects. But they have this peculiarity that all the eggs of a swarm are laid by only one bee, the largest of them, called the queen bee. Only one queen bee can remain in a hive; if there should be two, one must leave. When it does leave a part of the swarm goes with it.

The queen bee lays one egg in a cell. This may produce either a so-called *worker bee*, always a female, or a male bee, called *drone*; and in some cases a *queen bee*. A swarm may contain some 20,000 or more workers, and from 500 to 1,000 drones. While at

work laying eggs the queen bee averages some 2,000 a day. The drones are hatched in cells somewhat larger than those which answer for the worker, and the cells for the queen bees (there are frequently more than one,) are still larger. A similar difference is in the food. After the egg is laid the bees place a mixture of honey and pollen into the cell, for the use of the larva which hatches in about three days, and then feeds on the food by its side for some six days. It is then ready to go into that stage which is the same for all insects,

Fig. 40—Queen.

Fig. 41—Worker.

Fig. 42—Drone.

the pupa stage. (See p. —) The bees seal up the cell with a thin cover of wax, and in about twelve or fourteen days the worker bee comes out of this cell, ready to join in the common work. Drones require a few days longer, the queen bee a few days less. From the laying of the egg it takes 21 days for the ordinary bee to develop, 24 days for the drone, but only 16 days for the queen bee. The food for the queen bee larva is much richer; it is especially prepared by the bees and has the name of "royal jelly."

Instinct guides the bees to prepare for the lack of flowers during winter. Honey is made only while flowers are in full bloom. As long as there are any flowers the work goes steadily on until the hive is well

stored with honey. From 50 to 100 pounds may thus be produced by an average colony. This is more than the swarm will need, and a part, sometimes the greater part, of this quantity can therefore be removed by the bee keeper.

If all the seasons were as favorable as some are, there would hardly be a business yielding more net profit than bee keeping. *But this is not the case.* Some seasons the supply is very poor, yielding scarcely enough honey to winter the swarm. And then there are frequently cases of disease which cause the loss of large numbers. It is not always possible, at least not for the farmer, to prevent these. For these reasons bee-keeping should not be carried on extensively on a farm. The work is suitable for women, and most people who engage in it find it very fascinating. But a bee-keeper must have a gentle disposition to avoid stings. The bee is provided in the rear end of its abdomen with a sting which consists of two sharp lances. A bee will sting only when provoked and in defense of the swarm, but when it pushes this sting into a person's flesh it drops at the same time into the opening a small quantity of poison. This poison and the sting itself, which remains in the flesh as its shape makes its removal difficult, cause pain, dizziness and sometimes an illness that may continue for a day or longer. It is therefore important to remove the sting one way or another and to neutralize the poison as quickly as possible. For the latter purpose ordinary soda may be used.

Persons used to bees are rarely stung, and if stung

will not mind it much as they soon get used to the poison.

It is recommended to be often with the bees, to allow them to settle on one's hand, and even on one's face, without making any hasty motions. The trying time is when the bee-keeper wants to take out honey or examine the hive for queen cells. He must then use a "smoker," a small pair of bellows which keep a rag burning in a tin funnel. The smoke thus produced is blown into the hive and compels the bees to leave it.

Another occasion for stings is at swarming time when the bee-keeper wants to catch the escaping bees. To this end he will throw water upon them, a small pump or syringe is used for the purpose, and the bees will then settle around the queen bee on some object, generally the twig of a tree. After they have had a little rest to quiet down, the whole swarm can be caught in a bag and this bag emptied into a vacant hive. During these operations the bee-keeper should wear over his hat a veil long enough to protect his face and neck. He should also tie up his sleeves, etc., to prevent bees from creeping into them. With some practice all this work can be done with little trouble, but in order not to become discouraged, it is well to proceed very cautiously at first.

Various kinds of hives are for sale at reasonable prices. Foundations can also be had in most localities. The outlay, once a start has been made, need not be large. The result, in the long run, will amply justify the trouble and the expense.

In order to obtain the largest amount of honey

*extractors** are used. These extract the liquid honey which may then be put into glass jars and kept like preserves. The *combs*, that is the cells in a mass, may then be returned to the hives. This saves the expense of new foundations, and allows the bees to go right along gathering honey.

It is important that only Italian bees are used. It is only necessary to have a first-class queen of this stock, the rest may be of another kind. In a short while the whole colony will be Italians. There are other varieties, but the Italians have given by far the best satisfaction in this country.

Honey differs according to the flowers from which it has been gathered. A very choice variety is basswood honey, gathered from the blossoms of the basswood tree. White clover honey is another fine variety. Buckwheat honey is dark, and the least valuable, though a good honey in itself.

When it becomes necessary to move the hives to another place they should be shut up for a day. They may be opened late in the afternoon of the day following their removal when the bees are not apt to fly away far. This gives them time to recognize their new surroundings.

In very hot and dry weather the bees feel the need of water. This should be furnished in abundance, but in shallow vessels where they can easily reach it without any danger of drowning.

Bees may be wintered in a dry cellar. They will do

*Extractors are for sale at reasonable rates at all the stores where beekeepers' supplies can be had. They must be made by experts.

better out of doors, if the winter is not exceptionally severe, or if they have the protection of buildings, straw stacks, etc., on the west and north sides.

Like many other insects bees help in, or directly cause, the fertilization of flowers by carrying the pollen from one plant to the other. They are especially useful in the orchard.

The bumble-bee does this for red clover. It has been said that in order to raise clover we must have cats. Why? Mice destroy the combs of bumble-bees and thus kill the young brood. As the old bees do not live long, there would soon be no bumble-bees to fertilize the clover blossoms. Cats feed on mice, hence cats are necessary to raise clover. But the same may be said for snakes, owls and other animals that prey on mice.

CHAPTER X.

BIRDS.

Our songbirds and others perform a most important service in keeping down noxious insects of all kinds, but, with few exceptions, they also do some injury. During the fruiting season of raspberries, blackberries, grapes, cherries, the robin, catbird and others live to some extent on fruit. The injury they thus inflict is,

Yellow-bellied woodpecker
(*Sphyrapicus varius*).

however, of small consequence compared with the good they do to the farmer. These birds feed their young on insects, adding only sparingly some soft fruit until their stomachs have grown strong enough. The stomachs of the nestling birds are thin walled and very weak at first, hence unfit to digest any material that is not perfectly soft. Insects

answer for this purpose. At first snails, caterpillars, grubs and spiders are fed, later on beetles and other insects.

The food of the bluebird is in the following proportion for the nestling and the adult bird, as shown in recent illustrations of the Yearbook of the Department of Agriculture, D. C., for 1900.

NESTLING

ADULT

Fig. 43c—Diagram showing proportions of food of the bluebird, young and adult.

Our song birds produce on an average two or three broods of three to five nestlings each season. The young birds are fed by the old ones from before sunrise, with but short intermissions,

Fig. 43a—Hairy woodpecker (*Dryobates villosus*).

until after sunset. The capacity of the nestlings for food is such that at first they digest more than their own weight of food in a day, making a gain in weight of from 20 to 50 per cent each day. The reports of close observers show that, for instance, a young robin, kept in captivity by Pro-

fessor Treadwell, of Boston, Mass., consumed sixty

earthworms daily. Another observer, Dr. Brewer, of Illinois, observed the young of a pair of European jays and found that they were fed half a million of caterpillars in a single season. As the nesting period occurs at the very time when agricultural work is most active, the importance of the food fed to the nestlings by the old birds should make us lenient toward the latter when we find that they share our taste for fine cherries, luscious grapes and the different berries.

Fig. 43b—Flicker (*Colaptes auratus*).

The wren, especially the *house wren*, feeds only on insects. There is no more useful bird on the farm, and it should be protected by all means.

Dr. S. D. Judd, of the Agricultural Department in Washington, D. C., observed a nest of about three-fourth grown wrens. There were three nestlings, and these were fed by the mother wren 110 times in four hours, thirty-seven minutes, receiving and consuming during this time 111 insects and spiders. Among the insects he identified 1 white grub, 1 soldier bug, 3 millers, 9 grasshoppers, 15 May flies and 34 caterpillars.

The food of the old birds is of a similar kind.

The diagrams on page 222, taken from the Yearbook, show the character and relation of food of the house swallow, catbird, wren and others.

The usefulness of the swallow has gained for this bird the special protection of several European gov-

NESTLING.

ADULT.

FIG. 44.—HOUSE WREN.

[1, Cutworm ; 2, spider ; 3, stink-bug ; 4, May-fly ; 5, weevil ; 6, grasshopper.]

NESTLING.

ADULT.

FIG. 45.—CATBIRD.

[1, Ground-beetle ; 2, cutworm ; 3, ant ; 4, grasshopper ; 5, spider.]

NESTLING.

ADULT.

FIG. 46.—BANK SWALLOW.

[1, Weevil ; 2, ichneumon-fly ; 3, winged ant ; 4, fly ; 5, dragon-fly ; 6, stink-bug.]

Food of Nestlings and Adults of some Common Birds.

[The diagrams show the proportions of the various orders of insects in the food, each order being represented by the insect belonging to it that is most commonly eaten by the bird whose food is shown.]

ernments. These diagrams show how very great this usefulness is.

Our native sparrows are not looked on with much favor. They belong to the family of song birds, but

Fig. 43c—The Bluebird.

their song is not of the kind to invite attention, and the adults live almost exclusively on seeds and grain. Nevertheless, they are not entirely useless, for as far as known their young are reared exclusively on insects. Dr. Judd reports that a parent bird, a so-called

Fig. 47—The Swallow.

grasshopper sparrow, was carefully watched at Marshall Hall, Md., as she brought food to her four naked young. "Three long-horned grasshoppers, two species of short-horned grasshoppers, a chrysalis, and an army worm were identified in the parent's bill. Another

grasshopper sparrow in the same field, that was carrying food to its older and feathered young, was shot. In its beak and mouth were two bugs and two spiders, and in its stomach two of the same species of spiders, a

Fig. 48—The Bobolink.

bug, two leaf beetles, a weevil, a cutworm, the jaws of a cricket, some seeds of rib grass, and a grain of wheat. In the stomachs of ten nestlings and fourteen adults collected in Kansas, half of the food of the old birds was found to be grass seed, while that of the young

YOUNG NESTLING

NEARLY FLEDGED

ADULT

consisted entirely of insects—caterpillars, grasshoppers and a very few spiders.”

Equally good reports are given of young chipping sparrows. Even the English sparrow, though the adult lives mainly on seed and other vegetable matter, feeds its young an astonishing number of noxious insects.

In the following diagrams of the food of nestlings some of the principal birds useful to the farmer are represented.

“With the exception of doves and pigeons all birds feed their young on some animal diet. Birds that are largely vegetarian, such as the crow, crow blackbird, catbird, robin, cedar wax wing

Fig. 49—Diagram showing proportion of food of the Barn Swallow, young and adult. [The extraordinary usefulness of the swallow has caused several European governments to place it under the special protection of the law.]

7 DAYS OR LESS

1 TO 2 WEEKS OLD

3 WEEKS AND OLDER

ADULT

FIG. 50.—Diagram showing proportions of food of American crow (*Corvus americanus*), young and adult.

NESTLING

ADULT

FIG. 51.—Diagram showing proportions of food of chickadee (*Spiza americana*), young and adult.

NESTLING LESS THAN ONE WEEK OLD

ADULT

FIG. 52.—Diagram showing proportions of food of English sparrow (*Passer domesticus*), young and adult.

NEWLY HATCHED

HALF GROWN

NEARLY FLEDGED

ADULT

FIG. 53.—Diagram showing proportions of food of crow blackbird (*Quiscalus quiscula arvens*), young and adult.

These diagrams show that the services of the nestling crow blackbird in destroying insect pests, such as cut-worms, May beetles, weevils and grasshoppers far outweigh the loss due to its consumption of corn.

NESTLING.

FIG. 54—GRASSHOPPER SPARROW.

ADULT.

[1, Flea-beetle; 2, grasshopper; 3, cutworm; 4, spider.

NESTLING.

FIG. 55—KINGBIRD.

ADULT.

[1, Grasshopper; 2, drone honeybee; 3, rose-chaffer; 4, spider; 5, winged ant; 6, May-beetle; 7, fly.]

NESTLING.

FIG. 56—CUCKOO.

ADULT.

3, May-beetle; 4, grasshopper; 5, caterpillar; 6, cutworm.]

and English sparrow mingle fruit or grain in constantly increasing quantities with the insects fed to their young, though insects usually remain the chief component of the food until maturity is nearly reached." (Fig. 50-56.) Hairless caterpillars, such as cankerworms, cut worms, and army worms are largely consumed. "Hairy caterpillars are eaten to a certain extent. Mr. E. A. Forbush, of Massachusetts, has noted thirteen different species of birds giving tent caterpillars and the caterpillars of the brown-tailed and gypsy moths to their young."

In addition to the examples already given, the following may be added in proof of the great usefulness of birds. During the outbreak of Rocky Mountain locusts in Nebraska (1874-1877) Professor Samuel Aughey saw a long-billed marsh-wren carry thirty locusts to her young in an hour. At this rate, for seven hours a day, a brood would consume 210 locusts per day, and the passerine birds of the eastern half of Nebraska, allowing only twenty broods to the square mile, would destroy daily 162,771,000 of the pests. The average locust weighs about 15 grains, and is capable each day of consuming its own weight of standing forage crops, corn and wheat.* The locusts eaten by the nestlings would therefore be able to destroy in one day 174,397 tons of crops, which at \$10 per ton would be worth \$1,743.97.†

Another use of birds is the destruction by certain varieties of incredible quantities of the seed of noxious weeds. The subject is therefore of very great import-

*Year Book, U. S. Dept. of Agriculture, for 1894, p. 222.

†Year Book, U. S. Dept. Agriculture, 1900, p. 436.

ance. One young dove which had recently left the nest had in its crop 7,500 seeds of yellow sorrel. According to Dr. Sylvester D. Judd, of the U. S. Biological Survey, from whose article on "The Food of Nestling Birds."* we have quoted freely, the barn owl is probably the most valuable rat and mouse catcher in the United States. "The screech owl is an abundant, widely distributed, harmless little species that destroys mice and quantities of insect pests." It is particularly useful in destroying May beetles.

Even the great horned owl, so destructive to chickens when not carefully housed at night, is useful to the farmer. "In and about a nest containing young of this species were found the remains of 113 common house rats."

"Grouse, quail, pheasants, prairie chickens are commonly credited with being exclusively vegetarian in diet, but they are mixed feeders and probably nourish their newly hatched chicks principally on insects. Quail and prairie chickens destroy such dreaded pests as cutworms, army worms, twelve-spotted cucumber beetles, chinch bugs and Rocky Mountain locusts."

It is believed by some ornithologists that the extensive "legalized slaughter of these birds, which in some sections has amounted to practical extermination, is largely responsible for the increased depredations of certain insect pests. *In any event, they are of too much value to the farmer to be killed off recklessly, and whenever the sportsman is privileged to shoot them the farmer should demand full compensation.*" **

*Year Book, 1900, p. 431.

**Year Book, 1900, p. 432.

An examination of the preceding facts and illustrations cannot but impress on every reader the great importance of birds for the farmer and horticulturist.

The damage done by some birds to the farmer is scarcely worth mentioning by the side of the benefit they confer. Crows may pull up some corn in the early part of the season, but their consumption of ripened grain later will scarcely be felt as a great evil.

The horticulturist is often more seriously injured. The robin, the catbird and the cedar waxwing consume a good deal of small fruit. Prof. F. E. L. Beal found that raspberries, blackberries, blueberries, cherries and service berries formed 70 per cent of the food of the adult robin. But the food of their young consisted almost wholly of insects, only 7 per cent of it being small fruit. The robin is also very destructive to early grapes, especially the Delaware variety, and in years when wild cherries are scarce. As there is generally some work going on in the garden or vineyard, at the time the fruit is ripening, the birds are to some extent deterred from indulging their appetite too freely. Most of the damage is therefore done very early in the morning before work begins. Scarecrows and other devices help to keep the birds off, but cannot be relied on absolutely. Special protection should be given, not only to the swallow, but to the wren. This little bird is exclusively insectivorous and consumes an astonishing number of insects. It will gladly avail itself of any nesting place near the house, and as many small boxes as possible (even tin cans will do) should be nailed up at convenient places for its accommodation.

PART VI.

RURAL SCENERY.

CHAPTER I.

THE ELEMENT OF BEAUTY IN FARM LIFE.

All rationally formed human beings have a craving for the beautiful. Many confuse the terms beautiful and luxury. Luxury makes use of beauty as a servant and therefore never displays beauty at her best. The flowers used to decorate a splendid hall for the enjoyment of the very rich are merely material for a purpose; they are not themselves the object for which that hall will be visited by hundreds of invited guests. And yet, any one of these flowers, in its original beauty, and surrounded by other products of nature, is a spectacle far more wonderful and admirable than the most brilliantly decorated hall with its thousands of flowers and other ornaments.

A sunrise in the country may be the most beautiful spectacle imaginable, and the varying aspect of the sky and landscape may at times produce effects which for grandeur, majesty and beauty surpass anything that the human imagination could picture to itself.

All that is necessary is that man should open his eyes in the country to the beauty around him. If he

can *see* properly, he will never weary in his admiration of the glorious scenes that unroll before him as the seasons come and go.

But while this beauty of nature is always appealing to him, it is not all that a man desires to look on in order to satisfy his craving for the beautiful.

He wants to see beauty in his home, both outside and in, in his yard, and in all the nearer surroundings of his house. It is not a very difficult matter to make a great and desirable change in the appearance of very many houses in the country. To begin with the house, if it be a frame house, it may be painted to look well in the landscape. The glaring white paint which is often used for country homes ought to be softened by the admixture of some pigment that will produce a more restful effect. A soft gray, an olive green, or even a rich cream tint looks well at all times, provided it be freshened up from time to time by a new coat of paint.

It would be well to give the window panes and doors a different color, one forming an agreeable contrast with the color of the body of the house. A deep red for the sash of the window will generally look well. The frames may be of a darker tint than that of the house, but of the same general color. The door may be treated in the same way, and the cornice likewise. Loud contrasts should be avoided, and it is best never to try an unusual color. The very fact that such a color is rare will make it appear unpleasant, for the eye is best pleased with soft transitions, not with sharp contrasts.

The same principle should govern inside painting. Avoid above all dark reds or browns for doors inside.

Let these and all other wood-work be of a cheerful color. In case of doubt choose a good cream tint; such a tint never fails to give satisfaction. Whenever possible have the inside walls of your house painted rather than papered. Paper attracts and holds dust, and dust is the abiding place of *microbes*, those invisible enemies of human health. If paint is considered too expensive, calcimining will do nearly as well, provided it is frequently freshened by a new coat.

On the floor large rugs rather than carpets nailed down should be the rule. A rug can be taken up, shaken and beaten almost any time, a carpet once nailed down is generally a fixture for the year. Danger from microbes lurks in permanent carpets, and the air in a carpeted room is rarely ever perfectly pure. In the kitchen and dining room well-oiled or well-painted floors should be the rule. Paint makes perfect cleanliness possible, and it is generally secured when possible.

Whenever carpets are the rule, the sunlight is apt to be shut out by curtains, and with it the most essential condition of good health. "Where the sunlight does not come, the doctor will," is an old Spanish saying.

Fresh air and sunlight are the sovereign remedies for worn-out people, more important than food, provided there is good water. They are invaluable for children, especially in the winter season.

The average housewife has a superstitious reverence for her parlor. No ray of sunlight must enter it, for the sunlight injures the carpet. The windows must be tightly closed, for the draught might displace some of the nicknacks on the center table or the mantel of the fireplace. On the days when it is opened for com-

pany it will be occupied by a solemn procession of guests. The children give it a wide berth, if they can find any other place for their play; but if they enter it the girls are unnaturally stiff and ceremonial, and the boys look as though they had never laughed aloud and it was now too late to learn.

On the walls of all the rooms, including the bed rooms, pictures should be hung, nailed on or even pasted. This is the age of cheap and good pictures. Some may be frequently had for the asking from those who use them for advertising their goods. They do not represent the height of art, but neither are they deficient in some elements of beauty. Many comic pictures should be avoided. What you and the children daily see should be free from any taint, and many comic pictures, especially caricatures, are what rotten apples are in a barrel of good fruit. There are of course exceptions. Good natured fun has its proper place everywhere, but many of the funny pictures that are most frequently used do not show this kind of fun. Some of the Chicago dailies frequently furnish with their Sunday editions handsome engravings, often colored, which answer well for wall decoration.

From the windows of the dining or sitting room the outlook into the yard and farm should be as pleasing as possible. This brings us to the subject of ornamenting the grounds near the house.

Windbreaks have been and are generally planted, but as a rule with no eye to beauty.

It is desirable to have the trees stand in straight rows to facilitate cultivation, but they might so stand and yet produce the effect of a curve or semi-circle.

Neither would cultivation be more difficult, if a variety of trees were planted, instead of only one kind.

In front of the trees there might be flowering shrubs, and in front of these a bed or two of flowers. The view from the house at the proper season would be charming, and yet the expense in labor and original cost

A Rural Scene.

would not be greater than it is where stiff rows of windbreaks are planted on the one side and shrubbery and flowerbeds scattered irregularly over the grounds at the other. A good sod of Kentucky blue grass should be the foundation of the lawn. It is true a lawn requires frequent mowing with a lawn mower to produce its *best* effect, and it is impossible, on the average

farm, to find the time for its proper care. But if the sod be well established the grass may be cut with a regular grass cutting machine two or three times during the season and allowed to remain on the ground. The next rain will beat it down and the new grass will soon hide it completely. This is not the best way, but practically the only way for the busy farmer; and the effect, while not such as is produced by a velvety lawn, the result of frequent cutting with the lawn mower, is not unsatisfactory.

Shade trees near the house should be planted at such a distance that their branches never reach or overhang the house. Their shade is very grateful on the east, south and west sides. Sometimes it may be desirable to plant a few evergreens on the north side, partly for effect, partly as a protection from the cold winds. Whoever can afford it should have evergreens for a windbreak. But they should stand at a considerable distance from deciduous trees, because the latter will spoil their looks if too near. Evergreens need the sunlight as much as any other tree to do their best. If well planted and cared for they are a thing of beauty to which every one will render a willing tribute of praise.

The most satisfactory, as well as one of the very finest of evergreens is the *Norway Spruce*. In setting out evergreens *extreme care must be taken never to expose the roots to the sunlight or air, even for a minute*. Their cells contain rosin which is very apt to harden, if exposed, thus stopping the circulation of the sap from cell to cell. Very small plants give the best satisfaction in the long run, but large trees can be

planted if enough of the soil is taken up with the roots to enable the tree to draw the necessary amount of moisture from the ground, and if a good mulch is spread over the surface to prevent the soil from drying out. If due regard be paid to the roots, the planting of an evergreen does not differ from the planting of a deciduous tree.

Our "White Pine" is a stately and beautiful evergreen, but like the Norway spruce it needs plenty of room to develop its full beauty. The "Hemlock" is a graceful and elegant evergreen, but a slower grower than the others mentioned, and sometimes apt to turn brown in parts of its foliage. The Canadian fir resembles the Norway spruce, but its leaves are larger and of a deeper green. This fine tree does not seem to be as long lived as the spruce. The "Arbor vitae" is a common favorite, but it looks so dingy in the early part of the season that it should not be planted when the Norway spruce and white pine can be had. Two foreign pines are frequently planted, the *Scotch* and the *Austrian*. Of the two the Austrian is by far the finer tree. The Scotch has a straggling growth and should not be planted near a dwelling. In a rugged part of the farm, on or amid rocks, it may produce a good effect.

Do not waste time trying to remove such trees from the woods. Buy your plants from a competent and honest nurseryman. If you buy small plants, set them in rows alongside a fence, if possible, or at least put up a board along the south side of the row to shade the young plants, and lay clean straw or grass between the rows and around the plants. It will pay to water

them thoroughly in a dry summer, and this had better be done in the evening. With these precautions most of the young trees will live and make a good growth the second year. When about $\frac{1}{2}$ to 2 feet high they may be transplanted to a permanent place. If this is to

The Way to Town.

be a windbreak the trees should be planted twenty feet apart in the row, breaking joints with the second row by letting this row begin ten feet from the beginning of the first row. The rows may be twenty feet apart also, but for the sake of an early effect ten feet may be enough.

Thus planted and properly cared for a double row

of Norway spruce will be a grand sight in from ten to fifteen years. They will look very well much sooner, but as they attain age they develop an air of grandeur and beauty that commands admiration.

In good soil a Norway spruce will easily spread from 10 to 15 feet each way in as many years after transplanting. Never cut off or trim the lower branches. These should rest on the ground. To trim up an evergreen as one might a deciduous tree is to spoil more than half its beauty. Don't believe those "wise people" who tell you that they don't believe this. Judge for yourself after having seen some fine specimens showing a full natural growth from the ground up.

If desired, the windbreak may be made much thicker. Instead of two rows, three or more may be planted with excellent effect. The tall trees will become the resort of numerous song birds, and the family will have the privilege of being awakened in the morning by a charming and very original concert of well trained singers.

In order to avoid the effect of straight lines, while yet retaining the principle of straight lines for the sake of easy cultivation, the trees may be planted in the way here shown. Each x denotes a tree, and this may be an evergreen or a deciduous tree, provided only the two kinds are *never mixed*. The figure o marks a shrub to be planted in front of deciduous trees only.

In planting a grove of deciduous trees for a windbreak, some quick growing tree like the cottonwood may be planted in the rear. One row of cottonwoods ought to suffice. But as these trees spread their branches very wide, it will be hard for the next row of

trees to hold their own unless they are also of quick growth. Hence the second row and the third should be white maples, also called *soft* maples. After these might come one or two rows of black walnut or butternut trees. These would be appreciated by a growing family, and the black walnut in particular is a fine tree in itself.

Trees for Windbreak.

A few catalpas, of the hardy kind, should stand in the front, purely for ornament, and also a few *hard* or *sugar maples*. If to these are added a few crab apple trees of the cultivated kind, and some shrubs like the *snowball*, the *hydrangea paniculata* and a few syringas, the total effect, as the years go by, will be such as to add a very considerable value to the farm and be a

source of great satisfaction and pleasure to the owner and his family.

It is desirable, on account of our long winters, to have some box elders, birches and perhaps a willow or two mixed in with the rest, because these are the earliest trees to show the green in the spring. The *cut-leaved birch* is a very elegant tree, perfectly hardy and a comparatively quick grower. It might stand nearer the house where its peculiar beauty would be noticed. In its season, and because it comes so early, there is scarcely a finer tree than a cultivated variety of the crab apple. Care must be taken, however, that the *borer* does not destroy it.

If the house faces west or north the front yard would be sufficiently ornamented by the plantations thus far noted, but if the latter are in the rear, the house facing south or east, the front yard still needs attention. Trees for shade at a suitable distance from the house are indispensable. They should be planted irregularly, in groups of three to five, and so that each tree has a chance to develop fully at least on two of its sides. All regularity in planting should be avoided. The trees to be selected are in the order of their ornamental and other values: The sugar maple, the white maple, the white ash, the box elder or ashleaved maple, the cut-leaved birch, and where the ground is inclined to be moist, and there is no lack of space, the American elm. There is no finer tree than the latter, but it will not do well on very dry soil where the maples flourish.

The great feature of the front part of the yard should be the *lawn*. Do not spoil the effect by dotting it all over with shrubbery. A few flowerbeds cut from

the sod will look well, if the weeds are kept out and the flowers *frequently picked* before they are past their prime. But shrubbery belongs to the rear and sides. It may surround the whole yard almost like a hedge, but should not intrude on the lawn proper.

A Country Road.

Provide for what has been called the "blind side" of the farm buildings. It is easy to devise some planting which hides all objectionable features and gives the effect of privacy. No special directions are needed and none would cover all cases. The essential thing is *a good working plan* so that all desirable features of a home may be added from year to year. First the necessary, afterwards the desirable; but a plan is a good thing and can be worked out in the many hours of enforced leisure which every farmer has, especially in the winter.

What has been said here about ornamenting the home grounds may be readily applied to the school house and its yard. Plenty of trees on the west and north; shade trees wherever needed; shrubbery in the rear and to hide outhouses; a flower bed or two in front which the children should keep in order, and, where such a thing is possible, a good lawn for a play ground. Where the school is large, grass cannot be expected to resist the tramping of so many little feet, but there are many of the smaller schools that could well afford a good lawn.

Every farmer ought to have a small nursery in which he may grow all the young trees and shrubs for the ornamentation of his grounds. Trees a year or two old can be bought cheap, especially evergreens. The nursery rows may run in the direction of the corn rows and receive the same treatment.

Some may have time and take pleasure in planting the seed of trees. If fruit trees be thus raised they should be grafted, as fruit trees from the seed are not

apt to produce the same kind as the one which furnished the seed. Nurserymen prefer to graft on the root of apple trees by a process called whip grafting. The piece to be inserted, the scion, should be cut from the tree in early spring while the buds are dormant. The grafting must be done in the *stock* before growth starts in the spring. Whip or tongue grafting requires that stock and scion be of the same size.

Fig. 58 — Whip or tongue-grafting on root. Used also in the case of small stocks.

Fig. 59 — Grafting in cleft or split limb. Used in the case of large limbs. In very large limbs two scions are inserted on opposite sides of the cleft.

Grafting larger stock is shown in Fig. 59. When the stock is very large two scions should be inserted. The scion must be cut wedgeshape and one of its sides should exactly match the outside of the stock, so that the layer just underneath the bark of the one connects closely with that of the other. It is along this layer

that the sap will rise and flow into the new layer, thus changing the nature of the fruit which the tree will bear. For all large grafts a thorough coating with grafting wax is desirable, and may be necessary.

An Attractive "Neighborhood Center."

CHAPTER II.

FINAL REMARKS AND A RETROSPECT.

Every intelligent farmer should take an interest in the work of the Experiment Station of the Agricultural College of his State.* These stations publish periodical bulletins containing reports on work in special lines. This work is scientific and accurate and furnishes a proof of the appreciation of the farmer's profession by the State, as well as valuable information in regard to all the various branches of farming.

A great deal of excellent work is done by the Farmers' Institutes. If at all possible, attending these institutes should be the rule with every live farmer. The boys and girls on the farm should attend these, for there is always some part of the work done at these institutes that interests the young fully as much as the older people, and then there is besides this the additional advantage of becoming mutually acquainted.

A few years ago a member of such an institute, Major E. A. Gilder, of White Hall, Ill., furnished a very interesting article on "The Illinois Farmer Then and Now." Instead of Illinois the name of almost any other state might be inserted without changing the value of this article.

The retrospect of this veteran farmer is interesting to young and old. The older generation of farmers is reminded by it of the hardships of their earlier years, and the gradual fruition

*We have said nothing of agricultural papers. These should be patronized by every wide-awake farmer, as a matter of course.

of their efforts to overcome the very great and discouraging difficulties that beset them on all sides. Young people will be benefited by the facts presented, as they show how great has been the progress made, and thus foreshadow the progress yet to come.

We often hear people talk of the "good old times." Major Gilder tells us that at that time there were very few stoves for cooking purposes. An iron bar swung back and forth in the huge fire-place, on which were hooks to hang the kettles in which the victuals were cooked. Some families had the old Dutch ovens in which the meat was placed and set on the hearthstone before the fire and thus roasted. A few had brick ovens in which they would at one time do a week's baking of bread. Pies and cakes, the modern range, and improved stoves, show the wonderful change that has taken place.

In those days the women spun the wool after having it carded, wove it into cloth and generally made their own garments,—there was very little money to buy store clothes. They also knit the stockings, mittens, socks, made the rag carpets, and often did the milking. Such, generally, was the condition of the women in the farm homes at that early date.

For recreation and amusement there was the annual camp meeting, the husking bee, apple parings, and the dances after the log rollings, brush cuttings, or barn raisings.

In such homes were raised the parents of those who are now enjoying the comforts of the modern improvements with which we are surrounded today.

At that time the improved implements now used

on the farm were unknown. What was known as the diamond cast steel plow had just come into use and was a great improvement over the old wooden mold-board, for under favorable circumstances it would scour, and thus do much better work.

In raising a crop of corn the field was generally all plowed, then marked off with a one-horse plow and was then ready for planting, which was usually done by one person with a horse and plow, marking off the ground, a boy or girl following and dropping the corn in the crotch and usually two men with hoes following and covering the corn. Ten acres was considered a good day's work for such a force. Then came the jumper which dispensed with the hoes. Next the marker, which enabled one hand to make three marks and thus lay off thirty acres per day. Then followed the hand planter, dropping and covering two rows at once, and finally the Brown two-horse planter, which seemed to solve the corn-planting problem, the later splendid implements perfecting the machine by the addition of the sled attachment and the check rower, making the machine almost perfect for planting corn.

The evolution of implements for cultivating the crop has been almost as great. The splendid plows, both riding and walking, and the various makes of cultivators have taken the place of the one or two-horse plows. These and the old-fashioned buli-tongue or shovel plow, which in those days were thought much of, are now curious relics of the past. The young farmer of today would consider his prospect slim of raising a crop if he had to use such implements.

Wheat was sown broadcast by hand and then harrowed in. The sickle gave place to the cradle. The cradlers were followed by the binders, and a shocker usually followed two or three binders. It was heavy, laborious work. The pay was usually the equivalent of one bushel of wheat and board per day, which, as a rule, included lunch in the forenoon and afternoon, with a liberal supply of whisky.

The crop at that time, when marketed at Alton, Ill., usually brought about $37\frac{1}{2}$ cents per bushel, and thirty bushels made a load. Under favorable circumstances it took three days to make the trip from White Hall. Receiving \$11.25 for his load, the farmer felt, of course, like a millionaire. The wheat was tramped out on the barn floor with horses, or beaten out with a flail,—the threshing machine had not yet made its appearance. When it finally came, 300 bushels a day was considered a good day's work with an eight-horse power and a full set of hands.

Improvement followed improvement until we have today the wonderful machine with a capacity, under favorable conditions, of from 1,500 to 2,000 bushels per day, cleaning the grain ready for market and stacking the straw.

The wheat drill, another great improvement, then made its appearance, making the crop more certain and saving seed. The evolution from the sickle and cradle to the machine of today is, to say the least, astonishing.

We may say as much for the improvements in saving the hay crop. We have now the complete outfit of mower, tedder, loader and stacker, or if put into barns

or sheds, horse hay forks of various descriptions, which elevate the hay to any desired height, where carriers take it along on iron roadways to almost any distance and there dump it. Under present circumstances there is very little risk, compared with those early days, in saving the crop, while the saving in drudgery is very great.

In those days timothy, red top and blue grass predominated; clover had not then gained the prominence it has since acquired, and its value as a restorer of fertility to apparently worn-out soils was unknown.

"I remember," says Major Gilder, "that a body of land that had been reclaimed from the timber and been continually cropped with corn and wheat, had become apparently worthless. The crops were so meager that it did not pay to cultivate the ground. Today, *owing to the clover crops on the same*, the land produces heavy crops of both corn and wheat and is very valuable."

Attempts at draining were made, but their value was mostly in paving the way for the present system of tile draining which has done so much to add to the value of the farms. The rich flat lands when thoroughly drained, and which in those early days were considered quite inferior, are today, other things being equal, far the most valuable.

"My own experience on one forty acres of flat rich land will give an idea of the benefits to be derived therefrom. One year in the late winter and spring I expended \$340 draining the same. It happened to be a very wet spring, but owing to the drains the water got off in a hurry and we raised sixty bushels of corn

to the acre and the ground was clean from weeds. My neighbor who had known the land from boyhood told me that he was satisfied that, had not the land been drained, I could not possibly have got over thirty bushels per acre with a splendid crop of weeds, for we could not have got onto the ground to tend it until the weeds had got the start. You can figure the difference it made in the income from the crop. We had 1,200 bushels more corn off the field, which at 30 cents per bushel would be \$360. I had spent \$340 in draining it and the work was permanent, and I was ahead \$20 the first year, with the field comparatively free from weeds; it certainly was a good practical object lesson.

"The farmer who has land that needs draining, and who can possibly do it, stands in his own light if he fails to do so. One mistake many of us made in the early days and that was the using of too small tile. When the ground was thoroughly soaked it took too long for the water to get off. When properly drained the sloughs and draws now dry out and are ready for cultivation before the higher ground.

"The old Virginia rail fences enclosed the farms almost universally. They were followed by the osage orange hedge, which, when properly cared for, I think superior to any other for an outside fence, adding beauty to the landscape without the danger of crippling so many horses, as is too often the case with the cheaper though useful wire fences which are now in general use.

"The log cabins of the first settlers were gradually giving way to brick and frame dwellings, although yet

quite numerous. Tramps were unknown and the latch string generally hung outside the cabin door. It was customary, too, in those days to ask the guest to take a nip of something stronger than water; now it would be considered quite cheeky to do anything of the kind. There was not near the toleration either in politics or religion that there is at present. The Baptists seemed to think there was no hope for those who had not been immersed, and the whig looked askance at the democrat. What a wonderful change has taken place!

"In those days you could take your pick out of a farmer's herd of cows for \$7 or \$8; three-year-old steers were worth no more. Now, a person owning a decent milk cow would feel insulted if he or she were offered \$30 for the same. They would want \$40 or even \$50 if the cow were a choice one, and as for steers, they are simply out of sight. One of our wide-awake buyers offered James Stubblefield, one of our prominent farmers, \$18 a head for spring calves, and not for breeding purposes at that, and he would not take it. How about horses? Bicycles and electricity had not begun their work; railroads had not invaded the west, and yet the very best horses did not sell for more than \$50 per head, and the inferior ones in proportion."

As an illustration of the low prices then prevailing the Major quotes the sale of seventy-four fat hogs, in 1855 or thereabouts, twenty-one months old, for \$340, or an average of a little over \$4.50 a head. One and a half cents per pound was the average price of

hogs. In the case stated the hogs were driven from White Hall to Alton and there sold *at a loss*.

"At that time the neighbors generally joined together and drove their hogs to Alton, and then sold them. Alton was the porkopolis of this section at that time. It took about eight or nine days to make the trip, and sometimes the roads were horrible, and when a hog gave out we had to wade in the mud and load it on the wagon. I remember we had no rubber boots those days; all we had were very inferior cow-hide stogies, which cost \$3.75 per pair. Better ones can now be bought for half the money. Compare, if you please, those conditions with our present mode of marketing hogs; the change, indeed, is very great. The good old times we hear so often mentioned, to my mind, do not loom up so favorably.

"Of course there were a few sheep, and plenty of dogs and wolves. There was plenty of game, chiefly deer, prairie chickens and squirrels, also plenty of opossums, coons and foxes.

"We generally had a six months' school, three in the winter and three in the spring and early summer. The teachers were paid by the patrons at a stated sum per scholar for the term, and usually boarded around. Fifteen dollars per month was about their average income in the winter, and some less in the summer. The older children were kept at home to assist their parents in the house or on the farm.

"It was no unusual circumstance to find a large part of the family in most of the dwellings shaking with the ague in the fall season, or down with bilious fever, and the latter were generally brought to a close ac-

quaintance with grim death before they took a turn for the better, and then they were generally salivated and almost in a fair condition for a set of false teeth, for those they had were usually in a very loose and shaky condition. It takes something more than bilious fever or ague to puzzle our physicians of the present time."

Wages were from \$7 to \$8 a month in 1842-1844, and not much higher for many years afterward.

In order to sum up, let the Major mention a few of the farming implements unknown to the farmer of fifty years ago, which he, as well as every other farmer, considers almost indispensable to good modern farming.

"First, the self-binder, which makes the work both outdoors and indoors so much lighter; second, the corn planter and check rower, which enables the farmer to plant the corn as fast as the ground is plowed, and thus get ahead of the weeds; third, the wheat drill; fourth, the disk-harrow; fifth, the iron disk roller, which ought to be on every farm."

Truly, we have reason to be thankful for what has been accomplished, and may look forward with confidence to such other improvements as will make life on the farm both profitable and increasingly desirable.

Nowhere is the change from former unfavorable conditions more strikingly apparent than in the attention now paid to agriculture and horticulture by the national government.

III. DEPARTMENT OF AGRICULTURE.

The DEPARTMENT OF AGRICULTURE has developed into one of the most prominent agencies in the service

of the farmer. Its different Bureaus vie with each other in their efforts to promote the interests of the most important industry in the country.

The WEATHER BUREAU is assisting the farmer in choosing the right time for securing his hay crop. Predictions of changes in the weather prove correct eighty times out of a hundred. Improvements in the service are constantly being made. The Bureau is now experimenting successfully with wireless telegraphy. Messages have been sent over fifty miles of rough country.

The BUREAU OF ANIMAL INDUSTRY inspects meats for interstate and international trade; it inspects pork with the microscope for countries requiring such inspection; it inspects vessels that carry animals to foreign countries, looking to their adaptability; it inspects imported animals to protect our herds; it experiments with swine diseases through serum treatment; it experiments with blackleg in cattle through distribution of vaccine, with prospects of eradication, and with sheep scab with like prospects.

DAIRY DIVISION. Experimental shipments are being made of dairy products across the Atlantic and Pacific and to Cuba and Porto Rico.

In the fiscal year 1899,	4,861,994	head of cattle
	6,125,095	head of sheep
	315,969	head of calves
	23,428,996	head of hogs
	5,559	head of horses

A total of 34,737,613

animals were inspected at time of slaughter; 61,906

were condemned. The meat inspection tag or brand was placed upon 17,177,442 quarters, 343,427 pieces, and 1,554 sacks of beef; 6,050,444 carcasses of sheep, 310,126 carcasses of calves, 1,138,507 carcasses of hogs, and 653,756 sacks and 48,485 pieces of pork.

The ordinary meat inspection stamp was affixed to 5,584,995 packages containing beef, 24,151 mutton, 107 of veal, 13,122,677 of pork and 602 of horseflesh.

Seals were attached to 69,937 cars containing inspected products.

MICROSCOPIC INSPECTION OF PORK. The number of carcasses examined was 999,554. Of these 96.88 per cent were free from *trichinae*, 1.17 per cent contained disintegrating *trichinae*, and 1.95 per cent living *trichinae*.

THE PREVENTION OF TUBERCULOSIS. This most destructive disease, which afflicts man and beast, is very common with cattle and swine.

Modern investigations show that tuberculosis is produced by a specific germ, the *Bacillus tuberculosis*. It is a strictly contagious disease.

Experience has shown that inspection at the quarantine stations, even by the most skillful inspectors, is not reliable. Accordingly, the tuberculosis test has recently been adopted, and it is hoped that with this more accurate means of diagnosis the American farmer may be protected from further importations of this contagion.

It has also been decided to place an inspector in Great Britain to test and certify to the animals there bought before shipment.

The Experiment Station of the Bureau supplied

1,500,000 cubic centimeters of blood from antitoxin animals for use in the bio-chemic laboratory in making hog cholera serum.

AGRICULTURAL EXPORTS. Our total sales of domestic farm products to foreign countries during the fiscal years 1897-1900 aggregated the enormous sum of \$3,186,000,000, or close to \$800,000,000 in excess of the export value for the preceding four-year period. In other words: During 1897-1900 we received an average of nearly \$200,000,000 a year above the annual amount paid us for such products during 1893-1896.

During the fiscal year ending June 30, 1900, our agricultural exports amounted in value to \$844,000,000, exceeding all other records except that of 1898, when a valuation of \$859,000,000 was reached.

During the past four years the average animal value of farm produce exported was \$797,000,000. It was only \$598,000,000 for the prior four-year period, 1893-96.

The census taken in 1870 showed the number of farmers in this country to have been 2,660,000. In 1890 this number had increased to 4,510,000, and is now in excess of 5,000,000.

The arid or desert states of the Far West—Colorado, Utah, Wyoming, Idaho, Montana—have in recent years excelled in farming industry even more than in the mining of gold, silver and other metals. The art of irrigation is still in its infancy, but already its far-reaching effects can be predicted with certainty.

There never was a time in the history of the country when the outlook for the energetic and *professional* farmer was as encouraging as it is now.

The immense importance of the farming interests is understood and appreciated by the whole people. Progress has been steady and in every sense remarkable, in spite of occasional set-backs. But the times have gone by when any bungler could expect to make enough out of the yet untouched soil of our western prairies to enable him to look with contempt at scientific farming. Science rules the day, and our farming industry is rapidly becoming transformed into an art based on the laws discovered by science.

One of nature's specialists.

APPENDIX.

CONDENSED STATISTICS OF A PART OF THE AGRICULTURAL PRODUCTION IN THE UNITED STATES.

I. HORSES, CATTLE, SHEEP.

An estimate of the Yearbook, A. D. 1900, places the value of our horses, cattle and sheep at \$1,829,000,000.

The amount of hay produced was over fifty million tons, valued at \$445,538,870.

This hay would scarcely more than suffice to feed our horses, cattle and sheep during three months of the year. Seventy-five per cent of the hay and forage necessary to maintain our stock is furnished by our PASTURES AND GRAZING LANDS, which, accordingly represent an annual yield of three times the value of our hay crop.

II. CEREALS.

<i>Yield in 1900.</i>	<i>Bushels.</i>	<i>Value.</i>
Corn	2,105,102,516	\$751,220,034
Wheat	522,229,505	323,515,074
Oats	809,125,989	208,669,223
Barley	58,925,833	24,075,271
Rye	23,995,927	12,295,417

III. POTATOES.

Yield in 1900.....	210,926,897	50,722,553
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IV. COTTON.

The value of this crop for the year 1899-1900 was \$334,847,868.

As to the cotton industry the Yearbook says: "There never was a time when so many American spindles were in operation, and rarely, if ever, a time when they were so severely taxed to meet the demand for cotton goods."

V. HAY.

The farm value of the hay crop, Dec. 1, 1900, was \$445,538,870. The acreage was 39,132,890, and the production 50,110,906 tons.

Statistics for other agricultural products of the greatest importance, such as our DAIRY PRODUCTS, BEEF, PORK, MUTTON, POULTRY, etc., are not yet available, but the foregoing samples give a fair idea of the magnitude of the total production.

The industries sustained by our breeders of horses, cattle and sheep have an estimated value of \$2,000,000,000 (two billion dollars), "industries upon which the very existence of the human race is dependent."

AVERAGE YIELD PER ACRE OF CORN, WHEAT, OATS, POTATOES AND HAY.

The average yield per acre in the different states varied greatly. The average yield of CORN for the whole country was 25.3 bus. per acre. The highest yield per acre was obtained in Vermont and in Wisconsin, 40 bushels. The average yield in Iowa, Massachusetts and Indiana was 38 bushels; in Illinois and Ohio, 37 bushels; in South Carolina, 7 bushels.

The average yield of WHEAT per acre was—

	<i>Bushels.</i>
For the whole country.....	12.29
In Montana	26.6
In Vermont	23.6
In Texas	18.4
In Kansas	17.7
In Iowa	15.6
In Wisconsin	15.5
In Illinois	13.0

In Michigan	7.6
In Indiana	5.3
In North Dakota.....	4.9

The world's production of wheat in 1900 was 2,586,025,000 bushels. The production of the U. S. constitutes about 25.4 per cent of this total.

The average yield of OATS per acre for the whole country was 29.6 bushels in 1900, against 30.2 bushels in 1899. The highest average was obtained in

	<i>Bushels.</i>
Illinois	38.0
Maine	37.5
Massachusetts	36.8
Iowa	34.0
Wisconsin	32.0
North Carolina.....	9.5
Tennessee	9.7

Of the marketed crop of 242,850,477 bushels, much over one-half, 133,500,000 bushels, came from Illinois and Iowa.

The average export price ranged between 30.2 to 32.3 cents.

POTATOES yielded an average of 80.8 bushels in the entire country. The highest average was reached in 1895 with 100.59 bushels.

The average for 1900 was in

	<i>Bushels.</i>
Nevada	156
Idaho	136
Montana and Vermont.....	134
Maine	126
Wisconsin	103
Michigan	97
Missouri	93
Illinois	92
Indiana	83
Iowa	72

(The results in Nevada, Idaho and Montana are due to irrigation.)

HAY yielded an average of 1.28 tons per acre in the entire country.

The average yield per acre was in

	<i>Tons.</i>
Idaho	2.80
Utah	2.65
Colorado	2.23
Alabama	1.85
Iowa	1.42
Nebraska	1.38
Kansas	1.32
Michigan and Missouri.....	1.29
Illinois	1.27
Indiana	1.21
Ohio	1.06

The heavy crops in Idaho, Utah, Colorado, etc., are due to irrigation. The hay is for the most part alfalfa, and an average of two crops is taken from each acre.

THE ITEM OF WASTE.

While these figures show the immense resources of the country, and the importance of its agricultural industries, other figures, showing great and avoidable loss from waste, might be adduced to complete the picture.

"The needless wastes upon Illinois farms," says Prof. P. G. Holden, of the University of Illinois, "if saved, would secure to agriculture profits enjoyed by no other profession. The fact is, no other business could survive such tremendous losses as are common in agriculture.

"In the great cotton and woolen mills of the east the competition is so close and the margin of profit so small that the difference of one-thirtieth of a cent per yard in the cost of manufacture will prosper one establishment and drive another to the wall.

"It is certain that most of these losses are matters

of careless farming, and extend to all the crops and operations of the farm.

"Recently I was obliged to drive twenty-four miles across the country, and in this distance counted 200 farm tools and machines housed in the corner of fences, in fields, and in barn yards, representing thousands of dollars. I am told by those who should know that the average life of a binder in Illinois is between three and four years, and I do not wonder that it is so. Here were binders, mowers, road graders, and every kind of farm machines, used but a few days in the year, and left to the ravages of rust and decay the remainder of the time, thus reducing not only their durability, but their efficiency as well. Properly cared for and properly used, the mower and binder, on the average sized farm of 127 acres in Illinois, should do service for eight or ten years."

The losses from bad management and improper feeding in Minnesota are not less than \$14,000,000 annually, according to Professor Hecker, and the losses from inefficient animals \$17,000,000.

If we could present in figures the added losses of all the states in waste of fertilizing elements, neglect of animals and machines, carelessness in the selection and treatment of seed, and slovenliness in cultivation, the sum total would surprise and stagger the friend of agriculture.

This fact, more, perhaps, than any other, proves the necessity of special training for the farmer's profession. It ought to be a profession, not a make-shift or a careless experiment.

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