CAMPBELL'S PROGRESSIVE AGRICULTURE

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Progressive Agriculture

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TILLAGE, NOT WEATHER, CONTROLS YIELD

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PREFACE

Progressive Agriculture has been selected as the title of this book for the reason that these two words have much meaning to the American people on two very vital lines.

Progressive, as defined in the dictionary, means going forward, advancement, improvement, developing greater things, conditions, crops. Agriculture is farming, husbandry, tillage, the raising of food for man and beast. Therefore applied Progressive Agriculture means briefly increased prosperity and happiness.

In semi-humid regions the problem of general farming is one of how to avoid waste. Twenty-one years ago we began writing and speaking on the subject of soil tillage to conserve the moisture and obtain better crops, having begun our observations 14 years before. Now we are able to give in these pages results of 35 years of actual field experiments in the rich region which stretches from the Missouri valley to the Pacific and from Mexico to the north boundary of Alberta. Much progress was made in the early years, but never so much as in the past four years, in which time we have had the hearty cooperation of a large number of progressive farmers, over a wide scope of country.

Our ideas have undergone change with better knowledge of the problem and a more practical field information as the result; and while in a way there is nothing fundamentally new in it,

the practical application of the vital principles is all new, and today we are better prepared than ever before to give information that will be immensely helpful to all who are engaged in general farming in the west.

The real question is one of results—large crops in all seasons, surer crops every year, cutting out uncertainty and chance wherever possible. It can be done, it has been done, you can do it.

A great army of doubters has been forced to recognize the plain fact that these problems are being solved, and public sentiment now more than ever before favors the demonstrated fact that by soil tillage very much can be done to overcome the handicap of limited rainfall in the semi-humid west. There is better appreciation of the close relation between soil tillage and available plant food, together with the quantity of seed and time of seeding, and consequent increase of crops. It is a growing and expanding subject with immense possibilities.

Results of actual farm work form the basis of this book. The principles stated and discussed have been developed from actual experiments in the great variety of soils under many climatic conditions. The pictures used are from photographs, and names, dates and actual results are invariably given to illustrate what has actually been done.

This book is dedicated to the farmer who is desirous to make progress in agriculture, who will study these pages and take home the lessons of these pictures, who approaches the subject without prejudice or skepticism, and who is will-

ing to take the steps that will surely increase the returns from his labor. This is true Progressive Agriculture.

Yours for greater prosperity in the semi-humid sections. HARDY W. CAMPBELL.

Lincoln, Nebr., Jan. 1, 1916.

Progressive Agriculture

CHAPTER I

A FEW OPENING SUGGESTIONS

What is tillage of the soil?

Writers have been answering the question for a century and they have not told it all. That part of Agriculture which deals with soil tillage is, and ever will be an unfinished science, because we shall go on learning more and more about it and never quite reach the end.

Tillage, in its broad sense, means all handling or treatment of the soil incident to crop growing, —plowing, packing, disking, harrowing and cultivating.

Under this broad term comes any mechanical work or process that is applied to change the physical condition of the soil, to prepare the seed bed, to assist the growing plant and to keep the field free of weeds.

Not all farmers, or those interested in farming, or persons who have made some study of agriculture, agree as to the relative importance of tillage as compared with other phases of farm work. Some place the emphasis at one place and some at another. There are those who insist that success in farming is wrapped up in animal husbandry and others who make a fad of crop varieties and of seed selection and seed testing. Then there are those who have asserted that tillage is nothing as compared to climatic conditions, or in other words, that every farmer everywhere

is at the mercy of the clouds and sunshine, the drouth and storm.

But most practical farmers know that tillage is very important, and they understand pretty well how to get some good and sure results through intelligent tillage. But there are some things that are more important than others, and that, so it has been demonstrated, are doubly important in the semi-humid regions of the country, in connection with tillage. For instance:—

Tillage and its relation to available plant food in the soil by the storing, controlling and utilizing of the available water, whether from the clouds. ditch or sub-irrigation. This has not heretofore been considered as of first importance.

The farmer must recognize this importance, and he must eventually come to understand just what happens in chemical action or bacterial development under certain ideal soil conditions, as well as what happens when the soil is not in condition to properly utilize the water.

Available plant food depends on this process which goes on in nature's laboratory during the time soils are being prepared for crops or between the time of fitting and planting of the crops. The farmer may, to a large extent, guide and control this. Intelligent tillage is the key to the situation.

As it is now fully understood, that which is done to bring about the most favorable condition for this laboratory action,—whatever it is or however it comes about,—will also produce the ideal condition for the soil for quick germination of the seed and rapid root growth. (See Cut No. 11.)

Now all of this means a great deal to the farmer and it will require thoughtful care and intelligent handling right from the start, no half-hearted work will win out. At the outset it should be said that set rules, regarding the mechanical work in all soils, cannot be made that will take the place of those worked out by local intelligent observation. The most that can be done is to establish the right principles most favorable to plant growth, leaving to each farmer to work out the problem of mechanical work largely with his own tools and in his own way and according to the special conditions that obtain in his own fields. Once you catch on to the real fundamental principles, you will ever after find yourself intensely interested.

Please observe, as previously outlined, that it is not alone needful that there shall be such tillage as will tend to store water in the soil that it may be on hand when needed, but the farmer must just as surely direct his efforts to bringing about soil conditions that will utilize this moisture in every available form to increase the available plant food. This means a soil condition where there is combined in the soil, the proper proportion of air and water so that the summer heat, when it comes, will develop the conditions that make for rapid and healthier growth of the plants.

SEVEN POINTS IN TILLAGE

To more clearly establish the main points in tillage the subject has been divided into *seven heads or general classes* for consideration. It is

hoped that in this way the reader may more readily grasp the basic or fundamental principles or ideas involved. In the study of each class, as well as in the application of the principles, the fact must be kept constantly in mind that under semi-humid conditions, more perhaps than elsewhere, nature sometimes helps and sometimes hinders the progress of work done to bring about the ideal conditions.

Because of this fact, be ever alert to note and understand what happens, as for instance, why soil slightly dry or too wet will not assume the same ideal physical condition when plowed as will moist soil that is just right for the plow. Why a half inch of rainfall will not have the same effect in dissolving and settling the lower portion of the soil furrow that an inch or 2-inch rainfall will; neither will a 2-inch rain have the same effect 30 days after plowing that it would have one day after.

Intelligent observation, understanding and recognition of these primary facts is of wide importance. The lack of it has many times misled the investigator and farmer in conclusions as to the correctness of principles and methods he has been following. The farmer always needs to remember that his attitude towards and faith in progress, advancement and confidence in the theories involved in any question, regulates very largely the value and the amount of truth grasped in his investigation of the basic principles.

While the "How" and "Why" of tillage are broad and to the untrained mind complex ques-

tions, yet a correct solution can be reached. Greater problems have been solved; and when these questions are really mastered, the farmer of modest means will have more dollars added to to his earning capacity than could be added in any other one way. To this branch of human endeavor that beautiful old adage, "Knowledge is Wealth", truthfully applies.

CLASS I—PLANNING

The first step in Progressive Agriculture is to thoughtfully and *carefully plan in advance all tillage work.* In doing this recognize the fact that certain principal factors govern growth, production and maturity of all farm crops. Most vital of these are—physical condition of the soil and available food, the quantity of seed per acre, and time of planting. All of this is to be considered in connection with the farmer's judgment, based on observation, study and experience, as to the kind, time and manner of work to be applied, for this is the foundation of all you anticipate.

CLASS II—PREPARATION

The work of *preparing the soil for plowing* is a necessary preliminary work on which very much depends in most of the years. Most important in this preparatory work under semi-humid conditions is that of loosening the soil at the surface early in the spring, or just after the harvest in summer or fall. This is with the purpose of causing the proper percentage of moisture to accumulate and remain in the firm soil just below

the loosened soil, commonly termed the mulch. Proper moisture in soils means life and growth, but dryness death to all plant development. The right per cent of moisture will also make possible easier and better plowing. More surely, also, will this careful preparation assure to the soil the moisture that will make it more susceptible to each and every tillage act designed to obtain the ideal physical condition of the seed and root bed. In short, water is the prime element, not only for the plant to drink but to aid in getting the soil in ideal condition, to build up the soil and increase plant food.

CLASS III—PLOWING

The third division of the topic is the command to *plow the land well,* and in this much depends on the moisture conditions of the soil when it is done. If you would get the greatest good out of the least possible expense in tillage, give to the second class very careful consideration, then be sure your furrow is even in depth and width and well turned. As to the depth of plowing, very much depends upon what is possible in the follow-up work as well as the condition of the soil when plowed and the time likely to elapse between the plowing and the planting of the crop. Much also depends on whether the soil is new or virgin soil or old land that has been plowed several years.

From 5 to 7 inches is a fair range of depth, but the deeper the plowing is done the greater effort must be made to immediately obliterate all air cavities or firm the lower part of the furrow.

CLASS IV—PHYSICAL CONDITION

After plowing it is important to put the plowed ground into *proper physical condition,* with as little delay as possible. The tendency of the plow is to leave numerous large and small openings in the bottom of the furrow. Sometimes when soils are in ideal condition to plow moderately fair, rains will dissolve and settle the lower part of the freshly plowed ground, but this cannot be depended on; so spare no time in quickly getting the lower portion of the furrow slice fine and firm, leaving the top somewhat coarse and loose. This prompt action is especially important to offset bad effects that will come if there follows closely a period of hot, dry weather. The quicker the seed and root bed are put into condition after plowing, to carry the proper per cent of air and water, the greater are your chances for a high limit in yield from a small amount of water.

CLASS V—KEEPING UP TILLAGE

The fifth thing to remember is to *improve the seed and root bed by every subsequent act of tillage,* prior to planting. In other words, let the work all be timely and of the right kind, that at planting time there will be most favorable conditions for quick germination of seed and rapid growth of roots. This will also aid nature in her further liberation of plant food. The favorable time for crop making is when the seed and root bed is fine and firm and carrying a high per cent of moisture, with the proper amount of air and the right

degree of warmth. To obtain rapid healthy growth of all cultivated plants there must be at all times a liberal amount of moisture at the top of the firm soil just below the loose soil mulch. The farmer will try every concievable plan to obtain this, for it means much. The simple keeping out of the weeds, where the atmosphere is dry or low in humidity, is not enough. The cultivation must be deep enough and frequent enough to obtain those conditions that will assure, as far as possible, a continuous moist character to the top of the firm soil or root bed.

CLASS VI—PLANTING

The sixth is the matter of *planting the seed,* and in this we must consider how much of each kind of seed to plant or sow, also, when to do the planting. In considering both quantity of seed and time of planting, due consideration must be given to the physical condition of the seed bed and quantity of available moisture. Success or failure often depends almost entirely on the time of planting and quantity of seed. Later planting than is now common, if preceded by careful spring tillage, will bring increased yields, as a rule, and frequently defeat the ill effects of a drouth. Not infrequently is it true that a well fitted field fails in reaching its best results because of too much seed.

CLASS VII—CULTIVATION

The most vital part of tillage, after all else has been said, is the *cultivation of the crop.*

It is to the advantage of every farmer to observe and make continual study of his work until he clearly understands why any and all crops are cultivated after planting. Each time there is any mechanical work done the effort should be to better the soil condition for healthier and quicker growth, and a more prolific yield from the plant. The better you know what the soil conditions should be the more effective will all your work be. To get the most good out of labor there must be timely and correct application.

Vital questions in the cultivation of crops, to which greatest care must be given, are cultivation to keep the weeds down, for the weed pest is a growing one; to keep the mulch coarse and loose to a sufficient depth; and to prevent as far as possible moisture loss by evaporation; but never cultivate deep enough to destroy the roots of the growing plants. Don't let a crust form on the surface or under the mulch.

This brief outline should be studied well before proceeding, as it will greatly aid the reader in understanding and appreciating each of the following chapters. The thoughts involved will be developed more in detail in various ways in the following chapters.

CHAPTER II

FARM POSSIBILITIES

Agriculture is not a completed or perfected science. The end has not been reached. We are going forward and every man who becomes somewhere near as interested as Edison has in electricity, will learn new and progressive ideas and principles for years to come.

There is advancement in other lines of human endeavor, in everything that contributes to the convenience and comfort of the human race; why not, also, in the art of aiding Nature in the production of useful crops on a more certain basis. Better and more profitable farming in the semi-humid sections means a greatly increased farm population and more and larger towns and cities. There are millions of acres of unoccupied lands, waiting for the "Home Maker". Not for the man that ignores better and more correct and appropriate ideas and insists on redeeming the country by very deep plowing or some other notion that may apply under 30 to 50 inch annual rainfall for he is liable to fail just the same as thousands have in the past. But to the man who will apply modern ideas, study the question carefully and continue to modernize, there are many vacant fields that can be made to bloom like Mr. Hahn's rose garden. (See Cut No. 2.)

We are all by environment made skeptics and it is true we are suspicious of any new idea or advanced theory. Some of us are not even willing

to be shown. We are all inclined to be selfish and to be filled with egotism. Each one of us thinks his way is the best and what he does is right. But mistakes are so easy, yes, we have all made mistakes. And while we dislike to admit or take the blame for any losses from our mistakes, we all are hoping right down in our hearts to do better and to accomplish more, yes, much more some day.

We do not want to stay in the rut, so to speak, however much we deny there is any rut, and we note with pride the very marked advancement and improvement in all other lines such as in automobiles, flying machines, wireless telegraphy, wireless telephones, moving pictures and phonographs, all of which contribute to our comfort, pleasure and entertainment, and we rejoice, then why should we be content with the present farm methods and their uncertain and sometimes meager profits.

When we consider what has been done we can but realize there may be some further advancement and improvement in the many practical lines of farm work, if we put forth a little mental, as well as physical effort. Observe, see things, then do some real thinking. We are sure this will result in a more certain annual cash income per acre.

What was it that gave us, only a few years ago, such little faith in farm results? Why was it so difficult to keep good men on the farms and at work along lines that we know ought to be most profitable? Why so much discouragement? Were it possible for the average farmer to turn to bus-

iness and professional callings and succeed with no more real knowledge of the business than is displayed by him in his farm work, the farming industry would long ago have been abandoned. Too many however, have already tried such a change and find even greater and equally perplexing problems to be solved. Really, when we come to know the soil we find it more submissive and much more responsive to good treatment than the human race.

The real fact is that, as farming has been done, there is much cause for discouragement that is hard to overcome, and it is due to the occasional years of big crops, then a few years of fair crops, interspersed with crop failures, and as we were inclined to rely on the weather, it is no wonder that under these conditions, as they have prevailed, we are continually out of balance, in debt and faith shaken.

Prosperous and happy farm homes are the hope and ambition of every man and his family who are endeavoring to so plan their labors on the farm that there may be each and every year a little surplus profit. Though this may be modest, if it comes every year it lends enchantment, but when they find the profits of two or three years wiped out by crop failure the next year, they not only find their cash short, but their courage and energy depleted and we all know what follows. Not only is the home minus the cash for the neccessaries and comforts, much less for pleasures, but sorrow and peevishness too often pervade the home circle, under which condition many

things are done at a disadvantage and loss until hope for better things almost or quite fades away.

The experience of our New England forefathers was a beautiful illustration of the point we wish to make. They were principally farmers on a modest scale, they did not make much each year, but every year found their holdings and conditions slightly improved because of the safe and sure methods and contentment and happiness pervaded every home.

Many thousand dollars have in the past been loaned for our western development by individual New England farmers, who started on 60, 80 or 100 acres of timbered land with little capital outside of a strong physique and ample energy, but from the start a little was added every year until there was a surplus.

Not that we would go back to the old narrow, modest routine grind of our forefathers, but before any country, state or section can be on a stable, prosperous basis, gambling and extreme uncertainty of success must be very largely eliminated, and one of the heavy screws in the balance wheel to this question is, to prevent crop failure or even a small crop, and it is the ease with which we believe this can be done by tillage of the right kind at the proper time that prompts us to beckon the man of modest means to the new semi-humid west, and to say to those who are now located in this great belt, "Eureka".

Don't misunderstand us. We wish our reader to look the situation squarely in the face and then no matter who you are or where you are, you will

not be disappointed in the outcome. We shall show you big crops that have made big profits. We have a few farmers that are getting these big profits every year, both in years of very light rainfall and heavy rainfall.

We shall try to explain to you how to do it, and if you become interested and really try, you can easily beat any record we have, but the greatest source of enthusiasm with us is based on the fact that crop failure in this great belt will not occur to any man, barring hail storms and cyclones who becomes familiar with the principles and applies them as we now understand them; therefore, the possible steady annual farm profit, so much needed.

We personally know many who have overcome, to some degree, the handicap under which they formerly labored, and by a little careful thinking have vastly improved their situation, and are still improving. They have endeavored earnestly to make progress and to follow the principles that we developed and commenced to advocate a good many years ago. Many of them stand ready to testify to the good results attained by actually getting out of the old ruts and applying plain and sensible methods to the newer problems of their immediate life.

SUCCESS WITH RIGHT PRINCIPLES

While many have succeeded by following the right principles it is also a fact that others have honestly but modestly tried to do the same thing and have failed. It is these failures that have

made the most noise over the widened scope of country and have given opportunity for doubters to declare there is nothing in tillage, no rules can be fixed, no way to succeed in the semi-humid country, and that "it won't work in drouthy years". The trouble is that they may have tried to apply the principles without trying to understand them. They have sought merely to do what they have supposed was necessary without really knowing why, then followed the disappointment.

This fact should be realized at the outset, that farming is one art where it may not be possible to lay down any hard mechanical rules that will fit every case; for example, a moist soil may be plowed 6 to 7 inches deep and with timely tillage be immediately worked into a perfect seed bed, while the same soil when wet or dry cannot. Many have tried the latter and failed without realizing that the mistake in their own work caused the failure. The same rule applies in putting the seed into the soil, or in the cultivation of the crop, a different amount of moisture will bring different soil conditions from the same mechanical work. Conditions change—climate, soil, elevation, water, winds, etc. But certain general principles can be stated that will help the farmer to meet all the changing conditions, just the same as the correct principles were worked out to build a successful flying machine. This means simply the correct application of true or scientific principles to agriculture. That doesn't mean anything hard to understand, or for the use of college professors alone; not at all, for science may be

simple and still be science, it only means the correct way and time of doing things.

Those who chiefly for selfish reasons, decried all efforts to improve the conditions of the semi-humid regions, are far less in number than a few years ago. When an extra large yield of any crop is obtained, there are still those who say it is impractical, it cost more than the crop is worth, it don't pay. Hold on, Mr. Pessimist; the next field may not cost as much, a little more of the know how, and a little efficiency may materially diminish the cost and further increase the next crop. No idea was ever conceived, or learned and perfected in a day. The first question in a new undertaking is, can it be done? Then comes the efficiency and reduction to a system and the elimination of cost without decreasing the value of the device or principle. There are some who continue to deny that anything can be done to make matters better. They refuse to look about and know the truth, for it is the truth that everywhere, all through the semi-humid region, great things have been accomplished wherever men have tried earnestly, and with open minds, to get at the facts. If you want to get at the true situation just call on any one of these farmers who have learned the how, and got results for a number of years. You will find him stronger in the faith and learning more each year. One only needs but to make inquiry to find that very much progress has been made on sound principles, towards better and surer crops all through the country.

EVERY FARMER AN INVESTIGATOR

It must be remembered, however, that most of this is still in the experimental stage. Every farmer must be an experimentor in his efforts to learn, but he must have some fundamental principles upon which to base his experiments or he is quite sure to go wrong either in his work or in his conclusions as to the why of his results. He must study and investigate, if he fails, try to find out why he failed. Don't give up. Every little helps. A great deal more in the future is to come right from the farms as the result of intelligence, tillage and observation by good thinking, persistent farmers, than any other way, because such individual farmers go at the experiments in a practical way and his observing neighbors, hungry for information, take note and appreciate a neighbor's advice.

It is said that before Edison produced the first successful incandescent light, he had used in his experiments over three thousand elements or combinations of elements. Why did he persist in so many trials, in face of repeated failures? He believed it could be done, and *he did it.* So, too, can the farmers all solve the question of surer and better crops at a lower cost. The pessimist who watched Edison finally saw a bright light, later he saw a still brighter one, and then a much brighter one, for not only has the first Edison light been many times improved and made better, but the cost of the light and globes have steadily decreased through other ingenious and advanced

ideas not at first thought of. The same will be true of the farmer of the semi-humid west and it is through more timely and more correct tillage that shall more accurately utilize nature's elements that we can and will populate these prairies with prosperous farmers, and beautiful farm homes, and happy will be the farmer and his family who grasps these principles and gets busy.

In the following pages we shall deal with the whole subject broadly. We will present all the results of our later observations and the selection of correct principles, and this with a better understanding of some of the earlier ideas we have put forth, we hope to clearly explain to the farmer the more advanced ideas and how he can carry out experiments in soil tillage and learn how with greater certainty to reach the maximum yield at a minimum cost each and every year, and crop failure in the semi-humid west be a thing of the past. Experiments should be small to begin with, not that the principles may be wrong, but you may not have a correct understanding of every detail. It is with practical experience and observation that the perplexing questions are cleared up and when clearly understood one frequently wonders why he did not so understand it before.

Remember this is the age of progression, the old heads of our largest business institutions are hiring experts on special lines at fabulous salaries to promote the methods of advanced efficiency and greater economy; in short, the heads of every known enterprise, business or profession are try-

ing to better know their business and how to more profitably run it.

Once you learn how to increase not only the magnitude but certainty of the crop or decrease the cost, it will not only be your perpetual profit, but to your children and grandchildren will come greater profits made possible by you.

MR. G. W. HAHN'S HOME

Mr. G. W. Hahn the subject of this sketch, came to Yuma, Colo. in the spring of 1910 and filed his homestead claim on 160 acres of land 6 miles northeast of Yuma, Colo. Coming from eastern Nebraska, with a very modest amount of money that he had accumulated by several years' renting land, Mr. Hahn came there with the idea that he could at least make a living for his family and have a home of his own. After learning something of the possibilities of the right kind of tillage in growing trees, crops and vegetables, he got busy.

Mr. Hahn has made a success of wheat and other crops and is now quite well supplied with hogs and cattle. In 1914 his 40 acre summer tilled field of winter wheat averaged 41½ bushels per acre. But Mr. Hahn has turned some of his good judgment to another line, that of having a real home with not only civilized but beautiful surroundings.

Note Cut No. 2, which shows only half of his front yard, as the other side of the walk is just the same. This picture was taken June 29, 1914, a somewhat dry year. One rose bush near the

center had at that time 43 double roses in full bloom. To the right is his small fruit, also a modest grape arbor and still further to the right his vegetable garden, and all were equally as prolific as this flower garden, no irrigation whatever is or has been resorted to for the flowers, fruit or vegetables. Tillage of the right kind changed the bleak, short grass prairie to this beautiful home in 4 years. No one ever visits the Hahn home in the summer season and goes away without a bouquet.

Cut No. 4 shows the corner of Mr. Hahn's farm as well as the yard surrounding his home. This picture was also taken June 29, 1914. Note the sign over the gate, "ROSE HILL FARM". The name is very appropriate in every way except the hill and yet close observation detects the fact that he is on a slight swell.

Cut No. 5 shows a row of Mr. Hahn's apple trees five years old, photographed July 11, 1915. To the right and back of the front tree can be seen the home. Why did not the earlier settlers have such homes? Was the rainfall too light? Oh no; statistics show that the average rainfall from 1910 to 1914 inclusive was slightly lower than any previous five years recorded, and these are the years that Mr. Hahn got his convincing results, due not to weather conditions but kind and time of tillage. Mr. Hahn said in a letter dated, June 29, 1915:

"One year ago today, you took your first picture of our trees and flower garden, we have had more than twice as much rain but nothing looks

as good as last year. We can't cultivate, it's too wet. I see now the correctness of a statement I heard you make three years ago, that sometime the people would realize that the light rainfall of northeast Colorado was a blessing in disguise. I see it now; give me the dryer years. Yours for more knowledge in Tillage,—G. W. HAHN."

CHAPTER III

PREPARATION BEFORE SEEDING

The early spring fitting of the soil has been given far too little attention in the past. The control and utility of soil water is and has been the most neglected part in crop production. For years we have depended on the climatic conditions as the ruling factor in crop production; this theory has cost the semi-humid west many a heart-ache and millions of money. The solution of this whole problem is a better knowledge of the necessary physical condition of the soil for the better control of soil water and how by tillage, to obtain it. Some advantages of this have been secured by many farmers through a modest practice of early spring disking; yet the real value of early spring tillage and the continued careful handling of the fields up to planting time, is by no means understood or appreciated by the masses. There is unlimited evidence that it cannot be too strongly advocated and adhered to in almost

any farming section. More especially is this true under semi-humid conditions. If the principles as outlined under this heading, are carefully observed and carried out, it will go a long way towards, if not completely defeat the ill effect of any drouthy condition on good soil or in any locality with an average annual rainfall of 15 inches or more.

We shall divide this preparatory tillage into three distinct classes: Spring tillage, for spring and early summer planting; summer tillage for fall seeding of winter wheat, oats or rye; and fall tillage for other crops to follow the one just harvested.

The continued careful work referred to does not necessarily mean a greatly increased amount of labor, but it has reference more to timeliness and the right kind of work. It is not uncommon for a farmer in the start to put on his field untimely as well as so much work that it is a detriment. Economy in labor adds to the cash profit just the same as increased crop yield, but one must not economize in labor at the cost of a lesser yield in the end. Don't let one dollar's worth of extra timely work loom up so high that you can't see beyond it five dollars more crop yield in return.

SPRING TILLAGE

Spring tillage is a somewhat new departure as its object is to make it possible to grow spring planted crops every year in much of the semi-humid section. Our three years of extensive experiments just past indicate that it promises much more than our plan of summer tilling out-

lined some years ago, emphatically so to the new beginner and to the man who has hogs and cows.

In discussing this topic what we wish to consider first is how to most successfully and economically conserve as far as possible all the rainfall. Second, how to utilize this moisture to the best advantage in building up the soil and increasing the available plant food. Third, how to get the seed and root bed in the most ideal condition possible for quick germination, and a rapid healthy growth. We hold to the importance of keeping the surface soil loose and allowing no weeds to grow, that the same moisture may be held in the top firm soil until not only this soil has become well warmed, but the weather has settled down to a more steady warm temperature, when a much greater per cent of plant food will be continuously available. Then during the prolonged period of spring tillage there may be added more spring moisture, and by holding this condition for 4 to possibly 8 weeks before planting, depending on both the kind of crop and location, you can produce three to six times the growth as has been the common experience with the same rainfall, the result of a more complete utilizing of the soil water and a greater increase of available plant food.

All cultivated land especially if intended for the spring crop should receive attention just as early in the spring as it is possible to do anything. Fall plowed land should be loosened rather shallow, but land not fall plowed should be double disked as early as soil conditions will permit.

The tandem or double-disk, (See Cut No. 23.)

is the most effective for double-disking in the fields, as it is more easily regulated as to the proper depth, draws lighter in proportion to the work it does and leaves the surface leveler than the single disk. As a rule it is not desirable to disk deeply in early spring, but more on the shallow order. With a reasonably level surface, two and one-half inches into the soil is ample, but do not as a rule, cut very much less in depth, too shallow is as serious as too deep. Above all things, do not leave any uncultivated spots.

Do not follow the disk with a spike tooth or smoothing harrow, as this is liable to make the surface too fine, and a fine dust-like surface does not hold the moisture as well as a coarser mulch. Besides, the fine mulch is more susceptible to blowing, and last but not least it is more certain to be puddled and packed by fairly heavy showers, (See Cut No. 9) which means also that a smaller quantity of the water will be taken in from the rains, since more of it will run off the puddled surface of the field and be lost, and then another cultivation will be required as soon as the surface is sufficiently dry.

The coarser mulch is, therefore, more economical, as it takes in the rains more readily, saves more of the water and requires less labor. With the coarser mulch, several light rains may fall without seriously affecting the protection of the moisture by the mulch; (See Cut No. 8), while the fine dust like mulch is usually put out of commission by one modest shower.

At no time of the season is the danger of loss

of water more vital than during the early spring winds and bright sunshine. That is why the early use of the disk is so very important.

In case the farmer is planning to plant corn with a lister months later, plowing is not desirable and this early disking and continued spring tillage, until soil is warm, is vital to large yields and certainty of a profitable crop. One careful trial will convince. If, however, the farmer expects to plow the ground for oats, potatoes, checkrowed corn, feterita, sudan grass, hog millet or any other crop, the early disking is of great importance. In fact, without this early disking followed with later timely spring tillage to keep the surface loose and prevent the loss of water and the weeds growing, the soil will deteriorate before planting time, and its available water and plant food will be less. This would mean that the crop would be smaller no matter what the season may be, but very much less, or a possible failure, in a drouthy year.

Early and continued spring tillage not only conserves the moisture, but aids in warming the soil. As previously stated, every act of preparation of the soil, disking, plowing, packing and surface cultivation, should be done with a full understanding of its purpose or object. The entire work must be done to improve the soil condition with special effort to obtain the fine firm seed and root bed with loose coarse mulch. All stages of this work if done, so far as possible, at a time when the soil is moist, will then be more susceptible to the desired effect of the implement used.

All this aids in obtaining a higher degree of warmth and the proper per cent of moisture, both of which are so necessary in increasing the available plant food. Timeliness in tillage and not quantity of work is the essence of success in this.

Land that is to be planted to small grain or checkrowed corn, should be plowed fairly early after the early disking, in fact the earlier it is plowed, providing the soil is moist, the greater are the chances for a more ideal seed bed at planting time, both from more tillage and a greater possible rain, good rains are necessary after plowing to obtain the most ideal seed beds.

The farmer must grasp at once in connection with this idea of more and better tillage before planting, the fact that it takes a larger number of days to grow and mature a plant if the seed is planted early in a cold, half prepared, dead, clammy soil than if planted later in a live warm soil. Warmth gives energy to the soil and energy stimulates growth, and the coaching of this energy by the right kind of spring tillage, is wonderfully effective.

Plowing should be a fair depth from 5 to 7 inches, depending on conditions previously referred to, but do not leave the freshly plowed ground to dry out, follow closely with the subsurface packer or disk set straight. Remember, you are now preparing the seed and root bed in which the plants are to be born, fed and matured. Don't make any mistakes. For later cultivation and before planting the Acme harrow is very good, (See Cut No. 35), as it tends to turn the live moist

dirt at the bottom of the mulch up to the top and leaves the firm soil underneath level. Continue this spring tillage at necessary times until the time of planting. It is the open door to better crops every year instead of every other year. Don't let the weeds grow, and get it thoroughly fixed in your mind, that if your tillage efforts are well directed you are continually adding to the elements, and improving the condition necessary for a big crop as you carry this work on into the warm spring weather to the time of planting suggested for the different crops referred to later on.

SUMMER TILLAGE

Summer tillage should be identical with spring tillage in the start, for recent experience points to the great value of the early thorough work. The plowing, however, in summer tillage should be delayed and the disk used mainly during the early spring. In short summer tillage is a continuation of spring tillage for fall seeding.

Where summer tillage is planned, the early spring disking should be rather shallow so that later disking can be slightly deeper, thereby throwing a little live moist soil on the top, for the double purpose of keeping the mulch coarser, to prevent blowing, and to keep the surface more open to admit later rains. It is better to use the disk mainly or entirely when possible up to the time of plowing. There again, timeliness is more than quantity of work.

PLOWING THE SUMMER TILLED LAND

Plowing as a rule, in the central west should be in early June; later plowing is somewhat risky, for if the rains do not come the excessive heat later on, last of July or in August, may dry out the plowed portion to that degree that practically no chemical or bacterial action will take place. If there is no weed growth to bother your field, for a considerable time after plowing, you may know your seed and root bed is not up to the standard; therefore when the wheat or other seed is deposited in such seed beds the germination and growth is very slow and stooling very little in the fall. The same will be proportionately true in the early growth the following spring. At any time and in many seasons of the year when you are preparing your seed bed you must keep close tab on the real condition you are getting your soil into. This real soil condition must also be given due consideration in deciding the quantity of seed to be put in per acre, and more especially so in fall seeding for winter wheat. Fields with unfavorable conditions require more seed.

Be sure to follow the plow closely with some method of packing the bottom of the furrow, but don't attempt to do it by pulling any solid roller or clod crusher over the field for it only firms the top and does not pack the bottom, which is the vital point and especially so if you have plowed five inches or more in depth.

There have been some mistakes made in the past by using the sub-surface packer, after the

plowing had lain long enough to become somewhat dry, under which conditions the soil would not respond to the pressure of the wheels and the very under portion would not become firm. Therefore, if a dry season followed, the desired effect was lost and the packer condemned because it did not do what could not be done.

Another very serious mistake, after the subsurface packer has been used effectively, the top may become packed by later rains. Now with the lower portion of the furrow made firm by the subsurface packer, when the top becomes dissolved and packed by heavy rains, as it will, especially if a free use of the spike tooth harrow has made the mulch fine, you then have the most serious condition, because it so greatly aids the upward movement of moisture by capillary attraction to the surface and direct loss by evaporation. This water brings to the surface alkali, magnesia and other salts of the soil in a dissolved or soluable form, and when the steam or vapor leaves the surface the dry salts are left between the soil grains. This with the loss of the moisture causes a most unfavorable condition for the growth and maturity of the plant. Do such conditions give ground for the argument, that there are times the subsurface packer should not be used? It certainly does not. The things that should not have been done were first, not to allow the surface to become so fine that rains would settle it so firm; second, not to allow the surface to remain firm after the rain.

A mulch should be kept over the surface as near

two and a half inches deep as conditions will permit and all possible effort put forth to leave it reasonably coarse. Another important thing is, do not let the weeds grow. A few weeds will make several bushels difference in the yield. If weeds persist in growing, it is an indication of a good seed bed and that plant food is being increased, therefore, get busy, for the more the weeds take of this the less you will have for the crop. Then if the weeds get any size they will not only utilize plant food but deplete the moisture to such a degree as to check bacterial or chemical action. Watch these points closely. A little timely work prevents all these unfavorable conditions and means many more bushels of grain.

While it is true that early June plowing followed by persistent work to get the lower portion of the furrow fine and firm will tend to more weed growth, yet if the weeds are kept down and soil mulch loose to a depth of about two and a half inches, a more ideal seed and root bed will be obtained and an increased amount of plant food will be available. This fact leads to an important question which will be more fully discussed later on and that is *quantity of seed.* Too frequently we find the farmer sowing 20 pounds of fall wheat per acre with little regard to the real soil condition obtained. Summer tillage may be so handled that 12 to 15 pounds of winter wheat per acre planted reasonably early would stool so liberally that it would have to be disked in the spring to thin it; while a less carefully handled field might be seeded a little later with 25 to 30 pounds of seed and yet

be none too thick. These facts mean very much and must be duly considered, in case of late seeding to keep clear of the ravages of the Hessian fly more seed would be necessary.

FALL TILLAGE

Fall tillage as we wish to indicate, refers to the work following the harvest of one crop and the preparation of the land for the next crop, whether it be for fall or spring planting. The first very important step is to follow the harvester with the disk harrow, as shown in Cut No. 21 showing engine pulling harvester and tandem disk, and Cut No. 22 showing horses pulling tandem disk. There is no time when ample moisture means more in the soil than during the hot weather following the cutting of a crop of small grain in July or August. This is especially true of winter wheat fields.

Many have said in the past, "What's the use of disking dry ground behind the harvester?" This points to the honest, but stubborn belief of men who have never watched the effect of such work. We have repeatedly observed the soil dry at the bottom of the disked stubble ground just as the disk harrow passed over reasonably close to the harvester and then again, at the end of ten days or two weeks, even though it was hot, dry weather and no rain, and the result of the upward movement of moisture by capillary attraction found this same firm soil moist enough to plow well.

It is the accumulation of this moisture in this

very warm soil held there by the mulch loosened by the disk that sets the little micro-organisms busy building up the life and energy in the soil.

Another very important point is that the mulch formed by the stubble being mixed into this loosened surface which is not readily settled or packed by almost any number of rains, does readily take in each rain and when the water comes in contact with the firm but moist soil below the mulch, it percolates down more readily and deeper. All the moisture you store in your soil is like so much cash in the bank.

When the top soil is not disked but left hard, soon after harvest it is not infrequently found dry down four to six inches. Following this condition there may be quite a rain and in two days of hot sun it is all gone, because it goes into the dry, firm soil so very slow that the heat of the summer sun aided by the reflection of the glossy stubble takes it up quickly. Remember a little moisture sometimes means very much.

Following this disking and before you are ready to plow one or two heavy rains may come, then the weeds may start. Do not let these weeds grow to any size. You have already been to the expense of one disking for a worthy purpose, now don't let the weeds later on, utilize this moisture and dry out the land then try to plow and say there is no value to disking after the harvester, for the worthless weeds have robbed you. Give the field another double-disking if you are not ready to plow at once. At all hazards, don't let the weeds grow, and then think you are adding

something to your soil by turning under green weeds.

We have repeatedly seen fields that were well double-disked following the harvester in July in elegant condition and being plowed four to six weeks later with soil rolling over nice and moist, when adjoining fields not thus treated were so dry and hard that plowing was impossible.

Do not forget the following seven advantages in double-disking after the harvester.

1. Retains the moisture you may need next year.
2. Soil becomes moist while very warm and more plant food is made available.
3. Soil becomes moist and plowing can be successfully done earlier and later.
4. Prolongs the period of good plowing.
5. Soil plowed most can be worked down into a good seed bed while dry soil cannot.
6. Moist soil saves plow shears and horse power.
7. It all sums up into a foundation for bigger and better crops next year.

PLOWING FOR WINTER WHEAT

Plowing in fall tilling for wheat should begin as soon after harvest as the soil is sufficiently moist to permit good plowing. If the land has been well handled and a fair amount of moisture had fallen prior to harvest and the wheat field disked after the harvester, there will soon be found moisture enough to plow well. The depth of plowing should be from 5 to 7 inches depending, as previously stated, upon soil conditions. Follow-

ing the plowing should come the working down of the lower portion of the furrow slice. Very much depends on this as to the amount of seed per acre. With all sub-packing that can be done on fall plowing for fall wheat seeding, nothing can complete the work quite like a good rain (but such rain don't come to order) that freely percolates down through the coarse mulch and to a more or less degree dissolves and settles the lower part of the plowing. Its great value depends, of course, upon how soon after the plowing it comes and how much falls.

After the rain, if a heavy one, the top should be loosened again. Some judgment must be used at this point. While it is desirable to have the seed bed fine, the top or mulch should be kept somewhat coarse.

For further information see chapter on growing wheat.

CHAPTER IV

CORN AND STAPLE CROP

Corn is one of the essential crops of successful agriculture. In almost every farming region, though wheat may be the farmer's staple crop, he must have a few hogs, cows and also teams to do his work, and corn is one of the grains much needed for feed. In addition it is a fact, that successful and safe farming must be backed by stock and dairy products. Therefore, the absolute necessity of ample quantities of good corn.

In the chapter on preparation of the soil we have briefly outlined the necessary early work which applies to planting corn with lister, in which case plowing is not necessary. While we do not object to fall plowing for corn, yet we are of the opinion that where spring plowing is done reasonably early and is preceded with thorough but not deep disking and followed closely with plenty of harrowing and later timely tillage, that spring plowing is best.

As to depth of plowing observe what is said under Class III.

As to check row planting as opposed to use of the lister or drilling, we are still somewhat in favor of check rowing for corn in all the semi-humid sections. But the farmer must be equipped with the proper tools and continue the cultivation with proper care until the corn is practically made. However, if you wish to put the corn in the ground and let Providence take care of it, we would advise the listing plan, as providence would have a better chance than if the field was check rowed.

SEED CORN

In selecting seed corn to plant outside of the corn belt proper, and in higher altitudes, or farther north, and as you change in location toward the two points referred to, study the conditions that are found and do not make too radical a change in the seed. Do not select too large varieties for the dryer or higher sections but look for a slightly smaller ear with early maturing

qualities. Keep in mind especially the average annual rainfall of your own locality, and the fact that the larger the growth of foliage the more moisture is needed and the less moisture is left for use in maturing the ears and grain. This is important should you be confronted with the usual drouthy conditions in mid-summer.

With the smaller stalk, other important matters considered, the corn might produce in average seasons, one 8-ounce ear to each stalk. Under same conditions the larger variety with taller stalk and heavy foliage might possibly produce an average of one 10-ounce ear to two stalks. This would be little more than half the yield of corn, which is quite in accord with our observations covering many experiments under various conditions.

Above all other things secure, if possible, acclimated seed corn; but if this is not available next in consideration is a seed that has been grown as nearly as possible under conditions similar to that in your fields.

The selection of the earliest well developed, uniform ears from strong, healthy, prolific plants in your own fields, after you get a desirable variety, is also very important. The development and planting of acclimated seed is one of the main factors making it possible to successfully carry the limits of the corn belt farther north and to higher altitudes, something regarded a few years ago theoretically as an impossibility, but stands today demonstrated as a possibility.

THICK OR THIN PLANTING

The number of stalks per acre is another very vital question to consider in corn growing under semi-humid conditions. With corn checked 3 feet and 6 inches each way and two stalks to a hill, there would be 7,112 stalks per acre, which is ample stand for a 30-inch average rainfall. If listed 3 feet 6 inches apart and one grain dropped every 21 inches there would be the same number of stalks to the acre. With one 8-ounce ear per stalk you would have a yield of 63 bushels per acre—remember an 8-ounce ear is moderately small, a 12-ounce ear is only modestly fair size

But this is too many stalks by at least a third for a section with only 16 to 20 inches of annual rainfall.

It is true that many corn fields in the semi-humid sections may not average more than 4,556 stalks to the acre, under conditions of planting as above. But are they evenly distributed—well, hardly ever.

Too thin a stand, however, has its disadvantages the same as too thick; an even stand over the entire field is more important under semi-humid conditions than where ample rains are more dependable, thick spots and thin spots will not deliver.

That a thinner stand may mean much was evidenced in the recent drouthy years when we had a number of field experiments in western Nebraska and northeastern Colorado with fields of corn where rows were planted 7 feet apart, or

skipping every other row, and the spaces between were kept well cultivated, and this with excellent results, in some instances the yield of corn was quite as much as in fields with rows 3 feet 6 inches apart. The illustration is a little radical yet it points to the correctness of the principle. Do not jump at conclusions; reason well this question.

True, if you are planting for a crop of ensilage, plant thicker, but even then a stalk every 18 inches is enough for certain results from anything below a 20-inch rainfall. We are strong believers in corn rows farther apart—at least four feet—but most cultivators are not wide enough to cover this width, and change in the width of planting would mean change of cultivators. This kind of planting however, would give each plant more pasture and facilitate later cultivation. Good seed that will practically all grow is very important, for in no other way can an even stand be obtained.

CORN CULTIVATION

Cultivation is referred to in Class VII, as the final and vital act of tillage for corn. The precise time, manner and depth of cultivation of any crop means much more to the final yield than is generally realized, and must be carried out with a system which recognizes at least the following six important factors.

1. To keep all weeds from growing.
2. To cultivate the crop and not plow it.
3. To carry a somewhat coarse mulch and not a dust blanket over the surface.

4. To allow practically no moisture to escape by direct evaporation from the surface.

5. To use every possible precaution in preventing any crust from forming under the mulch or on the surface.

6. To destroy no roots of the corn during its entire growth, but more especially observe this point after the corn begins to show tassels.

HARROW AND CULTIVATOR

If you have disked your land early and kept up careful cultivation, as suggested under the heading of early spring fitting, you have gone a long way towards cleaning the field of weeds and making it possible to keep it free. If the land was plowed early, followed by a good fitting and corn planted with a check rower, one or two good harrowings will again set the possible crop of small weeds back and aid greatly in holding the desirable per cent of moisture at the top of the firm soil.

From the time the corn plant has its third leaf well out to the time the corn is 10 inches high, the spike tooth harrow provides good and cheap cultivation, especially if your land is free of trash and where the average sand loam predominates, which is the soil most commonly found in semi-humid sections.

The riding cultivator, with three shovels on a side, is about as good as any now available in corn culture. We greatly need up-to-date cultivators that will cover either two or three rows at a time, as desired, for from the time the corn is

18 inches to 4 feet high quick and effective cultivation is frequently vital. This is the period above all others that steady, rapid unchecked growth is desirable.

The first cultivation after the harrow should be the deepest, but should not exceed 3 inches in any event. Later cultivations should be changed very little as to depth, slightly shallower never deeper. You should watch very closely what you are doing next to the corn row to see to it that you are not destroying any of the roots that are sent out as the plant increases in size.

PURPOSE OF CULTIVATION

One of the great questions in the cultivation of corn is to know when and what kind of cultivation will bring about the greatest improvement in soil conditions for steady rapid growth. The simple fact that you cultivate the corn, potatoes and other crops, five or six times and your neighbor only two times, does not of itself account for success or failure. That which brings sure results is the right kind, manner and time of cultivation. Don't know this, you say—then you must learn it by observation and experience, and when you do it will be like finding a gold mine. Five cultivations intelligently and carefully applied will always bring better results in corn or potatoes that two cultivations. Good crop results from tillage are in proportion to knowledge of the true principles, the "why" as well as the "how" and the intelligent handling of the tools.

A glance at Cut No. 18, will give you a practical

illustration of the effect of ample timely tillage on a crop of corn. This was grown on the C. B. & Q. farm at Holdrege, Nebraska in the drouthy years of 1910. The ground was double disked early and kept cultivated to hold moisture and keep out the weeds until about May 10, then planted with a lister, after which an effort was made to keep the surface loose and allow no weeds to grow, the ridges were worked down reasonably early before the corn was knee high. Although the rains were very few and far between before the corn was tasseled and ears well out, yet cultivation followed closely after each rain. Had there not been a liberal amount of moisture in the soil at the time of the first disking, the result of ample fall rains, we could not have grown the crop so completely.

Now compare No. 19 with this crop, these two fields are on the same level prairie and on adjoining quarters, only about 30 rods apart. No. 19, had the same amount of liberal moisture in the soil in the spring, but no disking, plowing or anything else was done to this field until the corn was listed in, at which time there was a liberal growth of weeds averaging about 6 inches high. The loss of moisture by direct evaporation and what was drawn out by the weeds reduced the moisture to that degree that the July drouth got the corn and by the tenth of August there was practically nothing green in the field, scarcely a tassel made its appearance. Did the weather make this wide difference? Yes, in a way, the hot weather and little rain dried up and ruined No. 19, and the same weather caused No. 18 to grow and mature, but timely tillage made it possible.

Many have said in the past years; "What's the use, if it rains, we will get crops; if it doesn't rain, we will not." No more foolhardy idea was ever conceived. A glance at Cuts 18 and 19 is certainly somewhat convincing. To get the seed bed in good condition and keep it cultivated and clean of weeds, means nearly or quite as much to the size and quantity of the crop of corn in a wet year as in a dry year.

The growing season of 1915 had the highest rainfall recorded in 26 years over a large portion of the Chicago, Burlington and Quincy railroad territory west of the Missouri river, and it gave a beautiful opportunity to observe and gather all kinds of positive evidence that the same careful application of principles in tillage that were applied for best crop results in drouthy years has brought proportionate larger yields in wet years and that where there was carelessness and less work applied the crops were smaller despite the abundance of moisture. In fact, in many sections the corn crop was not as good as in the dryer years.

One of the interesting points which has been established by this unusual season of 1915 is that you must keep up your work, and to get behind in timely work means loss every time, wet or dry. In any and all seasons it is important to keep out the weeds and to keep the mulch loose and somewhat coarse.

CULTIVATION OF LISTED CORN

The use of the common spike tooth harrow early in cultivation of listed corn is hardly prac-

tical; therefore, we must resort to such implements as are commonly used. One point fully established, however, is that it is necessary to split the ridge a little earlier in the game than has been done heretofore. See Cut No. 20 and observe the modest root growth from the smaller plant, then note the root growth from the larger one. In the latter you see that the roots have gone up near the surface of the solid soil in the firm center ridge. This condition is especially true if there have been no heavy rains to pack the loose dirt thrown up over the center at the time of listing.

This somewhat loose condition of this top soil or mulch holds the moisture with the natural result that this firm soil, by being kept moist and becoming quite warm, because of the direct rays of the sun on both sides, soon becomes a most ideal feeding place for the roots, therefore, when they reach this point they spread and grow rapidly; millions of little feeders permeate this ridge, and at this precise stage of root development the plants may be seen to be putting forth a very rank, rapid, healthy growth: more especially you will note the dark green color.

The corn at this stage is usually 12 to 20 inches high—then you proceed to split the ridge with the result of destroying a very large per cent of the principal feeding roots, and what happens? If the weather should be hot and dry, the corn is seen to wilt more or less and the growth is checked. This set-back if dry weather continues may mean much to the final crop. If, however,

good timely rains follow, the check in growth or change will be less noticeable.

Endeavor to split the ridge before this period or condition of growth is reached, then you slip by the hazardous risk. Watch and study these conditions, for like many other chance conditions they can be largely overcome by timely and appropriate tillage.

LATE CULTIVATION OF CORN

Do not forget, much less neglect, your corn field after the corn is too high for the riding cultivator. Be especially vigilant if you have a heavy rainfall that has a tendency to dissolve and settle, or to puddle the mulch after the last cultivation. Corn at this stage needs the closest care. If you have made no gross mistakes up to the time the corn is in full tassel, you have a fine chance for a good crop. Mistakes made prior to this time cannot be fully remedied by any amount of later care.

For this late work in the corn field a 13-tooth garden cultivator is very good, but you must hold the rear teeth high enough to clear all main roots. A very good device for this last work in corn is an old mower wheel. Just hitch to a spoke and let the chain or rope come up over the rim at the front, making the hitch of the horse short enough so the lower edge of the front of the wheel will only clear the surface. This throws the bottom of the rear part of the rim forward with enough slant to just cut the surface and carry the dirt over the rim, dropping it loose behind.

The number of cultivations of this late kind must depend on the soil and climatic conditions; not infrequently however, one or two is ample.

The same importance attaches to later cultivation of listed corn as that given for check row corn. Later cultivation cannot be detrimental except that roots are destroyed. In the growing of corn for ensilage, the same careful and persistent preparation and cultivation will always pay, as it will mean more growth in fodder and more corn on the stalk for the silo.

CHAPTER V

NEW PROBLEMS IN CORN CULTURE

Tradition has closed our eyes to a great many things that would make life sweeter and business better. It has gotten us into deep and long trodden ruts, and corn planting time in most sections, is apparently one. Our father and his father planted their corn about May first to May tenth. We have been doing the same without a thought that under certain specific conditions it might be better to plant June first to June tenth.

In theory it would take a month later in the fall to mature the corn should we delay a month in the spring from the old fixed manner and the time of planting. But theory does not always work out the correct conclusions.

We have directed a number of practical experiments in recent seasons, in the semi-humid

section, to determine just what is best as to the plan of prolonged spring tillage and later planting. These experiments demonstrate that where the fields are carefully tilled from early spring up to 2 to 4 weeks past the usual time of corn planting, the soil is warmer and more favorable to plant growth, and a better physical and higher fertile condition is brought about. The effect of this is to force the growth of corn to a degree that acclimated corn will, under these conditions, mature at a date nearly or quite as early in the average season, if planted 2 to 4 weeks later than if planted at the usual time under more common conditions. And the late corn, as is shown, is likely to be more healthy and more capable of resisting disease, drouth and pests.

RESULTS OF SPRING TILLAGE AND LATE PLANTING

In this book we have given some illustrations from photographs of field showing what results are actually obtained by adapting the planting time to the conditions which are found. These pictures tell the story much better than it could be told in any other way. They will repay careful study and stand thorough investigation. The location is given in each case, so there can be verifications by anyone interested.

A field of corn at Orleans, Nebraska, 237 miles west of the Missouri river, is shown in Cut No. 12. This field was planted July 1, 1914. The photograph was taken August 23, or 54 days from planting, when the corn was nearly 6 feet high and beginning to tassel. When corn is planted under

ordinary conditions on May 10, the farmer usually finds that on July 4, or 54 days from planting, the corn is up 18 to 24 inches, commonly termed "knee-high", or one fourth to one third as high as shown in this field at Orleans. This field was carefully spring tilled from early spring to time of planting. Do you understand the significance of this fact?

Now we do not use Cut No. 12 to establish as a rule or principle that July 1 is the proper corn planting time. But it does show the truth of our previous statement as to the time it takes to make the same growth after the soil has been well and timely tilled and becomes warm, and the seed bed has been put into a more perfect condition by the tillage and the liberation of plant food by certain chemical action is under way, as against earlier planting with less preparatory tillage and colder soil.

The same field is shown again in Cut No. 13, but the photograph was taken 30 days later, or 84 days from planting, showing the ears which matured. The corn in this case was not an early variety, but the common yellow dent.

Four other fields were planted the same year, on June twenty-ninth and thirtieth, at points some 50 miles apart, not expecting, however, to raise finished corn but to obtain a better and more tender ensilage; but strange as it may seem every field not only matured corn, but at no time did the foliage show the ill effect of the prolonged hot, dry weather.

It must be remembered that the season of 1914

was very hot and dry and at the time these five fields were at their best and well tasseled, most early planted corn was badly fired, while these five fields all remained green up to the late hard frost. The same rain fell on the fields that were so badly fired the last of August that fell on the five fields which made so much better growth and kept green well into October.

Cut No. 14 is a field of corn at Sligo, Colorado, in the northeastern part of the state 150 miles north of Denver, planted May 12, 1915, on early disked ground and well fitted. As a further evidence of the correctness of our proposition regarding the more rapid growth of later planting, when proper preparatory work is done, kindly contrast this with Cut No. 15, a field adjoining No. 14. This field was planted June 6, or 25 days later, but with the continued spring tilling of the soil from early spring up to time of planting. While the rainfall on these fields was almost double that of normal years, yet note the apparent stunted growth of the earlier planted field.

Cut No. 16 is a row of shocks of corn cut from the field planted June 6, and photographed the same day as Nos. 14 and 15. This is given to show the marked growth of corn that can be obtained at the high altitude of 5,400 feet, in a cool season like 1915, and a total rainfall of 13½ inches from January first to September twenty-fifth. These cuts, Nos. 14, 15 and 16, tell their own story. It is proper to explain that the photo for Cut No. 15 was taken after all the field except the three rows, had been cut, consequently the

thin appearance of the corn field. It is well to add that this same farmer, Mr. W. W. Cockran, with only 7½ inches of rain during the growing season in 1914, raised 540 bushels of good corn on 30 acres, also 700 bushels of wheat from 20 acres and 120 bushels of potatoes per acre.

In connection with these three pictures and the brief facts given, don't fail to recognize that tillage of the right kind at the proper time and planting when the soil conditions had been made more favorable by this tillage, were ruling factors in the wide difference as to these results. The same weather conditions prevailed over both fields, as there was a distance of only 3 feet and 6 inches between them.

OTHER RESULTS OBTAINED

A field of corn at Holdrege, Nebraska, is shown in the illustration, Cut No. 17. This was in the dry year of 1914. The ground was disked early and kept clean of weeds with a loose surface layer maintained, corn listed June thirtieth, photographed August 7, or 38 days after planting. The average height of the corn at the time the photograph was taken was 46 inches, or about double the height of the average corn on July fourth that had been planted May tenth. In other words, this corn made twice the growth in 38 days that the average early planted corn would make in 54 days. The ideal seed and root bed brought about by careful tillage, the warm soil and increased available plant food were the ruling factors in this remarkable growth in so short a period.

Mr. Haun, at Haxton, Colorado, planted a part of his corn May 4, 1915, and the rest of it June first, with a similar experience, that of having his later planting grow tallest and rankest and maturing corn at about the same date as the early planted.

Mr. Forrest of Brush, Colorado, planted part of his corn May 7, 1915 and the balance June 10, all in the same field, with same seed, an early maturing and acclimated variety. Four men were selected to estimate the crop of the two plantings on September twenty-fourth. They agreed that the late planting had produced more than three times as much fodder and more than two times as much corn; that the late planting was less than one week behind in maturing although planted five weeks later; and that the early planted field was badly smutted while the later planting practically had no smut.

Similar conditions were reported as to the absence of smut in a number of other late planted fields. Thus it would seem that the earlier planted being more or less stunted and consequently less vigorous and weaker was more susceptible to disease than the late. This smut problem is a question that is worthy of your careful consideration, for it is very common some years in the central west to find the majority of corn fields developing much smut. The situation we have just referred to indicates that a more vigorous, healthy plant, the same as man or animal, has greater ability to ward off or resist disease. We have a number of letters from farmers expressing

great surprise at the quickness and rankness of the growth of plants on well handled fields and late planted in 1913 and 1914 with their drouthy conditions and excessive heat; but with the cool season of 1915 and its excessive rainfall which has brought about such a difference in favor of early and continuous careful tillage and later planting by three and four weeks, which has been reported by more than forty farmers, we are earnestly inclined to urge all farmers to try experiments, that they may see with their own eyes how easy they can not only slip by a modest drouth without injury to the crop, but very materially increase the growth and final yield.

Remember distinctly our faith in the apparent advantage of this later planting is based almost wholly on the effect of early and continued timely tillage.

CORN FOR GRAIN AND ENSILAGE

Basing our conclusions on the results of the experiments just noted, and taking the south line of Nebraska and the center of the state as a base where semi-humid conditions usually prevail and where corn planting time has been, as a rule, about May tenth, we would urge the trial of continued cultivation for 2 to 4 weeks, regardless of the fact that you are delaying the usual time of planting, depending for the wide range of two weeks upon the soil, season and location.

But to those who try it, we say to give it a careful and thorough trial, and study well what we have said regarding the preparatory work,

under the head of Spring Tillage, and how much *it means* to the more rapid growth by the later planting, for this is the basis for the increased certainty and yield of corn, and all evidence so far is in its favor. Have you not, by accident at some time, planted your corn late and got good results? Then don't forget that the early and continuous cultivation gives you a still greater advantage.

Then as one goes north and west from the base point referred to, you should shorten the preparatory period slightly, while going south or east give about the same period of cultivation beyond the usual planting time. It is very apparent that this plan will carry farther east in the corn belt proper, but where the atmosphere is more moist the delay should be slightly less. As we go north or rise in altitude in the section of low humidity and lighter rainfall, we have found our most marked and interesting results.

In planting for ensilage there is unquestionable advantage in the very thorough tillage preparation and delay in planting. Every known experiment on this line properly carried out has been a success. In some localities for ensilage it may be advisable to continue cultivation and delay planting for at least a week or ten days later than where mature corn is the object.

If careful consideration is given to our base point as to planting time and modest consideration given to the local conditions and the proper tillage the increase in tonnage in normal years by reason of prolonged tillage and later planting will

be very marked, while in the more drouthy seasons, it will be a happy surprise to all who have not seen it worked out.

Much stress must be put upon the question of early disking and careful preparation. This will materially aid in promoting early rapid growth.

The delay of 2 to 4 weeks in planting should be solely for the purpose of permitting a longer period for tillage and that the soil may become sufficiently warm to give quick germination and rapid early growth.

Corn that is stunted by the unfavorable physical and a cool soil condition will never fully recover by any amount of after good tillage.

Good, early, careful preparation of the soil for corn counts in wet years as well as in dry years.

Careless and delayed preparation for corn means a small or no crop at all in drouthy years.

Corn was once king in Iowa; it can make kings in much of the semi-humid section.

CHAPTER VI

TIME OF PLANTING

We have already discussed the question of prolonging the preparatory period prior to planting the average crop. This you can readily see means planting the crop a little later, in some instances two weeks and in other two months, depending on the kind of crop. This seems almost ridiculous, but go with us carefully through. It is not our

purpose to discuss the question of later planting for better results but rather of prolonging the period of preparation sufficiently to obtain a much more ideal soil condition, for not only storing in close proximity to the feeding zone of the plant roots a greater supply of moisture and plant food, but to get the benefit of the warm weather in bringing about a more favorable condition for rapid development of rootlets and their feeders, and at the same time having a soil condition that will provide additional plant food to keep up the supply as the plants begin to reach up with a more rapid growth.

In the development of this kind of work or what we term Spring Tillage, there is one great advantage we are seeking, and that is to bridge over seasons of light rainfall, also the hot drouthy periods that so commonly play havoc with our crops the later part of June through July, and early August in all semi-humid sections.

For a time it seemed that for sections of lighter rainfall summer tillage was the solution, and in the production of fall planted crops, it has proved remarkably successful where the work was correctly done, and we know there is much more merit to summer tillage than has been commonly brought out. The difficulties militating against its success are two; first, a lack of full and thorough understanding of the principles and the observation of every detail; second, lack of adequate tools for handling the land more especially after the land has been plowed and sub-packed, to then completely keep out all weeds without destroying the seed bed by too deep cultivation.

Experience with summer tilling, however, is what has brought out the spring tillage idea, which points to a successful harvest every year for all spring planted crops, barring hail storms.

We have already found that for large results from spring tillage there is a necessary preciseness in the work the same as there is in any other line of work. It is also true that some of the ideas are radically different from all past practice. This is especially true as to the delay in planting time of nearly all crops, to permit of time for the necessary tillage to obtain the best results each and every year.

In the following chapters we shall refer to very marked results in the hot drouthy years of 1913 and 1914, where fields have had early and careful preparation followed by continued timely cultivation, to a considerable later period of planting not only produced large crops but were the only fields to fully resist the ill effect of hot weather.

In later chapters we will go more into detail as to the reasons for early and perfect fitting of the soil and this to be followed by late planting, as it relates to crops of corn, potatoes, cane and other things. We shall urge reasonably later planting, always to permit of the prolonged spring fitting, by from two to six weeks than has been the practice prior to 1915, depending always on the kind of crop. A better and more perfect seed bed is made possible, by the delay of planting to permit of a longer period of preparation. This is especially applicable in sections of light rainfall in growing feed for cattle and hogs.

The length of time of extended cultivation must depend absolutely on the location, conditions and kind of crops to be grown. Our conclusions as to value of this prolonged thorough fitting and later planting are based on results actually shown in dozens of practical field tests in the hot, dry summers of 1913 and 1914, with many other tests in the cool wet summer of 1915. These tests covered a wide scope of conditions and country, and therefore, we can say without hesitancy, that the plan is not in the least detrimental in cool, wet seasons but is a most marked advantage and success in hot, dry seasons, if the right kind of tillage is made use of with intelligence.

Later planting with due consideration as to kind of crop and location following proper preparation, means more to the farmer in the semi-humid sections than any other one thing possible in increasing the magnitude and certainty of crops in any and all years. While this is a comparatively new problem we believe firmly in this conclusion.

Like many other lines of effort to better the average crop production, the prolonged tillage idea before planting must have local consideration and adjustment. The time of planting in your field may be of necessity from three to ten days later or earlier than in a field not many miles away, because of local conditions regarding the soil, summer warmth and autumn frost.

We urge every farmer to try out these principles, as to late planting, to permit of prolonging the period of preparation for there is much in them, in the way of greatly increased growth

from the same amount of water, but begin your experiments with care and with the idea that you should continue the preparatory tillage as late as you can with reasonable assurance of time from planting for the plants to reach the maturity most desirable for harvesting that specific crop whether it be corn, cane, fodder crops, potatoes or garden. Work out the problem of the lateness of preparation for each farm and crop by small experiments carefully handled and results recorded. Some seasons the continuous hot weather comes earlier than other seasons and the soil may reach the ideal warm conditions earlier, when earlier planting may be advisable. But let us again emphasize that the value of later planting comes from the farmer's ability to destroy more weeds and store more water in the soil and further improve the condition of the seed bed under which conditions a greater amount of plant food is made available, and a much more rapid growth attained.

As has been stated before, the advantages are many why the growing season should be made as short as possible. Some of these might be stated as follows:

Less danger of injury from unfavorable conditions, such as hot winds, storms, hail, insect pests.

Greater opportunity to destroy weeds and a smaller opportunity for the weeds to take advantage of the field crops and crowd them out.

Far less danger of stunting the growth, a stronger, healthier plant because of quick growing, therefore, a greater resistance to plant disease and increased certainty of larger yield.

A larger amount of available moisture and plant food at time of planting, due to the longer preparatory period in which the moisture is stored and the plant food is made available.

It must be remembered that the availability of the elements in the soil for the use of the plants, depends largely on the preparation of the soil and the final physical condition obtained. Some plant food, it is true, is available in practically all soils nearly all the time; but for best results, especially in semi-humid regions, the largest possible amount of plant food must be made available to assure greater returns. This happens when there has been such treatment of the soil that the water and air are mingled in right proportions so that under influence of the sun's rays and the electrical forces, there will be quick and radical but favorable changes in the soil itself. That is what takes place naturally in the middle of the summer. The farmer can help it along wonderfully. So if he takes, say eight weeks in which to do his preparatory work of getting the field ready and coaching the elements, he can accomplish a great deal more than he could do in three or four weeks' time. Then, also, a week under weather conditions that come in the later part of May and early June, when the sun is reaching near its highest point, and the days are longer, is worth a great deal more in the development of plant food and growth of the plants than two or three weeks in March or early April, and yet the very early tillage means very much in not only holding the moisture that is in the soil, but in putting

the soil in better condition to take in the later rains.

The growth of all plants can be crowded, they can be urged and encouraged. Their growth can be hastened in many ways. That is why some fields of corn will mature in 90 days while others require 120 days or more. Much attention should be given to the selection of quick growing varieties. The great value of the quick growing crops is that they may be planted late, when the available plant food is most abundant and the general weather conditions most favorable, which is in mid-summer, and if the soil conditions are at their best they get through to maturity in much less time.

CHAPTER VII

WHEAT

Wheat was the first crop grown by the early settlers throughout the great central west, so far as history can be traced, and when the soil was new and did not as readily assume unfavorable conditions, the yield was good and promised the pioneer great and quick profits. Some early yields and profits from wheat on the virgin soils of Minnesota and Iowa, coupled with advent of the self binder, prompted the speculator and the capitalist to monopolize and operate large tracts of land.

In 1877 leading stockholders of the Northern Pacific Railway sought to induce settlement of

the long stretch of then uninhabited land running almost from the suburbs of St. Paul, Minnesota to the Pacific coast. Flattering offers were made for its development, and in 1878 the great Dalrymple wheat farm on the fertile level prairies just west of Fargo, of 40,000 acres, sprang suddenly into existence. Other great spring wheat farms followed, ranging down to one and two thousand acres each. Many of the first yields were 35 to 45 bushels per acre, some much less; fortunes, however, were seemingly sure and close at hand, a fact that doubtless led many of us off on the wrong plan of one crop farming.

Millions of acres of Northern Pacific and Union Pacific lands were soon purchased and thousands of homesteads, preemptions and tree claims of 160 acres each, were filed on, and the country from up near the Canadian line down to Oklahoma, filled with eager speculators and home makers.

Railroads were projected, and for the first time in history they were built into the interior beyond settlement. Cities and towns sprang up like magic, everybody seemingly had money or was going to get it. But there came an end to all this, the history of which we will not repeat.

The principal factors in all the grief that followed were the mistakes made in handling the land. We were all strangers in a strange land, there were so many things we did not know. While we do not believe in the one crop farming, yet a wide range of experience convinces us that wheat on a small scale can yet be grown at a profit,

and in the following pages we shall endeavor to prove this as certain, not by theory but by practical results.

WINTER WHEAT AND TILLAGE

Methods of tillage have very much more to do with crop results in semi-humid sections than weather conditions. In illustrating this fact, let us call attention to certain pictures. Look at Cuts No. 24 and 25 carefully. They represent winter wheat tracts on 160 acres each, both fields grown in the wet year of 1915 near Yuma, Colorado on adjoining sections, with soil of the same formation and both on land broken from the prairie sod in 1914. The field illustrated in No. 24, made 39½ bushels per acre, while No. 25 only made 13 bushels per acre. Fifteen inches of rain fell on both fields during April, May and June. One field responded most beautifully because the physical condition was such that nature could come much nearer doing her best. Have you ever seen such contrasts in adjoining fields and sometimes in different parts of the same field? Is it possible to get around the wide difference in the results of these two fields by saying it is only one of many similar freaks? This is too ridiculous; there is a cause for No. 24 and another cause for No. 25, and apparently both had their definite effects, therefore, the cause and effect are explained later on.

Now give careful consideration to Cuts Nos. 26 and 27, to which is attached some interesting history. These fields are closer related even than

Nos. 24 and 25, so far as soil is considered, because of the fact that the tillers of both attempted to follow the same plan. They both had been cropped a number of years and are on adjoining quarters of the same level section one mile southeast of Yuma, Colorado, handled by different men.

Both fields were summer tilled in 1913, each man endeavored to, and thought he was doing all he could to get a soil condition that would bring the biggest and best crop of wheat, but look at the result. Field No. 26, apparently (not happened to) was put in very much better condition and when you read about J. M. Moyer who handled this field you will more fully appreciate this fact.

The two fields after being summer tilled in 1913, were seeded in the fall, and in 1914 each field produced as follows: No. 26, 47½ bushels per acre; No. 27, 24½ bushels or a little more than half as much. The 47½ bushel crop is shown in Cut No. 30, in the rear field, where it is contrasted with the adjoining or front field, cropped in the usual manner yielding only 16½ bushels. About the same expense in labor in summer tilling was put on field No. 26 and 27 in 1913, the time, kind and manner of doing the work making the wide difference. One knew what to do and what not to do; the other thought he did, but made mistakes as many others have done.

Now as to the next year. Both fields were refitted the same season, 1914, each doing what he thought was best to prepare for seed and sowed that fall to winter wheat. In the two pictures

given we have shown the result of the 1915 crop. The field shown in No. 26 yielded 30 bushels per acre and that in No. 27 yielded only 11½. This added to the 1914 crop of 24½ bushels makes a total of 36 bushels in two consecutive years, following one season of summer tilling. And yet, No. 26 yielded 47½ bushels in 1914 and 30 bushels in 1915, a total of 77½ in the two years, or 43½ bushels more than No. 27 for really knowing how. This at 85 cents per bushel would be $36.98 per acre, or the three years' interest on the land at 6% on a valuation of $205.33 per acre, not the total return but more than the other at practically no extra cost.

The question naturally arises here as to why this difference? The yields were not accidents. There is a clear and distinct reason and this reason slightly enlarged is the "Why" some men are raising good crops in the most drouthy years in western Nebraska and eastern Colorado, and better ones in the good years, while others have gone there, tried to do the same work, and failed entirely. In short this striking illustration clinches the fact that there is a right and a wrong way of doing things. It also tells a valuable story in the lesson of summer tilling or summer fallowing, which, as commonly understood, means to cultivate one season to store the rain waters for use the next year, for it shows there is more to it, also that it is important to have every part of the work, tillage, quantity of seed, time of seeding, all carefully done. Unless it is all timely and correctly done you are liable to be sadly disappointed in

final yields, but if every detail is done correctly, and it can be, success is as sure in the semi-humid sections as in almost any other place. These four pictures just mentioned are shown together with Cuts Nos. 30, 31, 32, and 33 to establish more fully a fact that unfortunately has not been sufficiently well understood in the past, and that is, the crop is in proportion to the tillage or treatment the land has been given, the quantity of seed sown and time of seeding. Therefore, if you or your friends failed years ago, don't insist that others must likewise fail now.

FURTHER EVIDENCE

Cut No. 28, has a very interesting story that must be recognized as a further proof of our attitude as to how easy it is to make a mistake, and how a mistake may easily mislead anyone who is not familiar with the progressive ideas.

This field belongs to a neighbor of Mr. Moyer's, at Yuma, Colorado who came to Mr. Moyer in the spring of 1914 with the statement that he wanted 40 acres of his prairie land broken for winter wheat, but he had no money. Mr. Moyer, replied he would break the land and fit it for fall seeding and take for his pay one third of the threshed wheat, providing this party would seed at the time and with the quantity of seed per acre that he requested. The deal was thus completed. Mr. Moyer did the work. When the breaking was finished, the owner was through his spring seeding, so he broke 10 acres more alongside of the breaking done by contract, and fitted as to his

own notion and seeded as he thought best in the fall at the time the Moyer part was also seeded. In face of the unusual heavy rains of 1915, there was a very wide difference in the yield of the two pieces, so much that they were cut and threshed separately. Mr. Moyer's third was more bushels per acre than the total yield per acre of the additional ten acres.

Cut No. 28 shows the crop on the Moyer part just before cutting. Knowing that the same heavy rain fell on the entire 50 acres, we ask the question, was the weather responsible for the wide difference in the yield or was it the tillage? Again the question, is not this evidence sufficiently clear to establish the fact that the right principles and methods will bring results that wrong methods will not? You must know however, what is right and what is wrong.

Cut No. 29 is J. M. Moyer's 1915 winter wheat, 50 acres on land broken from the prairie sod in 1914, average yield 45½ bushels per acre, a very marked yield for new breaking. Remember this when you look at other fields grown by Mr. Moyer.

The full page Cut No. 30, in colors, rear field with its rank healthy growth is Mr. Moyer's 1914 crop on land summer tilled in 1913, and previously referred to in connection with Cut No. 26. The front field with its somewhat stunted growth is also winter wheat on land that had grown a crop of wheat in 1913 at the same time the rear field was being summer tilled. The two fields were sown at the same time, the rank rear field was sown with 20 pounds of seed per acre and the

front field with 30 pounds per acre. Mr. Moyer gave this front field the best care possible as he was still trying to satisfy himself whether it paid to summer till or not. The summer tilled field produced 47½ bushels per acre and the front field only 16½ bushels per acre, or slightly more than one-third. This result, in face of a rainfall considerably below normal convinced Mr. Moyer that Colorado prairies like her mountains have plenty of gold but to get it in liberal quantities it was necessary to learn better when and how to till the soil.

Cut No. 31 shows Mr. Moyer's field of summer tilled wheat after it was cut in the hot dry year of 1913. This field of 15 acres averaged 34½ bushels per acre, with plenty of fields in the surrounding country going from 8 to 12 bushels per acre.

Cut No. 32 is Mr. Moyer's 1915 crop on land summer tilled in 1914, 51½ bushels per acre. Don't forget that this is fully double that of the majority of wheat fields around Yuma and also that the rainfall recorded from the first of April to the cutting of this crop is more than double any other year. Then why does this summer tilled field produce so much more unless there is something in the theory of increased fertility from summer tilling? Then, again remember that Mr. Moyer's high yield in 1915 with its heavy rainfall is only 4 bushels more than in 1914 with less than half the rain. Is it the weather or tillage?

This No. 32, is a close second to No. 39, a summer tilled field grown in the dry year of 1904 at Holdrege, Nebraska and yielding 54½ bushels

per acre of 64 pound wheat, and referred to later on. In the eleven intervening years, many a farmer has tried to grow wheat by summer tilling and failed of any profit and strongly denounced the methods and principles all because of mistakes and a misunderstanding of the real how, not only in tillage but quantity of seed and time of seeding.

To more fully substantiate the fact that the correct time and kind of work means more than quantity of work in not only summer tilling but in successful crop growing, we take the liberty to state that Mr. J. M. Moyer farmed and fitted in the autumn of 1914, 210 acres, all of which was in crop in 1915 and well handled and largely re-fitted again, doing his work alone with the help of 3 horses and a gas tractor that pulled five plows, except his help for harvesting and threshing. Whether Mr. Moyer did good work on so large a farm with no other manual labor is evidenced by his fields of grain we have shown you in the various pictures. Mr. Moyer is not only growing crops with larger yields than any one else, but he is making all due preparations for a pleasant, attractive home in the near future. A glance at Cut No. 6, shows a row of Carolina poplars on the south of his orchard only five years old and fully 18 feet high now. Cut No. 7 is an interesting view of his five year-old cherry trees just north of the Carolina poplars. Mr. Moyer has never failed to get fine vegetables and potatoes since he learned how.

Cut No. 21 shows Mr. Moyer cutting his champion crop of wheat in 1915, pulling his

harvester and a tandem or double disk harrow, double disking the stubble as fast as the crop is cut, mixing the thick heavy stubble into the top three inches of soil. Explanation of the value will be gone into under the heading of "Disking After the Harvest."

Cut No. 33, another full page color cut, shows two fields of wheat grown by August Desens, on the high divide 1½ miles north of Stratton, Nebraska in the very hot, dry year of 1913. This, like No. 30, shows two fields of winter wheat. The rear field here was summer tilled in 1912, and seeded in early September, and produced in 1913, 33 bushels of 62 pound wheat per acre, while the front field was in wheat in 1912, refitted and again sown at the same time the summer tilled field was. This field started off well in the spring, but like many surrounding fields ran out of moisture during the hot weather without rain and dried up, never even heading as can be clearly seen in the cut.

The gentleman's feet standing in the front field can be plainly seen, while the man in the back, or summer tilled field, stands in thick rank wheat up to his hips. Such evidence as to the correctness of certain methods of tillage cannot be contradicted. Numerous fields of wheat in this locality were not worth cutting, due to the excessive prolonged heat without rain during June and early July.

Cut No. 34 is a most exceedingly interesting illustration of what the right kind of tillage will do in the growing of a good crop with very small

rainfall. This rye was grown by C. L. Morgan, Sligo, Colorado, on the Cheyenne branch of the C. B. & Q. railway, 46 miles east of Cheyenne, Wyoming in the dry season of 1914. The land was summer tilled in 1913 and during that year a total of only $7\frac{3}{4}$ inches of rain fell. The rye was put in August 25, 1913, made a very good start and by its liberal stooling afforded considerable pasture for about 20 head of stock and again in the spring was pastured. The total rain from January first, to the cutting of the rye was only $4\frac{3}{4}$ inches, making a total for the 19 months, prior to cutting of the rye, $12\frac{1}{2}$ inches. Again we insist the right kind of timely work makes success possible. Have we not given you ample proof?

CHAPTER VIII

DOES TILLAGE INCREASE FERTILITY?

When we speak of soil being fertile or rich, we very naturally look for large yields from that soil, and yet, all over the great semi-humid west we have a wonderfully fertile soil that does not as a rule produce large crops, because the fertility or plant food is not available. Though the elements are there, they cannot be reached and utilized by the rootlets.

When we consider the general climatic conditions that prevail during the growing season, usually we find one of two conditions quite unfavorable to large quantities of available plant

food, either a coarse loose, soil condition carrying too low per cent of soil or capillary water, or a compact surface and weeds which have depleted the moisture.

It is only in recent years that we have realized the wide difference in the crop production of the soil in the same field where only slight differences as to apparent conditions seem to exist and it has led us to plan many experiments, to find out how, if possible, by tillage, this fertility can be made available not only in larger quantities, but more continuous, believing much larger yields can be obtained if we can only understand this better, and know just what to do.

Under the captions of Spring Tillage, Summer Tillage and Fall Tillage, we have covered the principal points in mechanical work to bring this about, and in this chapter we shall reiterate to some extent. But our main object is to prove here by pictures and explanations that certain soil and moisture conditions do govern as to the quantity of available plant food.

Cut No. 39 gives one illustration. This very large crop of winter wheat was grown on the C. B. & Q. farm at Holdrege, Nebraska, in the somewhat dry year of 1904, on land summer tilled in 1903, and seeded September tenth with 25 pounds of seed per acre.

Note carefully the two especially interesting features of this 40 acre field, height and evenness of stand. The yield was 54½ bushels per acre of wheat that weighed 64 pounds to the measured bushel. Fifteen to twenty bushels was the com-

mon yield of surrounding fields weighing 58 to sixty pounds per bushel.

The early spring started off very favorable and all surrounding wheat looked fine but just before heading there came a dry period causing a check in the growth of nearly all fields but this one, because of a more perfect soil condition. It was also because of a surplus of moisture stored by the summer tilling the year before, as we then supposed,—more recently however, we have decided that this very marked growth was not so much the direct result of the large amount of additional available moisture during the growth of the wheat, but rather what the moisture had done during the summer tilling period and before the wheat was planted, when during midsummer we were able to keep the surface loose and prevent any weed growth whatever. The high per cent of capillary water which supplied the necessary moisture for a heavy bacterial growth or chemical action and made available the large amount of fertility, was undoubtedly the more direct cause of the rank growth shown in the picture than the water itself.

One square look at this field convinces one that some very unusual condition existed.

MORE EVIDENCE

As further proof of the correctness of this theory, note Cut No. 38, a winter wheat field six miles east of Akron, Colorado in 1912. Look closely and observe the high thick stand of the stubble in the foreground, then the numerous

large shocks. This field has an interesting history, as it was summer tilled in 1911 with a great amount of care, for the main purpose of ascertaining whether a certain soil condition in the heated part of the season during the summer tilling would bring about a more marked, rank growth the following year. Our theory in this was based on the keeping of the mulch at a fixed depth, loose and dry as much of the time as the more or less rains and timely cultivation would permit, thereby, holding the high per cent of capillary water in the top of the firm soil beneath the mulch continuously to permit a process of chemical or bacterial action, expecting to materially increase the available fertility.

Whether we were successful or not is evidenced by the growth of this wheat crop when we realize that moisture was stored to a depth of only 32 inches during the summer tilling process in 1911, and the rainfall up to the cutting of this crop in 1912 was very light and the last thirty days it was very warm giving our ideas a most thorough test.

A further fact is, that only 18 pounds of seed were sown per acre and that the field was twice harrowed in the spring to thin it, for early in its spring growth it showed too thick a stand from its prolific stooling. At one end of the field where the seed was quite thin, one stool was found with 213 stalks from one seed and numerous stools in the other part of the field with one hundred and over. As you look at this picture, think over carefully our statements.

Cut No. 36 also bears out the same point regarding the question of increased fertility by tillage. Here are shown two stools of wheat pulled the eighteenth day of November, 1910, at Holdrege, Nebraska from two adjoining fields, one from the C. B. & Q. farm, the other from a field immediately west of it. Both were seeded about the tenth of September; one, however, was summer tilled land, the other was land that had grown a crop in 1910, then plowed and fitted for crop again, and work well done by a good farmer. About the twentieth of September, ten days after seeding, a very good rain fell, about $1\frac{3}{4}$ inches. The larger stool which is from the summer tilled field is not exceptionally large, but a fair average sample and contains eighty-three well developed stools, or stalks, while the smaller stool contains only six stalks, and it would have been difficult to have obtained a larger stool in this field; it was above the average.

While it is fair to concede that the seed and root bed in the summer tilled field was finer and firmer, and carried at the start more moisture in the top six to eight inches all of which was more favorable to the rapid growth and development of the roots, yet after the rain the twentieth of September, the conditions regarding the firmness of the seed bed and available moisture would have been nearly alike in both fields because of the dissolving and settling effect of the heavy rain on the late fitted field and practically all the rain must have soaked in. Think of fully fourteen times as great a growth in the same time, a large per cent of which

must have been due to the greatly increased amount of available plant food in the summer tilled field.

While we are giving you many practical illustrations, dozens more could be given along the same line.

Cut No. 37, previously referred to, is further evidence of increased fertility under specific soil, moisture and climatic conditions. In this illustration the evidence is along the line of diminishing the amount of available plant food or fertility by carrying a too low per cent of moisture in the soil. Briefly explaining No. 37, some 30 acres of land were being summer tilled by C. L. Morgan at Sligo, Colorado in 1910, a season of very light rainfall. About half of the field became somewhat weedy because of a combination of rains and other work to be done, while he had kept the weeds out of the balance of the field; however, the same depth of mulch had been kept over the entire 30 acres. The weedy part was plowed first, plowing of the balance of the field followed immediately, same depth of plowing and other work was all identical, the seeding done at the same time and stools pulled 43 days after seeding. The average stool in the part kept clean was about 21 stalks, while in the part where the weeds had grown the average stool indicated about 6, which is unquestionably due to the low per cent of moisture reduced by weed growth in June and early July, checking bacterial development. These facts are also borne out to a degree in the contrast of Cuts Nos. 24 and 25, and Nos. 26 and 27, as well as in Cuts

Nos. 30 and 33. Do not fail to turn to all these pictures while you have this question in mind.

Cut No. 40 is another demonstration of increased fertility by summer tilling. Here are five heads out of 31 from one grain or stool, and there are 341 grains in the five heads or an average of over 68 grains each. This is not only remarkable but very unusual. There were four grains in every group, a fact that is very uncommon. This was grown near Morcroft, Wyoming, in 1915, on land that was summer tilled in 1914 and seeded, as we advised, with 20 pounds per acre. By an unavoidable combination of conditions the seeding was done late, therefore, very little stooling in the fall. The field started off in the spring seemingly so thin that the owner decided it worthless and plowed up about two-thirds, leaving the balance to prove that 20 pounds was not seed enough, but to his amazement he cut from this small field, what he admitted to be the largest yield per acre of the best wheat he ever saw. The five heads referred to were from this field. This is seemingly evidence in favor of the correctness of three principles or theories; first, that tillage of the right kind at the right time is a greater factor in influencing growth; second, that with ample available plant food, plants are much aided in that all important continuous growth that brings the big yield; third, that thinner seeding for the more ideal seed bed that is supplied with a liberal amount of available fertility is of great importance. The story also brings out the interesting fact, that

there are many things yet to know and study about timely tillage.

WHY THIS REMARKABLE STOOLING AND GROWTH?

Just a little discussion as to why this remarkable growth and stooling may be obtained under such soil, moisture and climatic conditions, as we have endeavored to represent. We fully appreciate that we are wading into a subject the facts of which are not known to anyone, in fact the most persistent investigator does not know. It is just the same as in dealing with electricity, no one knows what electricity really is, yet we do know that by certain mechanical devices we can rely upon specific results, in which we have every reason to believe in fact, say we know, that so-called electricity does this, or does that, and is a controlling element. So too, in discussing the growth of all plants we do not know just what it is. Yet we have found that by certain mechanical work under certain soil conditions combined with a certain per cent of air and moisture and with seemingly certain amount of heat, that we do get certain specific marked growth in plants, and for the want of better words to explain, after studying the question carefully, we refer to bacterial and chemical action as the means of bringing about or increasing the elements which promote that marked growth of the plant called fertility or plant food. In going into the details of the How and the Why, we have purposely kept out of chemistry and dealt almost entirely with the physical or mechanical condition of the

soil combined with the utility of air and water and the tillage or mechanical work necessary to bring the results in the most economical manner, as we now understand these questions after 35 years observation, thinking and experiments.

The following facts must be recognized by the average farmer, when the seed bed in a field is fairly fine and firm and carries a high per cent of moisture or what is properly termed capillary water, which indicates that each soil particle is enveloped in a thin film of water while the minute spaces between carries air and the surface is covered with a coarse loose mulch to protect or preserve this condition and the season is advanced far enough so the soil and atmosphere is warm, the plant makes a very rapid healthy growth. Why?

Our position is that with careful summer tilling in localities of light rainfall, that with soil conditions obtained that is indicated in Cut No. 10, and this uniform firm soil becomes warm, the seed after being deposited in such soil quickly takes on growth as soon as it germinates, and the single stem with its leaf is up as indicated in the cut, the soil moisture, temperature and plant food is so favorable that the rootlets shoot out among the soil grains, branch and multiply very rapidly, and each little rootlet sends out a mass of little hair roots for feeders and the elements or food is consequently gathered in, in very much larger quantities than the little lone stalk and leaves can utilize or assimilate. This plant food as taken in must, however, materialize somewhere in some

form, therefore, the additional suckers or stools as shown in the other end of Cut No. 10. These suckers will keep increasing until the surface of all the foliage originating from the one stool is sufficient to take care of all moisture by direct evaporation that is taken in by the rootlets.

Cut No. 11 shows not only the ideal seed and root bed with its liberally stooled plant, but the less favorable or coarse seed and root bed under which condition germination and root growth is very slow. Not only is it slow but the little feeders along the outside of the roots in coarser, looser soils are far less in number. Plants under similar conditions will stool very little if any, because the two or three leaves can utilize or assimilate all the few rootlets can gather in. Now as you vary from the fine perfect seed bed shown on one side to the coarse, imperfect condition on the other or from the coarse to the fine you change the growing and stooling tendency of the plant.

INFLUENCE OF IDEAL CONDITIONS

In addition to the physical condition of the soil and the soil water, is the available plant food. Each one of the three have their respective influence upon the stooling and growth of the small grain plant. First, is the carefully prepared seed bed with the loose mulch, then comes the accumulation of the proper per cent of moisture and as the soil becomes warm the bacterial or chemical action then sets in which develops the fertility. Where well directed spring or summer tilling has been carried on as experience indicates and our

illustrations show that a much more favorable condition exists and a greater amount of plant food is available, therefore, a still greater stooling and growth. Study well the specific design of Cuts No. 10, and No. 11, and grasp what they really represent. No. 10 illustrates the effect of an ideal soil condition on growth, and No. 11 gives a contrast of the influence on growth of roots and plants of both ideal and the poor fitting of the seed bed.

CHAPTER X

SUMMER TILLING FOR WHEAT

Under the heading of "Preparation Before Seeding", we have discussed at some length summer tilling in a broad sense, but in this chapter we wish to cover it with relation to winter wheat and much more in detail.

Summer tilling is handling the field from early spring to time of fall planting in a manner not only to gather and store the rain water as it comes, but to improve the soil and bring it up to a high state of physical condition for increasing the available plant food.

As first outlined years ago, summer tilling was only intended for wheat growing and more especially winter wheat. But we have found that similar principles, with some modifications, and previously referred to as Spring Tillage, are admirably adapted to the plan of growing corn, cane, broom, millet, potatoes and similar crops,

In applying the labor for summer tilling, as previously explained under the heading "Preparation Before Seeding", we have verified the truth that correct principles in the preparation of the seed and root bed is a long stride forward for growing good crops in any season in the semi-humid sections, but to complete the success it must be followed by timely seeding and the right quantity per acre.

The first step in summer tilling, as previously explained, is to double disk the land as early as soil conditions will permit. This may be done with a single disk by lapping half and letting the outside disk of the next round fill in the center or dead furrow made by the previous disk. But by far the better plan is to use the tandem or double disk shown in Cut No. 22. It is much easier to regulate the depth and a more uniform job can be done with less expense.

LOOK OUT FOR BLOWING

It is not desirable, as a rule, to disk deeply, especially the first time over early in the spring, for the reason that if it becomes hot and dry and frequent high winds prevail, the early disked field might begin to blow if the land was sandy and more especially so if the land had been farmed in a somewhat careless manner for several years, in which case it becomes loose and dead.

Soil not only becomes dead by untimely and incorrect tillage but it can be kept alive by correct timely work. If you have not disked deeply on the start it is very easy, should it start to blow,

to stop it by disking again and cutting half or three-fourths inches deeper. This turns a little of the moist firm soil just beneath the mulch on top, and by going at right angles with the wind, the blowing can be stopped. We have done this and completely succeeded in the face of a very high wind, and still held the top against later winds as the strips of live moist soil laid on the top by the disk do not fall apart, but resist the wind like small clods. Quite sandy soil cannot, however, be safely summer tilled.

For fall seeding the spring disking should continue from early spring up to the first to the fifteenth of June, then plow, and if the land has been cropped several times plow six to seven inches deep and no deeper. But as referred to in Class 4 of the "Suggestions", do not allow the land to remain long after plowing without using the sub-surface packer or the disk harrow set straight and well weighted to help fill up the open spaces in and firm the lower portion of the furrow while it is still moist.

THE PROBLEM OF WEEDS

After plowing and sub-packing, the surface mulch to the depth of 2½ to 3 inches should be kept loose but not too fine. Every possible precaution must be taken from this time to keep the mulch the same depth and allow no weeds to grow. The weeds must be kept out and if they are kept out and the surface continuously loose, big crops will follow, but a few weeds will make from 10 to 15 bushels difference in the yield of

winter wheat, and more and bigger weeds will cheat you out of 20 to 30 bushels, as repeated experience has shown. Suitable tools for this kind of work are not available, therefore, the task of keeping the weeds out with such tools as we have is not an easy one. It is hoped, however, that some day the real merits of summer tilling as it is now understood will be sufficiently appreciated to demand proper tools, but so far there have been so many failures because of the many mistakes that the interest in waning, a most unfortunate fact in the face of what we are giving you in this book, and the many similar big yields during the past fifteen years. What one can successfully do another should do if he really knows how.

As proof of our assertions regarding the cost of weeds, please note Cut No. 37. Here are two stools of wheat from the same summer tilled field. A part of the field was kept clean of weeds, a part in spite of conditions and reasonable efforts became somewhat weedy. The weedy part of the field was plowed first and the balance immediately following, same care was given to the entire field in plowing, packing and cultivating up to seed time, then to make conditions apparently all the more alike, the night following the seeding $1\frac{1}{4}$ inches of rain fell over the entire field. Forty-three days after seeding the stools of wheat, shown in the cut referred to, were pulled. The larger ones from the field kept clean and selected as an average sample of the stooling shows 20 stools or stalks; the smaller ones from the part that was

weedy averaged only 6 stools, but these weeds were turned under in early July, and from the plowing to the pulling of the sample stools no more weeds had grown, 45 to 49 days after plowing the seeding was done, and 43 days after seeding or about 90 days after the weeds were plowed under we observe this wide difference in growth and stooling. Is there anything in tillage? Certainly if you know how.

The weeds in this case had probably grown sufficient to reduce the moisture prior to plowing to the degree that the chemical or bacterial action was largely checked, therefore, less available plant food. Also the moisture was probably reduced to that degree that when the plowing was done the soil did not settle down as closely when the packer was pulled over the field, therefore, more openings or spaces were left in the seed and root bed.

EFFECT OF RAINS ON SUMMER TILLING

The coarser the mulch over the surface is kept, the less packing of the mulch by the light rains, and the more of the rain water soaks down below. This coarse mulch is best obtained by the tandem disk and if the disk manufacturers would put carrying wheels on these tandem disks, so we could regulate the depth by these wheels and still leave the disk sections set at such angle as would do the best work, a much more complete destruction of the weeds would be possible without cutting so deep as to destroy the seed bed.

The difficulty of the fine mulch is brought out in Cut No. 9. When the mulch has been so handled

as to become very fine or dust like, it takes little rain to settle this top very solid and should the rain be sufficient to settle the entire depth of the mulch, a few hours of sunshine and you have a dense crust, out of what should be your mulch, a very unfavorable condition. Therefore it must soon be again loosened.

On the other hand, if the mulch had been kept coarse, especially on the top, as shown in Cut No. 8, the light showers have very little effect and as previously stated the coarse mulch is by far the most economical, for it requires less frequent work and takes in more moisture, in fact several modest rains might fall without seriously effecting the protection effect of the mulch, and it is more effective in preventing loss by evaporation at all times, than the dust mulch.

ADVANTAGE OF THE PACIFIC COAST IN SUMMER TILLING

On the Pacific coast little or no rain falls in the summer time, so the serious packing effect of the summer rains are eliminated, but the weed question is even more serious and for best results must be kept out. The coarse mulch, however, is quite as vital in holding the moisture there also.

CHAPTER XI

AMOUNT OF SEED WHEAT PER ACRE

The question of how much seed wheat to sow per acre is a very broad one and needs much consideration. The mechanical and physical condition of each field as previously explained must be considered almost by itself, as regards the quantity of seed. Years ago, 60, 75 or 90 pounds of wheat per acre was the universal practice with no regard whatever as to the soil condition or location. There is no doubt in our mind, after fifteen years of study on the relation of soil conditions to the quantity of seed and the final crop yield in any and all kinds of seasons, that in many cases the 50 or 60 pounds of winter wheat seed has been directly responsible for the low yield or failure in seasons where hot, dry periods have come within the last six to eight weeks of the growing season and where the field has been well fitted.

We recall distinctly in 1912 a field containing about 20 acres that was summer tilled northwest of Indianola, Nebraska. The summer tilling was well done and the seed sown early in September, 60 pounds of winter wheat per acre, on a theory that a field in such fine condition would stand it. Early in the spring this field was deservedly commented upon very favorably. It was the first to show growth and was very thick and color good, and as both 1912 and 1913 were unfavorable years, because of light rainfall and excessive heat, the average winter wheat field under ordinary

treatment in early spring did not have a very encouraging appearance. But early June was reached with continued hot, dry weather and the grand prospect of this summer tilled field was soon blighted. It required too much moisture to keep up the growth of so much foliage. It was really the first field to show firing and never produced one bushel, and was heralded far and wide as evidence that summer tilling was a failure. Had 20 pounds of seed been sown per acre there would doubtless have been a good crop matured, as evidenced by the summer tilled field at Stratton, Nebraska, 45 miles west of Indianola. The Desens field shown in Cut No. 33, was grown the same year and a 33 bushel crop matured, due very largely to the lighter seeding following the good tillage. But had the Desens field been seeded with even 45 pounds under the conditions that existed it would have resulted in little or no crop.

We have endeavored to show that the more perfect the seed and root bed the less seed should be sown. Then again, in case of fall seeding, the later you put in the seed the more seed is required. The stand in the spring must not be too thick; then again, if too thin it cannot bring a good yield. This question can only be settled by close observation and experience. It is however a vital one.

FALL SEEDING SUMMER TILLED LAND

We will assume that summer tilling has been well done by the plowing being done early in June and weeds kept practically clean from the field

and location north-east Colorado, we would seed promptly September first, with 18 pounds of good plump seed.

If however, the plowing has been later and the seed bed has not been favored with fairly good rains more seed must be sown, possibly 25 pounds per acre. Good judgment as to its possible stand must be exercised and can only come from close attention to details.

THE REMEDY FOR TOO THICK STAND

In case of too much seed followed by liberal stooling, the field should be single disked in the spring with disk set at a sufficient angle to destroy enough to bring the stand down to proper amount. You cannot do one part of the work of summer tilling correctly, and some other part wrong and get results. Every part of a telephone, phonograph or automobile must be rightly adjusted and in its place or it is a failure. So, too, in growing good crops in the semi-humid sections, quantity of seed and time of seeding must be as carefully considered as tillage.

FALL SEEDING ON FALL TILLED LAND

Where wheat follows wheat on fall tilled land, more seed is needed, but if a good, fine, firm seed bed has been obtained and a fair amount of moisture in the soil, 30 pounds is ample in case of early seeding. If however, you have very little moisture, early seeding on fall fitted land is not desirable, for too much growth and no fall rains

might exhaust the moisture to that degree that winter killing might be the result.

Plenty of moisture in the soil in the spring to draw the frost from the roots in late winter or early spring thawing and freezing is proof against, so-called, winter killing which in reality is spring killing.

SPRING WHEAT

In seeding spring wheat, about one-third more wheat is necessary than for fall wheat in fairly early seeding, and possibly one-half more seed in case of late seeding on well fitted land.

Much depends on the physical condition of the seed and root bed and whether the land was fall or spring plowed, the real point being whether the wheat stools liberally or not, which is governed by the degree of care in fitting the seed bed and the available moisture and fertility.

CHAPTER XII

DISKING AFTER THE HARVESTER

Cut No. 21 shows a very economical way of harvesting wheat and double disking the land at the same time with a tandem or double disk harrow. No matter what crop is being cut, this disking we have always found of great value. J. M. Moyer, Yuma, Colorado wrote under date of October 4, 1915:

"Have just made examinations regarding moisture conditions in several fields. I find in the

stubble fields untouched the moisture is nearly all gone, while in stubble fields that were double disked after the harvester, I do not strike dry ground at 72 inches, the length of my auger; but I do not find as high per cent of moisture in the disked stubble field as in my summer tilled fields. I also find the native sod dry from the top down. This wide difference in face of the fact that $6\frac{1}{4}$ inches of rain fell in August and $1\frac{1}{2}$ inches in September is certainly very interesting."

While many farmers have learned the value of early spring disking yet very few practice disking after the harvest. In the average midsummer season over the semi-humid sections, the practice or non-practice of double disking after the harvest means almost the difference of success or failure when the following crop growing season is similar to 1913 or 1914. As previously stated there is no time that your soil is improved to as great a degree by keeping it moist as in July, August and September.

Some seasons heavy rains follow the disking. If a very heavy stubble has been disked into the top soil these rains have very little detrimental effect, but where a short and somewhat thin stubble is disked in, a fairly heavy rain will not only settle the mulch but cause weeds to start much quicker. In this case disking again is important and if done before the weeds get any size they will be practically eliminated. Single disking the second time will do a very good job if a bull tongue is attached to the disk harrow to tear up the center or ridge between the two sections to

leave this ridge to dry out is very wrong, but double disking is much better. The advantage of this disking is four fold. Keeps the weeds from growing, holds the moisture in the land, causes much more of each subsequent rain to go into the soil and permits of easier and better plowing.

CROPS AND THE SOIL FERTILITY

The question is often asked, and rightly, do continued big crops deplete the soil of its' available fertility more than small crops?

Theoretically, possibly yes, but practically we are in doubt when applied to the semi-humid sections, providing good and well directed tillage is carried on. Just look at Cut No. 29. Note the even stand above the top wire of the fence, then think that it averaged 45½ bushels per acre of 62 pound wheat, then glance at Cut No. 21, where this same field is being cut, then realize that the snarled up stubble in the foreground has had a tandem or double disk pulled over it with weight enough on the disk to force the blades three inches into the soil, and you can grasp some idea of how much organic matter is available to be worked into the soil. It is not only this long heavy growth of stubble, but the immense growth of roots that must have permeated the top soil in growing this wheat. Then look at Cut No. 25 or Cut No. 27 and think how much stubble would be left to plow under when each crop was harvested, also the difference in root growth. Do you grasp the significance of these facts?

If you can keep up the organic matter in the

soil, from which the humus is derived, may it not be reasonable to expect continued good results, with the right kind of timely tillage?

In plowing under such stubble as is shown in the disked field referred to, for best results, the soil should be moist and plowed fully 6 inches deep with a moldboard plow that will turn the furrow completely over burying the stubble in the bottom, then follow with the sub-surface packer well weighted. This combined condition and work will pack the soil onto the stubble and so fully obliterate the air spaces that decomposition will soon take place especially if plowed early when the soil is warm and just as soon as the cell structure of the stubble begins to break down and the decomposing bacteria get busy, your condition begins to improve.

CHAPTER XIII

CANE FOR HAY AND SILAGE

That the feed value per ton of cane hay depends very much on the time of planting, condition of the land when planted, and the time it takes for the crop to grow, there can be no question. With a number of experiments in 1913 and eighty especially handled fields in 1914 compared with a hundred or more planted in the usual manner, and over a hundred experiments in the wet season of 1915, this question is certainly a most interesting one. We saw a number of

cane fields in the somewhat drouthy year of 1914 that made five tons of choice, high quality cane hay right beside other fields that made only about a half to a ton per acre of poor quality.

CANE HAY A VALUABLE CROP

The smaller yields were invariably from early planting from the fifteenth of May to June tenth, while the larger yields were mainly planted from July 5 to 17, on carefully spring tilled land. See Cut No. 3; here are two fields adjoining grown by R. Crook, Wilsonville Nebraska in 1914. The front field planted May eighteenth, produced about half a ton of low grade hay per acre; the rear field planted July fifteenth made five tons of fine quality hay per acre, the direct result of careful spring tillage as previously explained. Here in this field is a most interesting and broad lesson, at the time the photo was taken the early planted was dead and brown while the rear one was rank and green and only just beginning to head. The feeding value of the later planted on carefully spring tilled land in all the experiments was invariably the highest.

SPRING TILLING FOR CANE HAY

The preparation of the land for cane hay should be along the same plan as outlined in "Spring Tillage For Corn", but the careful tillage should be continued three to five weeks longer before planting. There are three important advantages found in this continued careful cultivation before planting for the production of cane hay:

First. By beginning early and continuing on through to some date from June 25 to July 20 (depending on your location) you will not only retain the moisture that you have in the soil from the fall and winter rains and snow, but you can with proper care add to it practically all the spring rains up to the time of planting; thereby, having more available moisture from the time of planting to maturity than if planted earlier. See Cut No. 44, eight acres of cane grown by August Desens, in the drouthy year of 1914, spring tilled up to July twenty-seventh, drilled in with a common grain drill, 30 pounds of cane seed per acre, photo six weeks later at which time the cane had not reached its full growth by fully 10 inches. This field yielded fully 6 tons of hay per acre. At the time this was planted many adjoining fields planted in early June had already begun to fire. One field across the road drilled in June fifth, was then drying up and made between half and three-fourths tons per acre including Russian thistles.

Second. If the seed and root bed is made firm and fine in the early work and the surface kept loose and clean of weeds, a greatly increased amount of available fertility will be accessible to the rootlets of the young plants. As previously outlined, this coupled with warm soil and a fine, firm, moist seed and root bed will promote an exceedingly rapid growth of the plant, and a quick grown plant is more tender and has less crude fiber.

Third. By delaying seeding until some date

between June 20 and July 20, depending on altitude, and to some extent on latitude, you secure a warmer soil in which to start the young plants. The higher the elevation the nearer you should come to the earlier date. As a basis for a planting time date we would say that in the central part of Nebraska and on the Kansas line, we should plant July twentieth on carefully spring tilled land and slightly earlier as you go northward and rise in altitude in proportion to the seasons' changes. By this time the soil is thoroughly warmed and a greater amount of fertility is available. This coupled with ample moisture will bring about the quick germination and a rapid root growth followed by continuous growth of the plant which means tender, succulent and palatable fodder that is hard to excel and all stock eagerly eat it. Hogs as well as cattle indicate great fondness for it when well cured.

HOW TO PLANT CANE SEED

For cane hay, we would put the seed in with a common grain drill. The land should be plowed by the fifteenth of May, and the surface kept loose and free from weeds. By close attention to holding the moisture up to plowing, the soil will be moist and in better condition to plow. The plowing should be five to seven inches deep, depending on the number of years the field has been cropped, and the plow followed closely with the sub-surface packer. If no sub-surface packer is available, use the disk harrow set straight and well weighted. From this on to the time of seed-

ing, the surface two and one-half inches must be kept loose and somewhat coarse and no weeds allowed to grow. The more carefully this part is carried out the more life is discernable in the soil and a proportionate ranker growth of the cane is noticeable.

QUANTITY OF CANE SEED

To increase the certainty of continuous growth under ideal conditions, and anticipating the possible drouth later on, 30 pounds of black amber cane seed per acre is ample. See Cuts No. 3 and No. 44. The rear field in Cut No. 3, also the field in Cut No. 44 were sown with 30 pounds of seed per acre. The seed should be dropped just into the top of the firm, moist soil. Be sure, however, that you have good seed and that your seed bed is firm and mulch not too deep.

CANE FOR THE SILO

Cane for the silo should be planted in rows and cultivated. If put in with a lister, plant about three to four weeks earlier than for cane hay as above outlined, and if surface planted with a corn planter, plant five to seven days later than with lister, and apply the same early disking and careful handling before planting followed with timely tillage afterwards. Cane for silo should be more mature than for hay; in fact it should be headed and seed nearly matured, but the same continuous rapid growth is desirable.

See Cut No. 45. This cane was grown on the H. O. Ranch near Madrid, Nebraska in 1914,

a dry, hot year. This field was very carefully summer tilled up to June twentieth, then the seed listed in rows three feet and four inches followed by careful cultivation. The entire 40-acre crop was put into two large silos and figured up $8\frac{1}{2}$ tons of ensilage per acre, fully double the amount ever grown before on this ranch even in good years. One near by field did not produce one-sixth of the amount of feed. It was planted only about three weeks earlier but on land not early disked.

When such crops of number one cane hay can be grown in a drouthy year like 1914, as are shown in Cuts No. 3 and 44, and a few fields in 1913, with the numerous marked yields in 1915, the question of good feed for stock in ample quantities need not worry any one if he will adopt the plan outlined. Just what this means to the semi-humid country may be more fully realized when we call to mind the fact that a number of farmers were so short of feed some seasons within the past seven, that they were obliged to sell a part of their stock for the want of feed to take them through, and one season especially any ordinary quality of hay brought $20.00 per ton. then to realize that such crops of cane hay as are shown in Cuts 3 and 44, could have been grown just the same that year as in 1914, and the crop would have been worth $100.00 per acre. Is there any real value in knowing that this can be done and how to do it?

CHAPTER XVI

KAFFIR CORN

In Cut No. 42, is shown a fine growth of kaffir corn planted by Mr. Moench, at Orleans, Nebraska on July 14, 1914, on spring tilled land, photographed August twentieth, 36 days from planting and 36 inches high. This field made a very marked growth and was fully 70 inches high when harvested.

Cut No. 43 is another very interesting result in spring tilled land at Norton Kansas, grown by Mr. Arthur Saum, planted July tenth and photographed August twenty-fourth, 42 days after planting and 52 inches high a very interesting field of kaffir corn.

Kaffir corn is supposed to be something of a drouth resisting plant, from the fact of its habit of closing its doors to any growth during its early stages when the moisture is almost gone. Then if the rain is not too far away, when it does come the kaffir plant makes another attempt to grow; but its growth after such dormant or hibernating periods is never very great. In these two and about a dozen other fields similarly handled we observe a very rapid growth, but in no case quite equal to the amber cane, although a similar degree of eagerness by cattle and horses to eat it as against the slower grown or more stunted plants was reported in all cases, indicating the advantage of the quick or forced grown plant.

CHAPTER XV

HOG OR BROOM CORN MILLET

Cut No. 41, shows a field of hog millet grown on the H. O. ranch, Madrid, Nebraska. This was seeded July 10, 1914, photographed August, fourteenth, 35 days from planting and is three feet high and headed. It is known in the central west as hog millet, doubtless because of the feeding and fattening value of the grain for hogs. It seems to have a place in the dryer portions of the semi-humid sections as it possesses some interesting characteristics.

First, its grain when mature has nearly the same feeding value as corn.

Second, it will grow and mature a crop of seed in the shortest time of any grain plant known. We have seen it cut with perfectly matured seed in from 43 to 55 days.

Third, it is a heavy yielder when conditions are most favorable. We have known of numerous yields of 75 to 85 bushels per acre and one yield of 100 bushels per acre, on a basis of 50 pounds per bushel, but the seed when fully matured weighs fully 60 pounds to the measured bushel.

We know of a number of farmers who are growing it for the exclusive grain in fattening hogs in the higher altitudes.

Spring tilling up to the time the soil is thoroughly warmed by early summer heat, is the proper procedure; then drill with the common grain drill, about 20 pounds of seed per acre.

A little explanation of the habit of the plant will clearly show the vital importance of a certain soil condition for sure results.

If the seed bed is fine and firm and has been held in a uniform condition for three to four weeks by spring tillage before seeding, then after the seed germinates a small but vigorous system of roots form. Next a stem reaches the surface and immediately a crown is formed right at the top of the loose soil and the leaves begin to form. When the third leaf appears, roots begin to start from the bottom of this crown to go down into the soil. If by chance there is two inches or more dry mulch on top of the moist soil, these roots find difficulty in reaching the moist soil as it seems to be too far to go without moisture and not infrequently the plant withers, as the tiny thread that supplies the elements of growth from the original roots below to the crown cannot support the plant. If, however, there is not more than one inch of loose soil or a rain happens to fall and moisten the mulch, these roots soon get busy in the moist soil and very rapid growth of the plant follows. Therefore, a little extra care in fitting means many bushels difference in yield. We saw fields in 1914 that were entire failures because of a deep mulch and a prolonged period of hot, dry weather.

CHAPTER XVI

THE GARDEN

A good farm garden is the admiration of everybody, not only the beauty of a variety of rank, healthy growing vegetables, but there is so much palatable, healthy food to come from it that one's mouth almost waters, as he thinks of the many good dishes to be made from the crop of radishes, lettuce and young onions, melons and tomatoes, cauliflower and cabbage, beets, parsnips, carrots and many other equally desirable roots.

All these things are easy if you will have a little system in doing the work. Begin early every spring and spread a rather modest coating of well rotted manure evenly, very evenly over the surface and disk it in, cutting 3 to 4 inches. Then plow about 7 inches, turning your furrow as evenly as possible and completely bottom up. After plowing begin harrowing and harrow it several times before it has had time to dry on top and become cloddy. Every time it rains watch it; don't harrow too wet, but don't wait too long after the rain. Harrow just to loosen the top and keep up this plan. Don't let the weeds grow.

With the exception of a few radishes, lettuce and onions which may go in early for early use, don't plant until the soil is warm.

Early planting of the garden is an old rule that has come down many generations, but if you want nice, crisp, tender, sweet cucumbers, melons and vegetables and plenty of them, try the early spring

tilling act and delay your principal planting until the soil has a warm life-like feeling.

However, while you delay your planting, don't delay the cultivation. Absolutely keep the top 1½ to 2 inches loose, then after planting keep it timely cultivated. Thin out the plants; don't leave them too thick.

Put all your rows just far enough apart to admit cultivating with a horse.

One year of persistent work along these lines and you will get the habit, for there is nothing nicer than these garden crops when tender and sweet, and nothing aids these qualifications so completely as to grow them quickly. Note Cut No. 47. This picture does not do the row of pie plant justice. There are leaves in this bunch fully 16 inches across and stems 2 inches through at the bottom. Some well rotted manure and good tillage did it. Is there anything nicer than tender quick grown pie plant for pies or sauce in mid-summer? This field is only a short distance from northeast Colorado.

CHAPTER XVII

TREES ON THE FARM

Anyone living on the farm in the great plains country knows the pleasing as well as the intrinsic value of trees around the home. A small, well-located and well-groomed grove about the buildings on the farm, lends enchantment not only to the occupants of the home but to the passerby. They add many times their cost to the real value of the farm; in fact strong, healthy trees lend value to all adjoining lands. This is true because of the altogether too common idea that trees cannot be successfully grown or at least four to six years is the limit of their life in all semi-humid sections. Fortunately there are now many groves ten to twenty years old that fully disapprove this idea.

Trees, like corn, wheat, vegetables and many other crops, will not grow and thrive where conditions are such that they cannot. The reason many groves and orchards have failed in much of the semi-humid country is the same reason that some of the crops have failed. Take for illustration Cut No. 25. Here is a piece of wheat grown in the very wet year of 1915, what is the difficulty?

There are certain elements that produce a very rank, healthy growth that are not available until certain soil conditions exist, these conditions are not natural, they must be artificially produced by mechanical work and is most beautifully illustrated by that old adage. Cultivation is manure,

indicating in a broad sense that cultivation makes the plant grow.

A glance at Cut No. 24 and you have the counter effect of 25. Here an artificial combination of conditions has been mechanically brought out, which utilized other natural resources with the result of nearly four times the growth.

The farmer should no longer go blindly into these things; he must grasp the Why, then the When and then the How.

Just a glance at the trees in Cut No. 6, Carolina poplars. Note the uniform healthy growth, five years of good, timely tillage has done this. Observe that the surface soil is not fine and there are no weeds. The same fact is borne out in Cuts Nos. 4, 5, and 7, we personally know of several other groves and orchards equally good.

PREPARING FOR TREES

In starting shade, ornamental or fruit trees, especially in the sections of lighter rainfall, it is time gained in the end to summer till one entire season, following about the same plan as laid down for fall wheat as to time of plowing etc. The greater care you take of the field the greater will be the degree of success. Weeds must be kept out just the same.

PLANTING THE TREES

As a rule the best time to set the trees in summer tilled land is the following spring when the ground begins to warm. Early and careful tillage is also important. Should your trees come to you early

in the spring be sure to heal them in that day. A trench with the north side sloping about 45 degrees is best. Make the depth in proportion to the height of the tree.

Take the trees from the packages and lay them in the trench tops to the north and cover roots, body and into the branches with moist dirt. After the roots are well covered turn in just enough water to dissolve the dirt and settle it well into or among the roots, do not let the small roots get dry in handling.

Do not dig the hole until you are ready to set the tree, then dig one just large enough to take in the roots, and deep enough to let the tree in about three inches deeper than it stood in the nursery. Do not use water very liberally in setting the tree, just enough to disolve and settle the dirt well in among the roots.

In filling the hole after setting the tree, the roots should first be covered and water applied; the dirt should be well firmed up to within three inches of the top then filled with loose dirt.

If your tree is healthy it will sure grow. Then comes the tillage which is done much as you would cultivate corn. Upon the time and the kind of cultivation from this on, depends the rapidity of growth and healthfulness of the trees. Shrubs, roses and almost any annual can be made grow and bloom prolificly with this same treatment. It is always well to protect the body of the tree the first spring by wrapping loosely with stiff paper.

SMALL FRUIT

The same plan outlined for trees applies to currents, gooseberries, blackberries, raspberries, and strawberries, and if you observe closely the points referred to at the commencement of this chapter, there will be no question as to the success. To successfully grow these small fruits and flowers but little time is required if the work is properly applied at the right time. Just want to and it's easy.

BREAKING SOD FOR CROP

There is very much in the manner of breaking sod for crop, especially wheat. Early breaking is desirable but the soil must be moist for best results. The most economical way is to break about four inches deep and use every possible precaution to have all furrows even in width as well as thickness, then follow as closely as possible with a heavy roller to settle the sod down flat, and press out all air spaces below. This however, cannot be successfully done if the sod is allowed to dry while kinked. After the rolling the top should be double-disked about half the depth of the breaking. In midsummer it will probably be necessary to double-disk again to keep the top loose and keep down the weeds but do not go any deeper than the first time.

The special points referred to are vital, the point being to get the lower part as firm as possible and keep the top or mulch loose to aid in keeping the moisture, and keep the weeds out at all hazards throughout the season, when you will be

able to have an ideal seed bed liberally supplied with available fertility under which conditions either fall or spring seeding will start off under favorable conditions.

The old plan was to break thin, then backset about as much deeper. The above plan is more economical and will bring better results if strict attention is given to details.

CHAPTER XVIII

THE SOIL AUGER IN TILLAGE EDUCATION

Of all the details in soil culture, none are more vital and yet less understood than the utility of soil water. Water is wasted by the average farmer and we all know that water is the factor so much needed to bring us a good crop. We look for the rain; we hope for it; we long for it and pray for it; yet when it comes we allow a large per cent of it to go to waste and seemingly with no concern whatever, as to its utility and enormous value. We make no preparation to receive it. We put forth little effort to store and conserve it. Why are we all so lax regarding a question of such vital and universal importance? Because we have not been educated along this line. We are too much inclined to look to and trust the heavens for sufficient and timely rain.

THE SOIL AUGER, WHAT IT WILL SHOW YOU

There is no implement so little used on the farm and yet so capable of conveying a wider scope of

valuable information and practical assistance as the soil auger. It's intelligent use will disclose much of the folly of our past efforts. With a few minutes time and a little well directed effort on your part, the soil auger will clearly show you how deeply the moisture has percolated into your soil in the spring. With a little investigation and thinking you can see why it has gone deeper into some fields than others, a fact that if understood quite clearly, explains why certain things should or should not be done. It will show you how much real working capital you have on which to begin your season's work and where it is.

It will show you with surprising correctness how fast this money making moisture will get out of the soil during the early spring days if you leave the packed surface uncultivated. Once allowed to go in this manner it is like money foolishly spent, "lost forever".

The auger will show you how much more moisture the under portion of your plowed land will hold if well packed than if left loose. It will show you how the roots of your wheat, oats, barley and other small grain feed from the top of the moisture first, and how the roots then go down deeper for moisture as it is gradually used up at the top, during the excessive hot weather without rain. During the exrtemely hot June of 1913, by using a soil auger we found wheat roots which had gone down over four feet. If you do not have it stored down there the roots can't get it.

It will show you how completely you hold the

moisture just beneath the soil mulch if you cultivate just often enough and at the right time, and if used with persistent, close observation, it will indicate when to cultivate to retain the most moisture.

It will show how much faster a thick stand of wheat or other small grain will take the moisture than a thinner stand. It will not only show you, but will convince you with ample evidence what the right kind of soil tillage at the right time means to your crops and to your bank account.

KIND AND SIZE OF AUGER

There are special soil augers made, but the common wood auger of one and one-fourth inches in diameter with stem lengthened to about five feet long is all that is necessary for practical purposes. Cut off the little screw at the lower end and file or grind off the upper lips and you will find it easier to operate. If you have good soil and plenty of moisture down five feet in any average season, it makes little difference what is below.

HOW TO BEGIN

Remove the loose surface soil, and as you begin boring do not crowd the auger. On the contrary hold the auger back so it will cut lightly at each revolution giving you a smooth hole full size, and permitting the auger to be easily pulled out, as you go deeper, without tearing the top. See Cut No. 48. Go about four inches each time or until the pod is full.

WATER HOLDING CAPACITY OF THE SOIL

Some comprehensive knowledge of the different soil formations and the relation of their texture to their water holding capacity is quite important in planning for your crop and work. Therefore, they should be carefully studied. Know your soil and how to use it. This will all come to you through the use of the soil auger and a little careful thinking. Soil of a fairly fine texture will hold more moisture per cubic inch than a coarser soil. For illustration, a given amount of moisture might percolate eight inches in a fixed length of time in a fine texture soil containing no sand, while in a coarser soil containing some sand it would percolate twelve inches in the same length of time. In a still looser and coarser soil, the water might percolate eighteen inches. The depth at which the moisture is found in your soil, however, does not always indicate the amount of moisture there is in your soil available for plant growing; neither does the fact that the finer grained and more compact soil carries a higher per cent of available moisture in each cubic inch indicate that it will carry the crop a longer time without rain unless you play your part well. Quite often this finer textured soil with its higher per cent of available moisture will, in a well prepared seed and root bed, promote more stooling and a ranker growth of the plant, thus requiring more moisture to keep up the daily growth than the coarser soil that carries the moisture down deeper and faster, in which the return by capillary attraction is

also slower. In this coarser soil there may be less stooling. Consequently the total plant foliage would require less water and would exist as long or longer than the plant in the fine textured soil though there is less moisture per cubic inch in the coarser soil.

The tendency of all grain roots to go deeply after stored moisture during prolonged dry periods is the main reason why plants do not wither as quickly in a sandy soil as in heavier, finer textured soil upon which the same quantity of water has fallen. The finer texture soil requires much more watchful care and judgment as to the time and manner of cultivation than the coarser, more sandy soils. However, this careful extra care, if intelligently applied to these finer soils, brings greater returns in the end.

WHEN TO USE THE SOIL AUGER

Make borings early in the spring as soon as frost conditions will permit in all your different fields. Then observe by later borings the difference in the amount of moisture you have held where you have double-disked and otherwise cultivated the ground as compared to a field that has not been cultivated. Make frequent borings after rains for three or four days to observe how this moisture percolates into the ground in different soil conditions and at different grain growing stages. Observe the difference in the depth that a fairly heavy rain will percolate into the soil that is already moist to a considerable depth, as compared to the soil that is practically

dry. Make frequent borings in your thick or thin stands of wheat and other grains and observe how much longer you have apparent available moisture with the thinner stand of wheat than in the thicker stand on the same type of soil. This, however, does not refer to wheat so thin that weeds are growing where the wheat should be. You must be sure that the thickness of the wheat is the only veriable factor, before drawing conclusions. Remember also that a very thin stand does not protect the moisture by shading as does the stand that just covers the ground.

Bore in your summer tilled fields and in your adjoining fields and observe the difference in the per cent and depth of moisture you are carrying in your summer tilled fields as compared to other fields that are carelessly handled or are growing crops. Observe carefully the amount of moisture in the very top of the firm soil under the mulch when the surface has been frequently stirred or cultivated as compared to land that has remained a considerable length of time without cultivation. Observe the advantage of the coarser mulch in holding the moisture as against the finer dust-like mulch. This you will find very marked as you reach the more heated part of the season, and especially if a crop is growing. Notice the difference in the amount of moisture in the thick and thin stands of corn under the same conditions. The difference will be more noticeable after the corn reaches the tasseling stage. Above all do a little careful thinking as you observe these conditions, for as you become more interested you will

more readily appreciate how many more things there are to know, and how many things you really did not know.

EXAMINING THE SOIL AND ITS MOISTURE

If the auger is used with care and thought, you will soon learn just how to use it and how to obtain perfect samples of soil. Then with a little careful practice you will soon learn how to judge your soil moisture for all practical purposes. See Cut No. 49.

You will at times find some soil so dry that the soil particles will not cling together, under which conditions it is difficult to lift the soil with the auger from the hole without a sudden jerk. Such soil has practically lost all its capillary or available moisture.

When there is moisture enough, the soil particles will cling together until you lift the auger from the hole, and as you tip the auger over it readily falls. Such soil has considerable available moisture left.

Another degree of moisture is when it sticks together until you have to push it from the auger, or rather unwind it, yet it does not stick to the auger. This is the most favorable condition of the soil for the growing plants, but is usually found where the soil is of the loam order and under proper tillage.

Another condition is where there is sufficient moisture for the soil to not only stick together but to adhere to the auger so you have to scrape off or otherwise force from the auger. Under this condition the soil carries the highest possible per cent

of capillary water. This is a condition that should be found in summer tilled ground soon after a rain, especially in a soil that has only a light percentage of sand.

This is a very important point to be observed in your summer tilled fields. If your top firm soil immediately beneath the mulch does not carry sufficient moisture to nearly or quite represent the latter condition referred to, you can rest assured that you have not given your field the best of tillage. You have lost moisture either by growth of weeds, or the allowing of your ground to lie too long with a shallow mulch without cultivation, or your seed bed is not sufficiently fine and firm. Properly handled, summer tilled fields should carry this high per cent of capillary water in the upper portion of the firm soil right through the season or until the crop begins to grow, unless your soil is very sandy. This not only applies to summer tilling for wheat, but to quite a degree in early spring tilling for late planting for cane or corn.

THE AUGER AS A TILLAGE INDICATOR

By the study of your various fields during the summer season using the soil auger as a guide, you will very soon appreciate how very vital to the larger yields of all your crops is the cultivation of your fields at *just the right time.*

The one great question the farmer must recognize is that his last rain though it be a good one, may be the last one for the season. Therefore, it is up to the farmer to direct his work from early

spring until late in the fall in such a way as to economize this limited amount of rainfall and utilize it to the highest possible degree.

When you fully realize, as you will by the persistent use of the auger, that the surplus moisture of this year should and can be carefully retained in the soil for next years' crop and by retaining more moisture in the soil at all times, you promote a life like condition of the soil, a condition you will soon learn to appreciate as it helps to prevent blowing and increases the available fertility, all of which helps to increase your yields.

NOTE—It must be remembered that the auger test is not an accurate one. Sometimes a soil which apparently contains but little moisture may have considerable, depending upon the texture of the soil. The auger will, however, give accurate information in comparing soils of the same type, and noting general moisture conditions.

CHAPTER XIX

CONCLUSION

I am not satisfied with all I have told you for I still believe more can be accomplished when we know more about our soils and how to handle them. I am planning some extensive experiments for 1916 and expect to compile a larger book at the close and be able to tell you better how to get more out of Mother Earth.

I am more of the opinion that the moderately small farm handled by the farmer's own family, with the aid of implements that will get over the ground quicker, do a broader scope of work and more completely accomplish the work on time, and as it should be, is going to support in the future, the prosperous and happy farm home.

The real science or "know how" in farming is only in its infancy, because we are just beginning to see its broadness and some of its real possibilities.

WHAT SOME FARMERS ARE DOING

Below are given excerpts from just a few of the hundreds of letters the author of this book has received bearing on some of the questions discussed. They show what real farmers are actually doing:

Some Strong Endorsements of Our Work

INCREASED PRODUCTIVENESS

Mr. Ray Shepherd, merchant, Yuma, Colorado, June 11, 1915: "In conversation with Mr. Moyer only yesterday, your name and work were mentioned and Mr. Moyer remarked that in his estimation your teachings and demonstrations had increased the productiveness of this county more than we could conceive.

"The good your personal supervision and instruction has done to our farmers is unmeasureable. I have been in close touch with these people for the past six years. I personally know of more occasions than one when they have been almost discouraged and ready to give up but you came along and talked the matter over with them and they have come through winners, and I am only expressing the feeling of the entire country."

THEY PRODUCED RESULTS

Mr. John Dugan, Stoneham, Colorado, June 3, 1915: "I don't believe you realize the real benefit you have done and are doing this territory. Among the newcomers, there are a few who are familiar with your system of farming. These fellows went right ahead and produced results, showing the balance of us how to handle this land. The result is that last year we had over fifty cars of grain shipped from this small station where ten years ago it was thought impossible to raise a bushel. Your talk last April was a big help but just made our people hungry for more. The farmers knowing you by reputation have faith in your advice."

SUCCESS IN KNOWING HOW

Mr. W. W. Cockran, Briggsdale, Colorado, December 23, 1914: "Three years ago I listened to a lecture by you in Sligo, I then took up the study of farming as laid down by you, and since then the personal advice you have been kind enough to give me in my own fields has enabled me to grow what would be fairly good crops in Lancaster county, Nebraska, or any other place.

"My wheat this year made 34½ bushels, my corn 30 bushels, barley 20 bushels, millet 20 bushels, and potatoes 120 bushels. I have a small pit silo that holds 30 tons, which I filled from 7 acres of corn. These crops were all made on less than 8 inches of rainfall, and I owe my success to you."

EARLY DOUBLE DISKING

Mr. Fred Newrock, Weldona, Colorado, November 3, 1915: "I want to thank you for your timely advice last spring on late corn planting, for if it had not been for your encouraging answer to my letter, I probably would not have put in a crop last spring at all, consequently would have been 1,500 bushels of corn short of what I am. I double disked my ground early last spring and was getting ready to plant corn at the usual time, May tenth, but right at that time it kept on raining and freezing and I could not get the crop in, the next couple of weeks did not bring any favorable changes and talk was loud and general that it was useless to plant corn this year because it would not have time to mature. In the meantime I got your letter, then I harrowed twice, my field was nice and clean, and about June third, against the solemn advice and ridicule of my neighbors, I suddenly decided to plant all my 65 acres, so I listed till the eighth the old ground and then surface planted till the twelfth some spring breaking I had. Well I never saw anything grow any prettier; it made some of them take notice. I had little trouble with the weeds and my corn is thoroughly matured, while some of my neighbors' crops though planted May tenth, partly taken by the weeds are not well matured, therefore I am in favor of early double disking the ground and plant in June."

GOOD FARMING BEFORE PLANTING

Mr. J. M. Ralston, Oberlin, Kansas, April 14, 1915: "I am anxious to cooperate with you in your work this year. Your system is certainly helping this country.

"I sowed alfalfa on the land I summer tilled under your direction two years, and it is the best in the country.

"I am a great advocate of doing farming before the crop is planted. I am convinced your work is all O. K., the fault is with the farmer that is doing the work. Enough said."

ON WELL FITTED GROUND

Mr. Arthur Saum, Norton, Kansas, October 9, 1914: "The millet was planted July thirteenth and harvested September fifth, and threshed 35 bushels per acre of nice clean seed. I am more than pleased with the late planted corn. It is certainly fine. It is the best piece of corn in the country.

"The cane is higher than a man's head and all seeded. I am strong for this late planted stuff where the soil has been properly spring tilled. You are certainly doing a great work."

EASTERN COLORADO REJOICES

Mr. H. C. Hoch, lumber dealer, Yuma, Colorado, June 10, 1915: "Eastern Colorado is fast coming to the front as a farming section. Your untiring efforts to teach our farmers the best methods of tilling the soil and of keeping the moisture in it has been one of the main reasons that big results have been obtained.

"I might mention the names of a great many farmers that have taken up your methods of soil culture with good results, but will only name a few: G. W. Hahn, Jas. Moyer, Jas. Jacobson, Wensel Black, Thor Olson, Chas Chrismer. These have grown some wonderful crops on land farmed by your methods.

"Stay with it, Mr. Campbell; let the good work go on. We are not the only ones that appreciate your work."

GOOD RESULTS WITH CANE

☞ Mr. Geo. B. Thompkins, Sterling, Colorado, October 3, 1915. "On July third, I put in a piece of spring tilled ground to cane and it was six feet high September tenth when I cut it, and it will make five tons to the acre against two on ground planted to cane May twenty-fifth. You have been a big help to me this year by sending me better farming information. I believe in early and thorough, continued spring tillage and the necessary later planting."

SUMMER TILLAGE DOES THE BUSINESS

MR. AUGUST DESENS, Stratton, Nebraska, September 7, 1914: "Our summer tilled wheat was fine up to June eleventh, when we had a terrible hail storm making it a total loss. It would have yielded 45 to 50 bushels per acre.

"My cane sowed under your instructions is dandy. It stands about 5½ feet high, heading out and has been in the ground only 43 days, will make the best feed I ever raised.

"Our ground we have summer tilled for wheat next year is moist the full depth of the five foot auger. We have 56 acres of this summer tilling and are well pleased with the system, as it is the only way to raise big crops. Wish you could see my cane."

HEARTY COOPERATION ASSURED

MR. E. LORING, Yuma, Colorado, September 25, 1914: "Perhaps it might be interesting to you to know something of the 1914 crop conditions near Yuma. I could give you names of many who have wonderful yields of grain under your system of farming, farmers here are just beginning to realize what good or better farming means.

"I hope Mr. Campbell, you will continue to be with us for some time. I am in position to judge the feeling as to better farming among our farmers here, for during the winter time many farmers congregate in my office and we have thorough discussions regarding methods of farming. I can assure you of our hearty cooperation."

MILLET GETS BIG CROP

MR. EMIL ANDREEN, Dalton, Nebraska, September, 14 1915: "I am sending you today a sample of millet. It was planted the seventh of July on spring tilled land and made a most wonderful growth. I had five acres of it. It looks good for at least 80 bushels to the acre. This is the fruit of some of your efforts."

WELL PAID FOR THE WORK

MR. F. E. VANGUILDER, Haxton, Colorado, October 24, 1914: "My summer tilled field in 1913, yielded 24 bushels to the acre, and had no rain from May thirtieth, until wheat was ripe. I had 20 acres of wheat in a field adjoining which was planted in corn stalk land well cultivated, and from the 20 acres I got 46 bushels or 2¾ bushels per acre, which shows plainly that I was well paid for all work done on the summer tilled land. I never expect to let another year go by without summer tilling."

SEND THE SKEPTICS TO YUMA

MR. J. M. MOYER, Yuma, Colorado, August 26, 1914: "This year I disked my stubble ground while harvesting, as you advocated and I found that it surely pays, as I could go ahead and plow afterwards, while where the ground had not been disked, the moisture was all gone. I wish you could have noted the difference. The more your methods are practiced the less failures there will be and the semi-arid districts will be the best of all and bloom like Hahn's rose garden.

"I have been able to grow trees, fruit and grain of different kinds, where others have failed, but it has all been done along the lines of your advice. I wish hundreds of eastern renters could see and know just what myself and several other farmers have done here in the past four years.

"When you find any skeptics just send them to Yuma and we will convince them that with the Campbell system properly applied this country is as good as any."

BELIEVES IN THE PRINCIPLES

MR. F. E. DODSON, Stratton, Nebraska, April 2, 1915: "I fully believe in your principles and system of farming and I want to be able to put them into more effective operation. I would have left this country long ago had it not been for the possible results that I know can be accomplished by your system. I shall try to put into practice the principles of soil culture that I have learned with your help."

NOTHING TO WORRY ABOUT NOW

MR. ED DESENS, Stratton, Nebraska, November 2, 1914: "When one has plenty of feed at the close of a dry year like this it makes one feel proud to think he has accomplished something worth while, and I know I have. It has been a hard matter for me to raise feed for stock, therefore, I could only winter a few until you taught me your methods.

"The seventeenth of July, I sowed 20 acres of cane on spring tilled land from which over five tons of dry feed the finest quality I have seen. Now with one hundred tons of cane in the stack I have nothing to worry about."

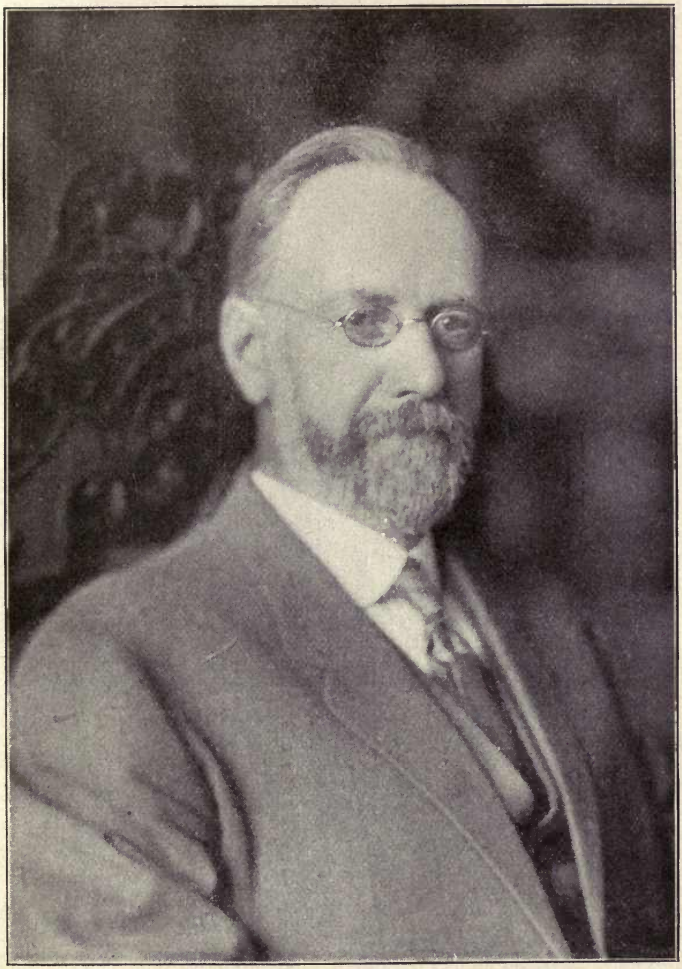
BUT THE WHEAT IS FINE

MR. P. E. PARKINS, Stratton, Nebraska, May 16, 1915: "While I believe your way is the right way, I am not in shape to carry out your instructions as I would like to. My wheat that I put in last year on summer tilled is certainly fine and encourages one to follow you more and closer."

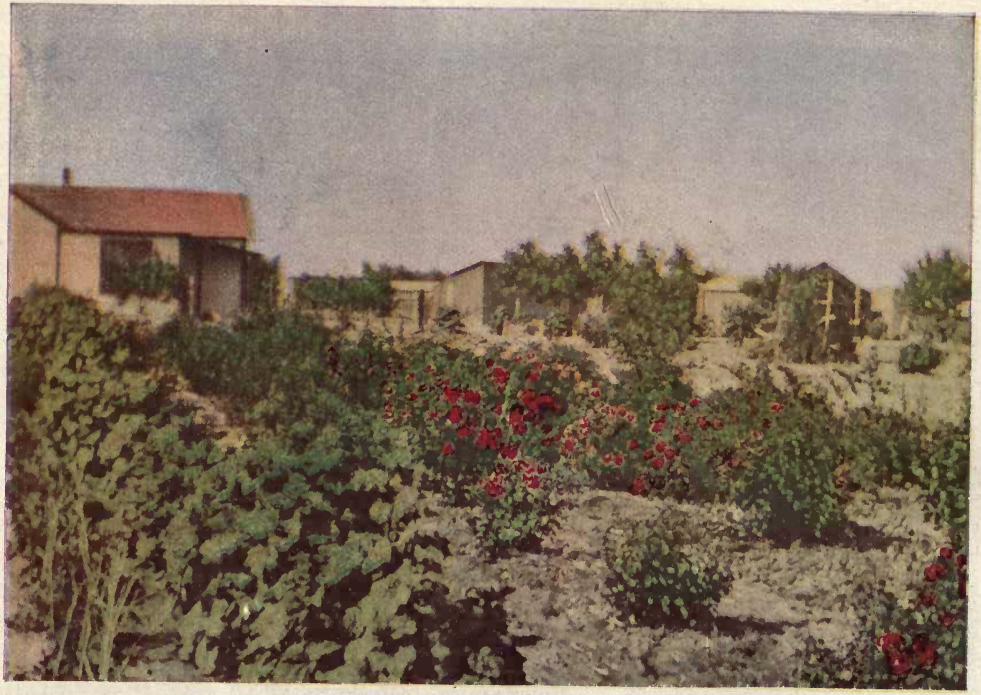
MAKES FOR RENEWED CONFIDENCE

MR. JOHN W. SCHMIDT, New Castle, Wyoming, May 30, 1915: "With many thanks, I wish to acknowledge the receipt of your instructions and interesting letters both of May eighteenth and May twenty-first, together with Bulletin, 'Some Tillage Suggestions.' This information has put matters more clearly in my understanding and makes one feel confident and encouraged to try again in spite of failures in the past when we can see why we failed and how to prevent it."

ILLUSTRATIONS



No. 1. Hardy W. Campbell

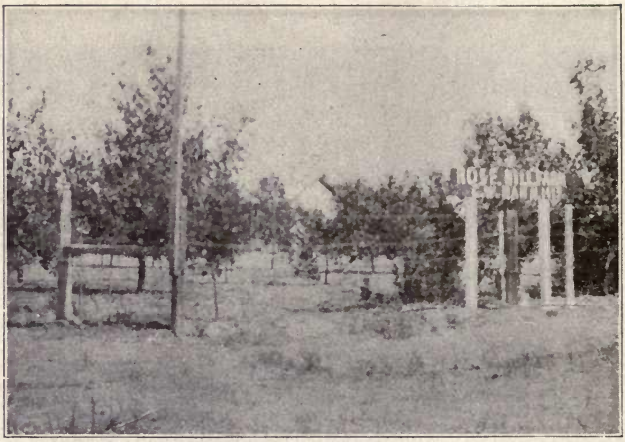


No. 2. Farm Garden Under Semi-humid Conditions

G. W. Hahn, 5 miles north of Yuma, Colorado; four years after raw prairie. Photographed June 29, 1914. A hot drouthy year; entire growth result of timely cultivation; no irrigation; one bush had forty-three double roses. Such was a theoretical impossibility a few years ago. See Page 25.

No. 3. Early and Late planted Cane

Field on farm of Mr. Crook, 2 miles north of Wilsonville, Nebraska. In the foreground, field badly fired, planted May 18, 1914, common method, yield about one-half ton per acre. Field in the background, spring tilled, planted July 15, yield five and a quarter tons per acre. Ten times as much for a little different tillage and time of seeding. See Page 98.



No. 4. Four Years From Raw Prairie
G. W. Hahn's home 5 miles north of Yuma, Colorado. A result of four years of careful planning and tilling with a purpose. This is entrance to grounds on Rose Hill Farm shown in No. 2. Many things are impossible until we know how. **See Page 26.**

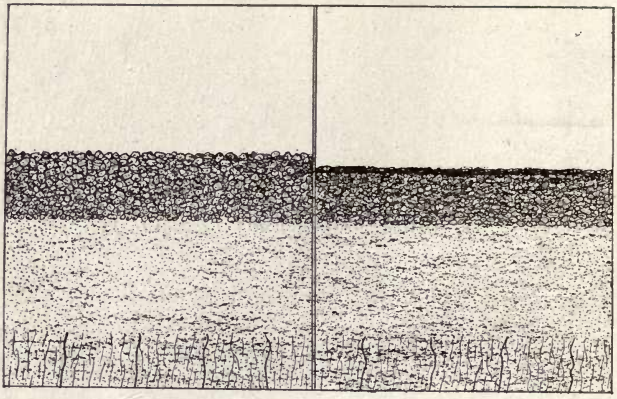
No. 5. Apple Orchard. Yuma, Colorado
Result of careful tillage for five years on Mr. Hahn's farm. These trees are directly to the rear of No. 4. Does this look bleak? **See Page 26.**

No. 6. Remarkable Growth of Trees

Windbreak of Carolina poplars grown by J. M. Moyer, half mile south of Yuma, Colorado; five years old, average 18 feet high; result of careful cultivation, no irrigation. Note the even course mulch among the trees. **See Page 73.**

No. 7. Cherry Orchard

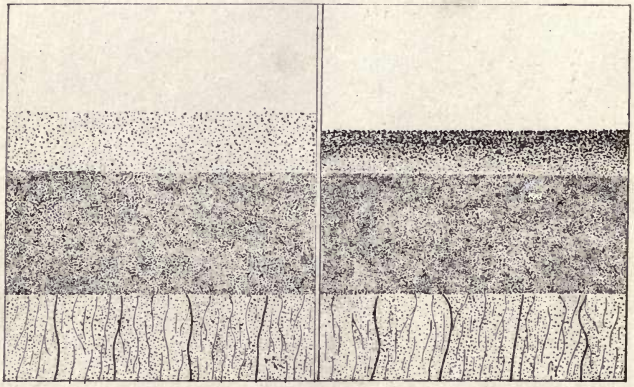
J. M. Moyer's cherry orchard, five years old, handled same as the Carolina poplars; no more marked growth could be obtained anywhere and what any farmer can have. Just a little know how.
See Page 73.



Before the Rain After the Rain

No. 8. Coarse Soil Mulch

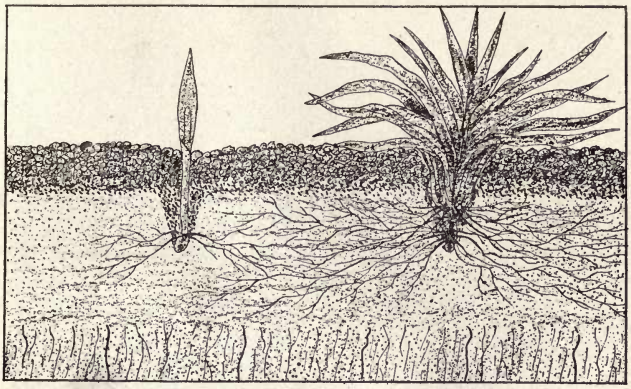
Illustrating the advantage of the coarse mulch as explained on page 30.



Before the Rain After the Rain

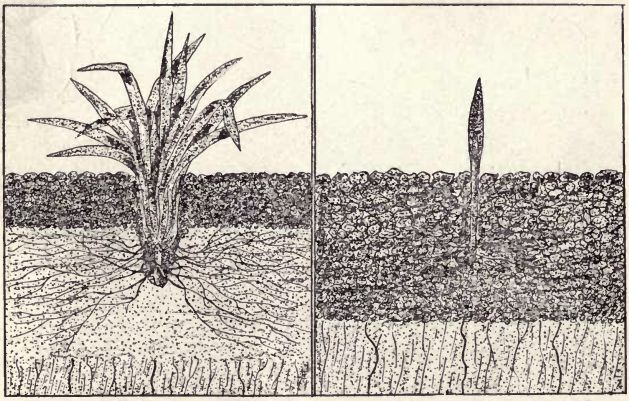
No. 9. Fine or dust Mulch

Showing the disadvantage of the fine or dustlike mulch as explained on page 30.



No. 10. The Stooling of Grain

Showing rapid growth and stooling of grain in an ideal seed bed.
See page 85.



No. 11. Good and Poor Fitting

Showing contrast in growth and development of plants in a coarse and loose soil as against an ideal seed bed. **See page 8.**

No. 12. Phenomenal Growth in Fifty-Four Days

Corn on Mr. Moench's farm, Orleans, Nebraska, planted July 1, 1914. Photographed August 23, fully six feet high and tasseled. Interesting explanation on page 52.

No. 13. Result of Spring Tillage

Same field as No. 12, taken thirty days later; crop fully matured while other fields with the usual preparation all badly burned.

See page 53.

No. 14. Stunted Growth From Early Planting

Grown by W. W. Cockran, five miles south of Sligo, Colorado; planted May 12, 1915, compare with Cut 15, that was planted twenty-five days later. **See Page 54.**

No. 15. Result of Spring Tillage

Same farm as No. 14, corn planted June 6, difference as between the two due to additional available plant food and warmer soil. Twenty-five days additional spring tillage. The thin appearance is due to the fact that the entire field was cut but these three rows. **See Page 54.**

No. 16. Remarkable Corn Crop a Mile High

Shocks cut from field No. 15 near Sligo Colorado, 150 miles due north of Denver. **See page 54.**

No. 17. Forty-six inches High in Thirty-eight Days

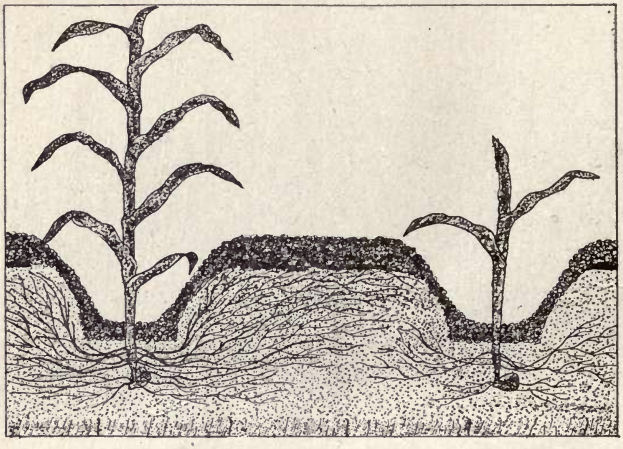
Corn on Burlington farm at Holdrege, Nebraska, planted June 30, 1914, photographed August 7; twice the growth in half the time of usual planting. **See page 55.**

No. 18. Early Tilled and Well Handled

Corn on Burlington farm, Holdrege, in the hot dry year of 1910; timely tillage made the crop. Compare with cut No. 19 just across the road. See page 46.

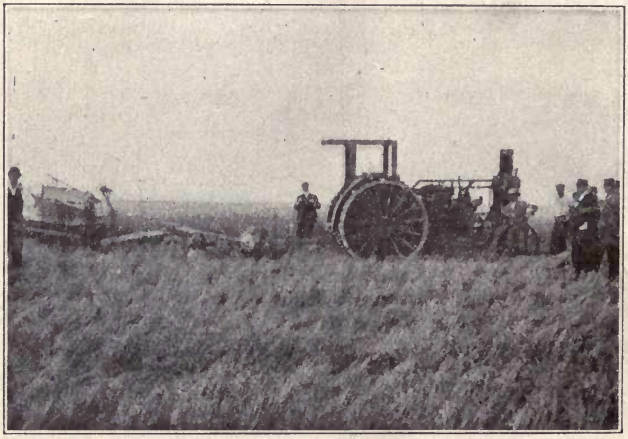
No. 19. Destroyed by Drouth

Field adjoining No. 18, no early preparation and but little cultivation, with result of no crop. See page 47.



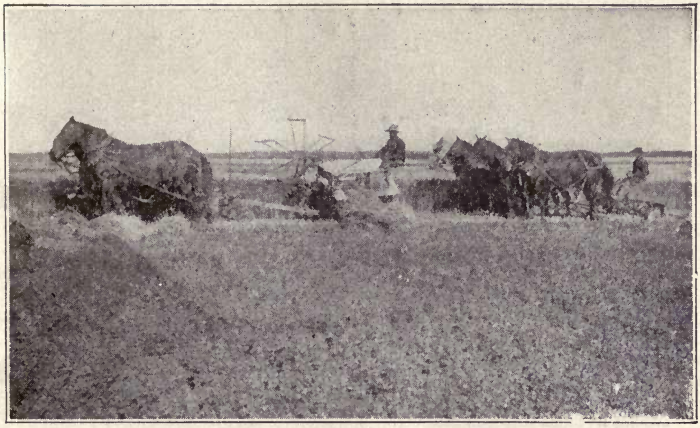
No. 20. Root Growth of Listed Corn

Dangerous practice is to not split the ridge until it has become the main feeding ground of the roots. **See page 49.**



No. 21. Harvesting and Disking With Tractor

Showing important practice of double disking ground immediately following the harvester on J. M. Moyer's 50-acre field on new breaking, average 45½ bushels. **See Page 37.**



No. 22. Disking After Harvester With Horses

Showing method of pulling the tandem or double disk behind the harvester. **See page 37.**

No. 23. Tandem or Double Disk Harrow

One man with six horses with this device will do double the work one man and four horses with a single disk. **See page 29.**

No. 24. Good Crop From Good Fitting

A 1915 crop on ground broken near Yuma in 1914 and well fitted; yield 39½ bushels of wheat. Contrast with No. 25. **See page 67.**

No. 25. Poor Crop From Poor Fitting

Broken in 1914, on section adjoining No. 24; yield in 1915 12½ bushels. Why the difference? Tillage only. **See page 67.**

No. 26. Second Crop After Summer Tilling

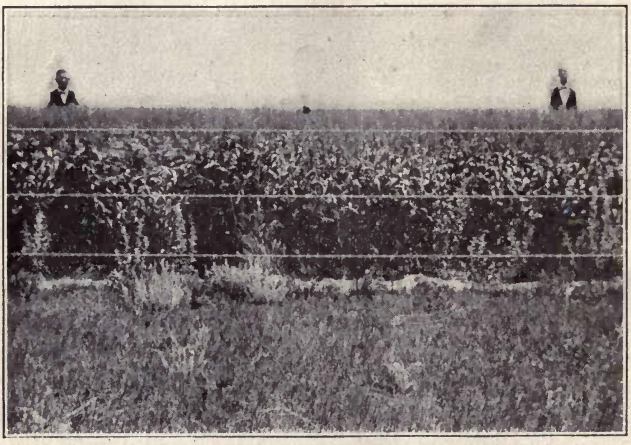
J. M. Moyer's field, Yuma Colorado; summer tilled 1913; 1914 crop 47½ bushels; 1915 or the crop shown in cut 31 bushels; two years total 78½ bushels. **See page 68.**

No. 27. Second Crop After Attempted Summer Tillage

On field adjoining No. 26, also summer tilled 1913; crop of 1914 made 24½ bushels; this crop on 1915, 11½ bushels. Two years total 36 bushels. Why not 78½? Did not know how. **See Page 68.**

No. 28. Winter Wheat on New Ground

For facts concerning this remarkable field and its lesson as to right and wrong preparation, see page 70.



No. 29. Good Preparation; Big Crop of Wheat

Broken and carefully handled by J. M. Moyer from prairie sod in 1914, crop of 1915 yield on 50 acres, 45½ bushels per acre. See page 71.

No. 30. Two Kinds of Wheat Farming

Field in foreground under common method 16½ bushels per acre; 1914 crop rear field summer tilled 1913 yield in 1914 47½ bushels. Experiment by J. M. Moyer. Does good tillage pay? See page 71.

No. 31. Wheat on Summer Tilled Ground

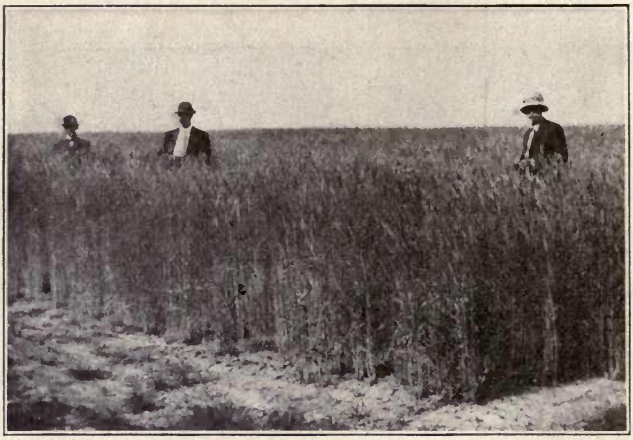
Summer tilled in 1912, harvested in the hot dry year of 1913, yield 34½ bushels, on J. M. Moyer's farm. **See page 72.**

No. 32. Moyer's Champion Crop

Ground summer tilled in 1914, crop of winter wheat 1915, 51½ bushels. Does it pay to farm well? Mr. Moyer says it does. **See Page 72.**

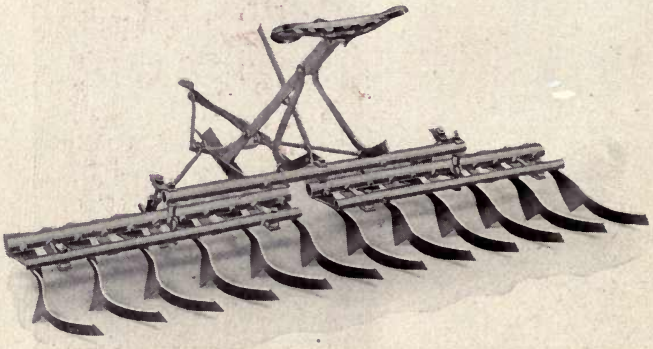
No. 33. Contrast in Tillage Results

Two wheat fields on August Desens' farm one mile north of Stratton, Nebraska, in the hot, drouth year 1913, the field in foreground never headed, field in the rear 33 bushels of 62 pound wheat. Tillage made the difference. See page 74.

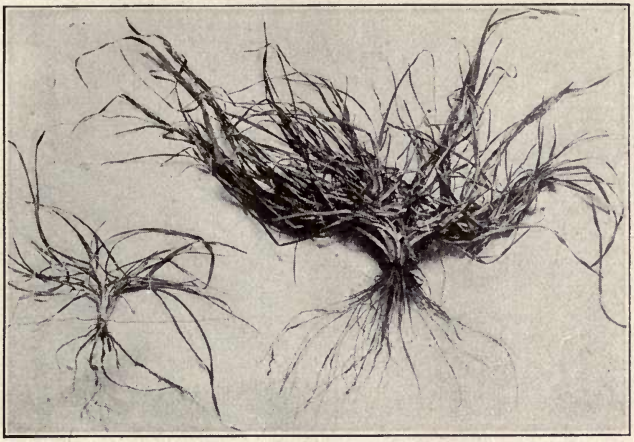


No. 34. Big Crop With Little Rain

C. L. Morgan's farm 3 miles south of Sligo, Colorado; summer tilled in 1913 with 7½ inches total rain; and 4½ inches from January 1, 1914 to cutting the crop or 12 inches in 19 months. **See Page 74.**



No. 35. The Acme Harrow. **See Page 32**



No. 36. Plant Food the Result of Tillage

Showing difference in stooling of wheat on adjoining fields, one having been summer tilled, the other given ordinary treatment, planted same day and pulled 41 days later. See page 79.

No. 37. Loss of Plant Food From Weeds

Showing how a few weeds depleted the moisture and checked the necessary chemical action. See page 80.

No. 38. Result of Thorough Preparation

Winter Wheat six miles east of Akron, Colorado; summer tilled 1912, crop of dry year of 1913; remarkable growth with little rainfall because of correct tillage. **See page 77.**

No. 39. Big Crop From Good Tillage

Winter wheat Holdrege, Nebraska; summer tilled 1903, harvested in 1904, a somewhat drouthy year; yield 54½ bushels of 64 pound winter wheat. **See page 76.**

No. 40. Big Yield From Thin Seeding

Five heads out of 30 from one grain of wheat, containing 349 grains, from summer tilled ground in eastern Wyoming. **See page 81.**

No. 41. Hog or Broomcorn Millet

Grown on H. O. Ranch, Madrid, Nebraska; planted on spring tilled ground July 10, 1914; photographed August 14, or 35 days from planting; average 36 inches high. Also called Hog Millet. A grain as well as hay. **See page 104.**

No. 42. Kaffir Corn

Grown by Mr. Moench, Orleans, Nebraska; planted on spring tilled ground July 14, 1914; photographed August 20, 38 inches high in 36 days. **See page 103.**

No. 43. Kaffir Corn

Grown at Norton, Kansas, by Arthur Saum; planted July 10, 1914 on spring tilled ground, photographed August 24. 52 inches high in 42 days. **See page 103.**

No. 44. Cane on Spring Tilling

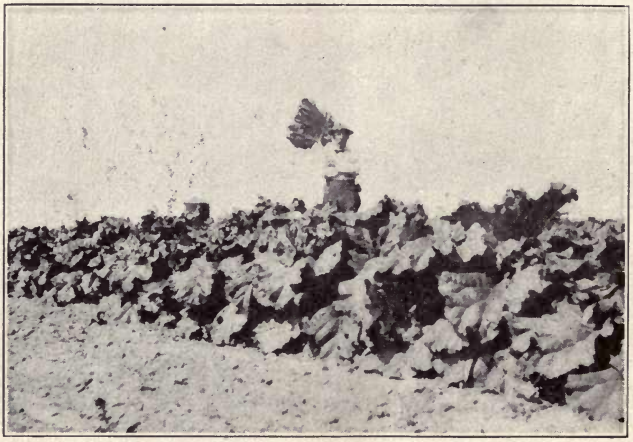
Grown by August Desens, Stratton, Nebraska; planted July 27, 1914; yield over 6 tons per acre of dry hay; cane on adjoining farm planted June 5, less than half ton. See page 99.

No. 45. Cane for Silo

Grown on H. O. Ranch spring tilled; listed in June 27, 1914; carefully cultivated; average yield 8½ tons per acre of ensilage; double amount ever grown there before. See Page 101.

No. 46. Sudan Grass

Grown by W. W. Cockran, Sligo, Colorado; planted June 15, 1915; over six feet high. Photographed Sept. 25. This plant promises well for hay; is probably better than cane.



No. 47. Tillage in the Garden

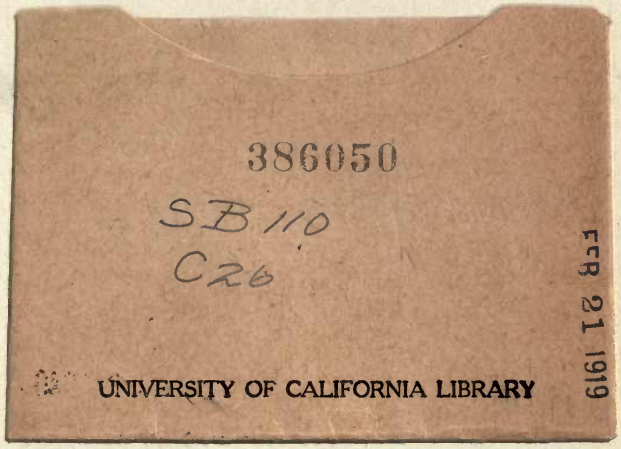
Rhubarb or Pie Plant, grown on the H. O. Ranch, Madrid, Nebraska in 1915 a result of thorough careful cultivation. **See page 107.**

No. 48. How Deep is the Moisture

Boring with soil auger to ascertain how deep moisture has been stored by tillage. See page 114.

No. 49. What is Per Cent of Moisture

Examining the soil to ascertain how moist the soil is at given points from the top down. See page 118.



Corn Forty-six Inches High in Thirty-Eight Days after Planting. How Big was Your Corn in Thirty-eight Days?