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THE NEW AGRICULTURE

A POPULAR OUTLINE OF THE CHANGES WHICH ARE REVOLUTIONIZING THE METHODS OF FARMING AND THE HABITS OF FARM LIFE

By

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1906
To My Friends
THE sense of pureness in the air,
Of wholesome life in growing things;
Waving of blossoms, blade and wings,
Perfume and beauty everywhere,
Sky, trees, the grass, the very loam—
I love them all—this is our home.”

—GILDER.
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EVEN a cursory consideration of the general subject of which this volume treats must prove an inspiration to many persons at the present time.

Individualism—the right and power of the individual to regulate his own life, think his own thoughts, express his own convictions, carry out his own theories, and strive without let or hindrance for the attainment of his own ideals, in so far as all this may be done without trespassing upon the rights of others—this undoubtedly constitutes the basis of many a man's aspiration who sees only a diminishing prospect of attaining his heart's desire in his present environment.

He feels that the incorporation of industries into one gigantic whole, or, at best, into a limited number of colossal units, renders him insignificant beyond what is right, deprives him of the dignity of manhood, and stifles his life. He feels that the embezzler, the speculator, and the thief in exalted places are given opportunities for public exploitation and self-enrichment, and that the common, ubiquitous and ever-hateful grafter is an inevitable product of the system.

In vain is he told by his teachers that there is nothing better for him. In vain is it pointed out to him that individualism is impossible: that as long as he lives in a community of his fellows he must surrender his individualism to the common good: that the only way to realize his ideal is to become a hermit or an anchorite. It is not the surrender of what is necessary and reasonable that galls him. It is the crushing out of him of that which he feels he has a right to retain, that makes him rebellious. But where can he go and what can he
do to better his condition? A course of possible procedure is pointed out in the following pages—a life in which he may breathe the air of freedom and health, in which he may enjoy room and sunshine; a life in which he may regulate his own hours of labor, and, walking abroad among his fellows, enjoy the consciousness of absolute equality.

Farm life was never so attractive as it is to-day, and this notwithstanding the fact that present methods of production and distribution outside the farm leaves much to be desired. Almost unthinkable sums of wealth which the farmer annually creates is annually appropriated by a few powerful corporations, but this is not more true than that all other classes of workers are equally and some of them even more terribly exploited. But an evolution so active that it approaches the phenomena of a peaceful revolution is going on in society, long-standing abuses are being curtailed or abolished, and the present social system is destined in the near future to undergo profound modification before it is finally displaced by something better or transmuted into another form. While, therefore, farm life offers more inducements than at any previous period of the world's history, and vastly more in America than in any other country on the globe, from the present moment of reform to the final fruition of the social growth of which the reform is an indication, is the farmer to reap more and more nearly the full reward of his toil.

There are probably not less than two millions of people in this country at the present moment who, by leaving the places they now occupy as clerks, bookkeepers, salesmen, factory hands and unskilled workers, could, by earnestly and intelligently adopting the avocation of agriculture, better both their own condition and that of those who are dependent upon them.
CHAPTER I. FIG. 1.—THEY'VE BEEN TO SEE GRANDPA. BROOKSIDE FARM, LEE CO., ILL.
"Back to the soil" was never a more attractive proposition and never so worthy of being heeded as during these opening years of the twentieth century. It is true that social economists have often uttered this cry because they believed, and rightly, that the overcrowded condition of cities could be relieved, to the immense advantage of everybody concerned, if the congested population found in sections of these human hives could be induced to leave their crowded quarters and become tillers of the soil. The advocates of the doctrine have had in mind a more decent and desirable condition for the objects of their solicitude—a place where they could develop a physical, social and moral life superior to that which is possible to them in their present places of abode. The cry with which this chapter opens, however, is not uttered especially to a crowded urban population. It is uttered to all men—to the inhabitants of every city, of whatever magnitude; to the dwellers in villages and hamlets, and to those who are already on the land, that they may be contented to remain there. It is uttered to the dissatisfied of every condition of life, or to those who ought to be dissatisfied. It is the cry, not of social economists only, not only of preachers, teachers, and statesmen, as distinguished from politicians, but of seers, of men who look into the future.
and see the good things that are there and the better things that are coming.

We are at the beginning of an era wonderful in the annals of agriculture; an era in which experiment and foresight and skill and invention and learning will transmute, as never before, the labor bestowed upon the land into wealth and health and happiness and length of days; an era of progress and development as wonderful as any that has hitherto astounded the world in other departments of investigation and endeavor, in which agriculture will, for progress, take her stand side by side with the industry of shipbuilding, for instance, which has within a comparatively few years reduced the time for crossing the Atlantic from three months to less than twice that many days, and increased the carrying capacity of single vessels from a few hundreds to many thousands of tons; by the side of railroading in which speed and safety and capacity has, in each succeeding year, laughed at the impossibilities of the year just gone; by the side of electrical development which, from a meagre beginning of a generation ago, now renders us speechless in the presence of its phenomena of light and heat and power, and other manifestations still more subtle and marvelous.

In agriculture, the great mass of mankind have not looked upon intelligence and mental training as of especial value. Too many have thought of farmers as men "whose talk was of oxen and whose employment was in their labours"; have thought of those "labours" as being drudgery for the most part, and of financial returns so meagre as to render farming utterly unattractive to any active man's contemplation. "By and by," said a philosopher of the last generation, "by and by it will be generally realized that few men live, or have lived, who could not find scope for all their intellect on a two-hundred-acre
CHAPTER I., FIG. 2.—A COTTAGE HOME ON A MONTANA FARM.
THE NEW CALL TO THE FARM.

Two score years have not yet gone since those words were uttered. To-day they are fulfilled. It is now generally known that agriculture offers an immense field for investigation and development by strictly scientific methods. Men of large business experience are going into it, and well-to-do professional men and merchants are taking it up as a feature of their summer life, finding in serious contact with the soil a worthy exercise of their highest faculties, and reaping from their labor a delightful experience of things brought to pass. Those who are already on the farm have come to realize that the best mental equipment is none too good for the tillers of the soil. They have demanded schools and colleges and courses of instruction for themselves and their sons which shall fit them to make of the farm a plant for the scientific and skilful production of all that it will yield. Statesmen and educators inculcated and fostered the same idea. Washington, a practical farmer, whose technical education was probably second to that of no man of his time in America, repeatedly brought to the attention of Congress the importance of providing adequate educational facilities and other encouragements in agriculture. Partly out of these recommendations, but more immediately out of the seed distribution originated in the Department of State during the Presidency of John Quincy Adams, sprang the United States Department of Agriculture, which in our day has attained such immense proportions, and whose work is of such incalculable profit and importance. The different states of the Union, seeing the importance of technical training among the farming community, have provided colleges for this purpose, which now dot the land in all its sections. These schools are surrounded with ample farms in which practical demonstration goes hand in hand with the theories taught and the facts
acquired in the classroom; they are provided with improved buildings, in many cases ideally adapted to the purposes for which they were constructed; they are granted large means for the prosecution of their work; they are equipped with precise instruments and all the paraphernalia requisite for the successful prosecution of scientific investigation; and they are manned by scholarly and competent men who are imbued with the importance and the possibilities of their positions.

The progress in other lines of human activity has had its influence upon agriculture. If men have found secrets in the sea and in the stars and in the ether which fills the interstices between the atoms of the air as water might fill the space in a barrel of bullets, the soil also has been searched for its mysteries, and is being made to yield them, too, in a truly wonderful manner. Lands which were not only thought worthless, but which were really so, are now made to bloom and blossom as the rose. Roads which were almost always bad, and at times impassable and considered impracticable of improvement, are now transformed by the magic of mind and muscle into highways of profit and delight. Frosts are defied by new varieties of fruits and grain which live and thrive and mature into money where their predecessors wilted and died under the blighting breath of a providence which they could not withstand, to the discouragement, and sometimes to the despair, of the husbandman. The cactus, that abundant but useless growth of the desert, has but recently been rendered a delicious fruit capable of being grown throughout the length and breadth of the continent, and not only has the noxious herb been transformed into a valuable food for man and beast, but the same skill and scientific treatment which has been efficacious for this amazing transformation has also removed the
CHAPTER I., FIG. 3.—HE WORKS IN SIGHT OF HOME.
THE NEW CALL TO THE FARM.

spines, those needles which formerly covered it and rendered it so difficult to handle. What has been done with the cactus is the adumbration and prophecy of what is, one might almost say, becoming general in the realm of agriculture. Already the seedless apple and the pitless plum and the stingless bee have been attained. Fruits have been developed for which a name had to be invented—the tangelo, for instance, which Adam did not find in all his rounds in the Garden of Eden, and which nature never produced till a wizard of agriculture, Webber, waved his wand over the fruit trees of his farm and bid the thing appear. Burbank has more than doubled the size of various fruits and flowers and esculent roots, and within a considerable range finds himself able to change the colors of nature almost at will. Under his manipulation the white blackberry is now an accomplished fact, and he tells us that he will give us a blue rose as soon as he can spare the time to coax it into being. And we must remember that it is only recently that he has been given the means and assistance that the dignity of his work deserves. It may not be said that Burbank is at the beginning of his career, but it is certain that the work which he has pointed out the way to perform will be carried forward by a great number of men, and that agriculture is but entering upon an era of development which will be as surprising as it will be profitable. Already the agricultural colleges of this and foreign lands and our own and foreign Agricultural Departments through their various experiment stations are working along these and other original lines, and the wonderful, the helpful and the profitable are being brought to light every day. The pests of his plants and the diseases of his animals which were once the terror of the farmer are now so subject to control and cure as to give him little more than
passing concern. Information is now available regarding probable weather conditions which subserve both his convenience and his profit. Eighty millions of people in this country alone are backing the work of the Weather Bureau which sends its forecasts to the furthestmost sections of the country, and rural deliveries and country telephone lines carry to millions of farmers these predictions, 85 per cent. of which come true. Our own Weather Bureau and that of other countries are studying climatic and weather conditions with an intelligence and enthusiasm never before displayed. The reasons for drouth and flood are being pried into with the same persistence that physicians seek for the germ of a deadly disease, and the origin and prognosis of a hot wind will yet be as accurately determined as that of a fever. The upper air is being explored, and men are already knocking at the home of the storm with the view of learning the secrets that lie hidden there. There are conservative data for believing that in the not distant future scientific forecasts of the weather will reach within 5 per cent. of absolute accuracy and that they will be made for at least a season, and perhaps a year, in advance. What will it mean when the Government foretells for our farmers, with 95 per cent. of fulfillment, for three months in advance, whether, in a given locality, the season is going to be early or late, hot or cold, wet or dry?

Starch is now increased in corn and potatoes at will, sugar in beets and cane, and gluten in wheat. If the eggs from your poultry are too small for your liking they may be increased in size, and if there is not enough nitrogen in your soil you may sow it broadcast with bacteria at four cents an acre and these microscopic organisms will extract the needed element from the air and feed it to your plants. Is your land
THE NEW CALL TO THE FARM.

an alkali desert, you may obtain seeds and plants which will thrive even there and return you a profitable crop. Not only is drainage appreciated and applied to an extent never before attempted in this country, but drouth is being circumvented and defied until, all in all, the uncertainties of the agricultur-alist are fewer than those of almost any other independent avocation.

It is freely admitted that the farmer's life still involves much hard labor and anxious care; that the elements may be against him, and that in one evil hour he may see the well-directed toil of months swept away; that his animals are subject to ills which his most assiduous care will not cure; insects and micro-organisms may blight and destroy his various growths of grain and fruit and root and deprive him, not only of his hope of abundance, but even of the most meagre returns for his labor. Men of wide observation and experience strongly advise against undertaking the avocation of the farmer without at least $500.00 of capital to begin with, and this would seem to be little enough, but the day when a man might begin without a penny and yet succeed has by no means gone by. Doubtless, under such circumstances, success is more readily reached in some parts of the country than in others. Seven years ago there entered one of the counties of west-central Georgia a young man who said he was from Indiana. He was very poorly dressed, and his few belongings he carried on a stick over his shoulder. He never vouchsafed much information regarding himself, more than that he had come down on foot—his appearance indicated it—and that he had stopped there simply because he liked the country. He worked for a nurseryman during the first winter for his board and lodging. The next spring he was given a pittance for helping to put in
the crops. Later he assisted in the cultivation of a neighboring farm, and so efficient did he prove that the whole county soon learned of his presence. He made a hand in the corn-pulling and the cotton-picking, and later found work with a ginner. During his first year he had been looked upon with some suspicion, but so scrupulously had he conducted himself, and so industrious and intelligent had he shown himself, that this feeling in regard to him was gradually disarmed. He applied for the position of teacher in the district school and got it. The term lasted six weeks, and he was three months in collecting his pay. He married the daughter of the best educated man in the county, a preacher, and, with his young wife, he settled upon a run-down rented farm. To-day he owns a hundred and forty acres of fertile land without a dollar of indebtedness, and is looked upon as one of the most prosperous and respected men in his section of the state.

These results may doubtless be duplicated, but only by the same factors of character, industry and intelligence. If a young man begin his married life without other means than those with which nature has endowed himself and his helpmate—a good, clear mind and muscular arms—he must expect years of struggle, of frugality, of resolute, persistent industry before he can find an assured and ample income, seasons of ease and the surroundings of comparative luxury. On the farm much of the work is rugged and some of it repulsive. He will see other men no brighter, no more able than he—merchants, manufacturers, professional men, making money with apparent rapidity and ease while his savings are meagre and hard earned. He must be moved by none of these things. He is not striving for another's success, but for his own.

And there will, of course, be failures. The incompetent, the
CHAPTER I, FIG. 8.—READY FOR ACTION.
shiftless, the indolent will fail. Those to whom farm life in general is distasteful, who do not like its solitude and who do not love nature, who can find no delight in growing things and in the marvelous processes of season and soil and seed—to such the farm would be a weariness not to be endured and they had better seek a livelihood elsewhere.

But even as we write the elements are being foretold, and as we shall see in a succeeding chapter, there are other means at the farmer's command for his protection against unfavorable atmospheric conditions, so that less and less is blizzard and flood and drouth to hazard the rewards of his toil. If it is suggested that labor on the land is sometimes repulsive, we recall that the work of some of the professions is equally so—the physician, the nurse, the soldier, for instance. As for the difficulties which beset him in the diseases which afflict his cattle and his crops, these are yielding to the same applications of intelligence that are proving so efficacious in the treatment of the various diseases to which human flesh is heir. It is the fact of modern science successfully combating the discouraging and destructive factors in the farmer's occupation that gives vitality and persuasive power to the cry of the new gospel of Agriculture, "Back to the soil."

But aside from the fair promises and glowing certainties of the future in agriculture, there is no other calling in which success is anything like as nearly certain as in this. Our most reliable statisticians estimate that ninety-five men fail where five succeed in the pursuits of traffic and trade. This estimate may possibly be too high, but probably it is close to the facts. Failures in these walks of life are so frequent and constant that they would seem tragic but for the fact that for every man who fails another immediately takes his place, so that
the wreckage is continually removed from view and the frightful accumulation of it is prevented from becoming an object of our contemplation. If a dozen men attempt to do business in merchandise and make money in a community which can only support three, it is certain that nine of the twelve will fail. There will be a period of fierce competition, more or less prolonged by the staying qualities of the men, their financial resources and power of will, but in the end nine men will fail and must fail. But you may double the number of farmers in any community whatsoever without dooming one of them to failure or appreciably affecting the profits which any one of them may reap as the reward of his toil. If the entire body of business and professional men who, in their present pursuits, are barely maintaining an existence—and there are thousands of them—should betake themselves to the soil to-morrow, the calling of agriculture would not be less profitable to those already engaged in it, while the entire population of the country would doubtless be greatly blessed and benefited. A competent business man or a wide-awake professional man may, by no fault of his own, be starved out of a given locality, but probably no one ever heard of an intelligent, energetic and frugal farmer who failed to make a comfortable living, and, unless disabled by disease or accident, such factors have usually secured for him who exercised them an independent income, albeit, perhaps, a modest one, before age and decrepitude deprived him of his ability to labor.

To whatever extent false ideals may have driven out the true in other avenues of life, however widely money and power may have come to be accepted as the most desirable things in the world, and however high the social standing attained and maintained by those who in the pursuit of these things have
CHAPTER I., FIG. 10.—EVIDENCES OF PROSPERITY.
perjured themselves and robbed and ruined their fellows under forms of law whereby they are saved from the arrest, trial and imprisonment which they so justly deserve, the foundations of God stand sure, and when truth is lost and honor dies the man is dead. The young doctor must have bread and is often tempted to the practice of a quackery he despises, and which at the beginning must be loathsome to him. Later in life, when the habit has become second nature, it is not bread, but money, more money, which constrains him, and thus his character may become crystallized into a hateful form. The same process may operate in the lawyer. To the first dirty professional job, he may drive himself against all his finer feelings. It may seem to him a necessity that he do "this thing." The second job will be less distasteful, though it may be equally dirty, and in this manner may he also be led to part with his priceless heritage of honor. These observations are true to a larger or less extent of every line of gainful endeavor, with but one exception. Where they occur some men yield not at all, some yield reluctantly, and still others are made ready by heredity to perform the ignoble and the mean; but the agriculturist, so far as his dealing is with the soil, is subject to none of these temptations. Here integrity—absolute honesty—is his sole reliance. He deals here with Nature and her laws direct, and she is to be neither cheated nor fooled. "Whatsoever a man soweth, that shall he also reap," while true of all men eventually, is obviously and evidently true for the husbandman at once. When he seeks to dispose of that which he has harvested, when he ceases from the strict work of the agriculturist and becomes a tradesman, there may then come the temptation to trickery, but so long as his dealings are with the soil, instead of offering the slight-
est inducement to substitute one thing for another that he may reap an unearned advantage, he finds that the behests and encouragements of Nature are all and always on the side of that which is recognized in the last analysis to be most worthy in man—truth, righteousness and rectitude.

There is probably no other calling which is so conducive of thoroughgoing manliness as that of farming. Nobody expects the farmer to cringe or try to curry favor. In other words, he is, and is recognized to be, the overlord of his own life. He is never tempted to hide his opinions in the hope of more successfully dealing with his fellow-men, nor is he fearful that, if outspoken, he may discount his prospects of prosperity. He may be orthodox or heterodox as to his religion: Republican, Democrat, Prohibitionist or Socialist as to his politics; he may hold and teach absolutely any sane conviction at which he has arrived, but neither Nature with whom he deals on the one hand, nor the markets with which he has to do on the other, will take the slightest cognizance of any of these things. Nature asks only that he be intelligent and industrious; and the markets, only that his offerings be of intrinsic value. Agriculture is rapidly coming to be one of the few callings in which the individual man may be himself, think and express his own thoughts, carry out his own policies, shape his own life, and wield with his might all the powers that he feels lie latent within him. In almost every other avocation in life the man is hampered and hindered, and perhaps denied the exercise of his most profound convictions. If the place he occupies is an humble one, so much the worse; but even though he occupy an exalted position which carries with it large remuneration, he finds always in attempting to carry out his policies, however vital he may feel these policies to be, that there are
other men, equals, in the employ of the same company; su-
periors, possibly, who must be consulted and argued with; that
often his desires, his strong convictions even, must be shaped
and shorn, and not unfrequently that they are entirely aborted.
Jealousies are ever present to defeat his ends and embitter his
life. Presidents and vice-presidents of great corporations are
often under the restraint of influential stockholders. In po-
itical life it is even worse. High officers, governors of states
and mayors of great cities must frequently be deaf to the rea-
sonable complaints of a long-suffering public, stifling at the
same time their own personal convictions, and be blind to the
misdeeds of the heads of departments who are ostensibly sub-
ject to, but are in fact contemptuously independent of, the
chief executive. He must all too frequently grovel to his
political boss and stand before the people as in the plenitude
of power while submitting to the most humiliating dictation
from the rear. Who shall say to the farmer, "Plant this field
with corn" when in his judgment it should be planted with
some other grain, or should not be planted at all? Who may
dictate to him in any other particular? He may be proudly
aware that no one expects him to confess any creed or main-
tain any view that is not in accordance with his deepest convic-
tions. Nor has he to yield to the opinions or to defer to the
prejudices or placate the jealousies of any man or of any set
of men, save only as the spirit of a broad humanity may lead
him in the paths of peace. His tolerance and self-restraint
may be exercised without the sacrifice of a jot or tittle of his
self-respect—without the impairment of his dignity or the de-
privation of the consciousness that he is essentially a gentle-
man.

There is not a section of the broad land which does not to-
day offer its own particular inducements to the agriculturist. The middle North, while still wonderfully attractive, no longer holds a monopoly of good things, either in lands or produce. There are farming opportunities in the East which are as attractive to-day as the West offered twenty-five years ago. The South is a veritable Promised Land. The stories of the far West and Northwest seem romantic in spite of their known truth and soberness.

It is the new era in agriculture that has rendered possible the reaping from the farms of this country the unthinkable sum of six and one-half billions of dollars within the year. These profits, evenly distributed throughout the farming population, are rapidly making for a condition of wellbeing unsurpassed by any other class of the citizenship. The social life of the farm is immeasurably more attractive than ever before, and the improved school facilities, the labor-saving machinery, the rural delivery of mails, the fine roads, the county and inter-county telephone lines are daily adding to the enticing features of the farmer's life.
CHAPTER II.

THE NEW SOIL—IRRIGATION

W E HAVE heard a great deal about "new land," and we know what the expression stands for, but as a matter of strict definition, there is no new land. The nearest approach to it is found in connection with great engineering works and in cities where, for one purpose or another, as for parks, docks and kindred uses, a few acres have been filled in, and these areas it were better to call "made land" than "new land." There are also very considerable tracts of swamp and marsh land too wet for cultivation which have been or may be rendered available for tillage by draining away the water, but such areas are "reclaimed" rather than "new," an appellation applied also to desert land made cultivable by irrigation.

What is usually termed "new land" is in fact virgin soil; soil which has never been pierced by the plow nor made to bring forth a crop, and which, because its constituent elements have never been drawn upon by cultivated vegetation, is found to be exceptionally fertile and productive. Wherever, therefore, a land exists the surface of which is at present non-productive, or but poorly so, by reason of climatic conditions, as in the arid and semi-arid regions of this country, or where, because of long-continued and unwise cultivation, or for any other reason, it lacks within itself the elements of fertility and productiveness, there, if the harmful factors are eliminated and the needful factors supplied, we shall have essentially a new soil, with all that such a soil implies of rich rewards for the labor bestowed upon it.
For the purpose of making possible such a soil, investigations, studies, analyses, surveys, engineering works, and all the ramifications of such an undertaking, are being carried forward by private enterprise, by corporate capital, by institutions of learning, by state governments and by the general Government, enriching old soils to a virgin state and adding millions of other acres of the highest fertility to the cultivable domain of the nation. Of equal interest is it that these researches and labors are not only adding to the fertile lands which are yet to be disposed of at Government prices, but the incalculably valuable information gathered by this army of experts at so great an expenditure of money, talent and time, all lies within the easy reach of anyone who will put himself into communication with the authorities who are leading the van of the enterprise.

The relation of water to soils, while known superficially for many centuries, is in this country only now in process of scientific investigation and development. In the make-up of a vegetable plant water is of very large proportionate importance. It is estimated that for every pound of dry matter which the plant produces, from 250 to 500 pounds of water are extracted from the soil; and while we know that but a small proportion of this fluid is retained in the vegetable tissue, the most of it being passed through and expelled by the leaves, we know also that the process is as necessary to the plant's life as the process of blood circulation or of breathing is to the life of an animal. Moreover, water is of the greatest importance as a solvent, preparing the food for assimilation and conveying it to the roots and rootlets of the vegetable growth.

Two decades have barely gone by since wise men were predicting the speedy coming of the day when all the available farming lands of the country would be pre-empted and occu-
CHAPTER II., FIG. 12.—LAKE TAHOE, COL., A SOURCE OF WATERS FOR IRRIGATION.
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pied, and that ruin would then overtake us because of the dis-proportionate growth of our cities. To-day there is presented to us the spectacle of a cultivable empire of 100,000,000 acres, and if we add the “dry farming” area which will become available when the art is only a little farther advanced, we have a farming domain still remaining not only greater in extent than all the farms which were under cultivation at the time the prophets uttered their dark sayings twenty years ago, but greater than all the lands actually under cultivation in the United States at the present time.

Thousands of acres of this new soil are now available, and millions of acres will become so as the vast systems of irrigation are completed which are now under way or are yet to be undertaken in the different quarters of the country, more particularly the West and Southwest. These sections deserve our consideration if for no other reason than that of their vast extent; but more particularly because they are evolving a material wealth and a social development of which no man who wishes to keep himself informed of his country’s progress can afford to remain ignorant.

In the southern borders of Colorado and Utah, in northern New Mexico and along the Salt River Valley of Arizona may still be seen the remains of irrigating works built by a civilization which centuries ago perished from the earth. He who visits the Pueblo Indians, either from curiosity or for some definite purpose, will find them irrigating their little patches of tillage just as their ancestors were doing at the time the first Spanish explorers passed through their country. The waters of the Rio Grande are laden with sediment, and this fact accounts for the hundreds of years of continuous service that have been rendered by certain old irrigating ditches
in New Mexico. In these, layer upon layer has been added to the sides and bottom of the waterways, until from a grade below the level of the soil they are now raised two or three feet above it. In this region one may see agriculture carried on by methods as primitive as those practiced in Palestine when Ruth followed the reapers of Boaz.

The Mission Fathers, accompanying and following the Spanish conquerors, established themselves here and there throughout the Southwest country to the coast. In Southern California, particularly, they surrounded their stations with fields which rivaled in beauty and fertility the farms and private gardens of the grandees of Spain, and this they did simply by the application of water to the arid plain. These meagre beginnings in irrigation remained unextended for centuries and naturally fell into decay, but in our day there have been constructed extensive systems throughout various valleys of this sunny land which supply to the soil the one element needed to make it abundantly fruitful, and the desert has been converted into a comparative paradise where thousands of acres of lemon and orange orchards blossom and bring forth under as skilful and energetic a cultivation, and with a remuneration in money unsurpassed in any section of the world.

For our beginnings of Anglo-Saxon irrigation we must go to Utah, whither the Mormons migrated, seeking their promised land. In July, 1849, the little band halted in Salt Lake Valley, turned the clear waters of a stream afterwards known as City Creek upon the parched and barren soil, and planted their last stock of potatoes in the hope of raising a crop which would save them from starvation. Utah is thus the mother of our modern irrigation industry, but she has taught us also the importance of public control in the division
and use of rivers, and the practicability and advantage of the small farm as the unit of the agricultural system in an irrigated region. With farms of an average size of thirty acres, Utah has grown rich with an evenness of prosperity unequaled in any other state of the Union, and the smallness of the farm holdings has resulted in an intimacy of social relationship and in a close peopling of communities that is found equally conducive both of contentment and wellbeing.

The Union Colony at Greeley marked the beginning of a new industrial development based on irrigation in Colorado. Prior to this enterprise it was mining, and the wandering and adventurous business of stock raising which had attracted settlement to that state. The Greeley Colony was an effort of homemakers who longed for the land-owner’s sense of independence, but who wanted no less earnestly the social and intellectual pleasures and privileges which had been theirs to enjoy in the long-settled communities of the East which they had left. Colony Hall was among their first public buildings, and the Lyceum among their first organizations. The only extravagance the Colony permitted itself was its school building, which would have been a credit to any New England town. Co-operation was the principle in the construction, and co-operation was the practice in the management of all public utilities of which the irrigating canal was the earliest and most important. Advanced methods both of irrigation and cultivation were sought to be put in practice, and wisdom was learned through failure and success until Greeley and its potatoes became famous together. Not many years elapsed before the Colony became the pride of the state, and supplied the inspiration which resulted in the settlement of northern Colorado. Boulder, Longmont, Loveland and Ft. Collins all
are the outgrowth of the success first shown to be possible at Greeley.

Twenty years after the beginnings of irrigation were made by the Mormons in Utah, and contemporaneously with those made in Colorado, similar influences were working like leaven throughout portions of California. She also had learned that her soil could be made as rich as her gold mines simply by the use of a little water, but the speculative spirit which had characterized the settlement of the state soon fastened itself upon her irrigating possibilities, infecting the whole region and running a course throughout the entire West as fierce as the gold fever of '49. Incorporated companies were formed to do the work hitherto performed by the individual or by communities working in co-operation, so that whereas the settlements in Utah and Colorado had depended upon their own muscular efforts in the building of their modest systems, the Incorporated Companies planned immense undertakings—enterprises worthy of the age—and for the construction of these issued stocks and bonds with visionary prodigality. Were they not going to build hundreds of miles of tubular and open waterways? Were they not going to provide for the irrigation of thousands and thousands of acres which, when so treated, would become incredibly productive and enormously profitable? Men began to dream of becoming billionaires by making merchandise of the melting snows; of an oligarchy of wealth unmeasured by the dreams of avarice and rendered perpetual by selling to settlers upon the soil the "rights" to the privilege of "renting" water, and in collecting in perpetuity an annual toll from a new class in Anglo-Saxon society who should be practical serfs, and be known as "water tenants."

There were two factors which made it seem reasonable to
CHAPTER II., FIG. 15.—WEIR ON MAIN CANAL, NEAR GRIDLEY, CAL.
suppose that these ambitious promoters and speculators would succeed in their designs. The first was the well-known and extraordinary fertility of the soil, rendered so only by the application of water. Upon irrigated land crop follows crop in immediate succession throughout the year; there is no uncertainty, and the yield is enormous—from three to ten times that of the same acreage in the older settled portions of the Union. Such farms as that of Samuel C. Cleek at Orland, Cal., had become famous. This “farm” consisted of one acre and contained no water; was characteristic of the region, parched and desert, a most uninviting place to begin a home. The first house which served as a shelter for himself and wife contained but one room. He laid out his land in an economic manner, and fertilized it by irrigation. Almost every inch of it became immediately productive. Crop followed crop in immediate succession and with unfailing regularity, as is the nature of crops from the irrigated soil of that section. Not only did the owner and his wife find an ample support, but every year terminated with a small, but augmented surplus in their treasury. A few years sufficed to build a beautiful cottage home, then two additional acres were bought and paid for, and thus the man became so independent, prosperous and well-fixed that he and his place, and men and “farms” of which this was a type were held up as object lessons to prospective farmers on the one hand and prospective purchasers of stock on the other. The other factor which made it seem probable that these dreams of an irrigated empire in the perpetual control of an oligarchy of capitalists would be realized was that nearly all the water of these regions that could be easily and cheaply diverted to the purposes of beneficial use had already been pre-empted by the early settlers, and henceforth the expendi-
ture of skill and money which would be necessary to develop irrigation would be beyond the means either of the individual or of the co-operation of many individuals.

And so companies were formed and stocks were sold to the amount of millions of dollars throughout the country, gigantic schemes were undertaken and very great and permanent works were built and rendered ready for operation. The Highline Canal, which watered the country contiguous to Denver, Col., with its tunnel through the rock and its aqueduct clinging to the cliff, but with scientific security because it was placed there by the highest engineering skill that money could buy; the system of the Wyoming Development Co., a single section of which—that through the mountain—cost more than all the Greeley canals combined, and its reservoir with a capacity for storing the total annual discharge of the Laramie River; the Sunnyside Canal of Washington, which, when first built, traversed the solitudes of a sagebrush desert for 60 miles—these are illustrations of what corporate capital did toward the development of irrigation in the great West.

Wherever these engineering works have been constructed there has been opened up for possible occupation a wide and fruitful acreage, and thus every region through which these artificial watercourses run has been potentially and permanently benefited. Every drop of water which they gather and divert will yet be utilized for the transformation of the desert into a new soil. They will yet do the full quota of work which they were constructed to perform—they will prove an unadulterated blessing to the whole country. In the meantime the hopeful investors in these large enterprises, the people who hold stock certificates for the millions of money which they contributed to build them, have realized nothing but a
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sweeping loss from their speculation. A single instance in one of the territories represents a loss to the stockholders of $2,000,000. The Bear River Canal of Utah, which cost $1,000,000 to construct, was sold for one-tenth that sum. A system in California represents a loss of $800,000, and so on throughout the list of these enterprises one finds almost invariably the same record of depreciation in values. The wreckage is shocking, but the catastrophe was inevitable.

The question has, of course, been asked over and over, “Why the failure of these speculative ventures?” Was it bad judgment in the selection of locations or in the methods of construction? Was it bad management in administration? Was it the actual misappropriation of funds and downright dishonesty? We believe that the percentage of downright dishonesty in connection with these enterprises was not preponderant. On the other hand, we know that in some instances at least the management was exceptionally able. Several explanations have been given; they may be summarized as follows: Inadequate and often reprehensible land laws, as found in some of the states. Settlers of limited means could not during the first year or two live and pay the water rentals. Long delay in securing settlers along the route of the canal. Speculative holders of land along the route—men who did not use the water, but held the land for its natural rise in value. Litigation as to titles and rights in water, and the expense and uncertainties of such litigation.

And thus the dreamers of empire have been unpleasantly awakened. The corporate control of the most vital element in the possible development of a great country has proven impracticable, and we think we know why it has so proven. The West is peopled by as hardy, independent and intelligent
a citizenship as ever trod the earth. To create a race of "water tenants" of them and their like from other parts of the Union who were actually disposed to become home-builders there is impossible, and should have been unthinkable. It was not that men were wanting who were able to live a year or two and meet the payments of water rental; it was not bad land laws as found in the several states, though these laws did doubtless need revising; it was not the speculative holding of land along the water route. There were hosts of people throughout the country who wanted these lands as homesteads—they knew the value of these new soils—but they would bear no hampering of their independence; they would suffer no uncertainty as to the value of their holdings due to a corporate control of their water supply; they did not propose, after years of labor, perhaps, and having brought their places into a high state of cultivation, to have their supply of water, which was absolutely essential to their life, raised just below the prohibitive point, or if they were found agitators for a more tolerable condition, cut off entirely. It was for this reason that the corporate ownership of these mighty works of irrigation has failed as a speculative venture, and however much we may sympathize with the guileless and hopeful investors who have lost their money, we recognize their loss as making mightily for the betterment of the whole people.

While the management of the companies which were incorporated for the purpose of building vast irrigating systems have been unable to induce settlers to occupy their lands with anything like a sufficient rapidity to save them from bankruptcy, nevertheless, taking the irrigated country as a whole, thousands and thousands of men did undertake to settle there, and they are the men whom we must thank for securing the
CHAPTER II., FIG. 18.—PRIVATE IRRIGATING PLANT.
rights of free men in this Western land. The struggle has been a very real one, not infrequently degenerating into physical encounters, but for the most part carried on through the tedious, often exasperating and always expensive processes of the courts; but out of the uncertainties, losses, hopes, fears, bitterness, persistence and faith of these years there have been evolved definitions of law and equity which secure the farmer in his water rights no less certainly than a good deed secures him in the possession of his land. The profound antagonism between riparian rights, the definitions of which were brought over from humid England and, being found adequate, were indorsed and confirmed in the humid portions of America, and the rights for beneficial use, as found needful on the arid plain, are settled at last in favor of the latter and in the interest of the irrigator, though time-honored common law traditions and precedents were invaded and a new process of adjudication had to be invented. Not only have state governments been compelled to take the deepest interest in the problems of irrigation, but the legislators of the nation have seen the necessity for action, and the Reclamation law of 1902 was one of the wisest and most far-reaching laws yet enacted by the general Government.

By the Reclamation law the proceeds derived from the sale of public lands is applied to the construction of irrigating systems and reservoirs, and the lands thus watered are sold at cost price on ten years' time to the people who benefit by them. That is, bona fide settlers may buy these lands, not less than 40 acres nor more than 160 acres, at the actual price which it cost the Government to irrigate them, paying for them in ten annual installments. As soon as the greater part of the cost shall be paid in, the management of the entire plant
—reservoirs, headgates, canals, etc.—will be turned over to the owners of the land, the title to the plant still vesting in the Government, to be disposed of by Congress. After the management has been turned over to the land-holders each owner, whether of 40, 80 or 160 acres, has one vote, and only one, for determining the policy to be pursued, so that no small holder may be "frozen out" nor the management be seized by the most powerful few. The plan is that of a pure democracy, and each share represents a definite tract of land.

Thus we are the favored ones who find ourselves at the beginning of the new era of irrigation. It is true that the laws of the several states are not all as yet by any means ideal, but the best is being rapidly evolved. The general Government is definitely committed to a gigantic, beneficent and most equitable policy; the mountain tops and highlands of the Northwest where the rivers originate are henceforth and perpetually to be set aside as reservations; reservoirs miles in area and hundreds of feet deep are to be built for storing the floods of great rivers; the water courses of the West are to be diverted to the beneficial use of a mighty population, and a hundred million acres of land as fertile and fruitful as the sun shines upon are to be opened to home-seekers as rapidly as the demand shall justify. Where corporate capital still controls the canals the laws of the states will see to it that "water renters" are absolutely secured in their rights, and probability points to the day when all irrigation systems will be in the possession of the people who depend upon them.

Irrigation reduces agriculture in the semi-arid portions of this country to a scientific certainty. The irrigator argues that, besides being more satisfactory, his water supply is cheaper than natural rainfall. He calls attention to the fre-
quency with which drouth in the Middle and Eastern States reduces the crop to half a yield. If the value of the full crop would have been but $25 an acre, then the loss per acre is $12.50. What would the farmer give for a sufficient water supply to secure a maximum crop? Certainly $10 an acre. But the irrigator gets his for $2 an acre, and besides he has constantly the satisfaction of knowing in advance precisely what he may depend upon, both in supply and in results.

But the benefits of irrigation become plainly apparent if we compare the selling price of farm land in the irrigated and in the other sections of the country. First-class Eastern farms sell for $100 an acre, because they are at the doors of an illimitable market. The same class of lands in the middle West sell at practically the same figure because of their abundant yield, and also because they are not too distant from the great markets. But what is it that gives to farm lands in Western Dakota and Kansas, in Montana and Idaho, in Utah, Colorado, New Mexico, Arizona, and particularly in California, a value equal to and often surpassing that of the best lands in the best sections of this country? If we consider the yield from irrigated land, the question will answer itself. In these regions 8 tons of alfalfa and 5 tons of timothy and clover may be mowed from a single acre during the year. An acre in potatoes will turn you out 13 tons, and an acre in orchard will bear you 12 tons of product. On the irrigated sugar plantations of the Rio Grande Valley, the average yield is 40 tons of the raw material, or 5,000 pounds of refined sugar to the acre, and the cane reproduces several years in succession before replanting becomes necessary. Onion growers have realized as much as $600 from a single acre. Near N. Yakema, Washington, lives Mrs. Snively on a farm of 4
acres of irrigated land. Her reported yield for 1904 was 40 boxes of apples, 5 tons of prunes, 1 ton of tomatoes, 1 ton of grapes, 4 barrels of cider, $15 worth of vinegar, $60 worth of cherries, $75 worth of pears and $20 worth of celery. In taking care of this produce she employed one man throughout the year, and an extra man for two months. Without definite knowledge of the value of the different items, the total cannot, of course, be given, but $1,200, after paying the cost of her help, is certainly a conservative estimate.

It is such yields as these, with the element of uncertainty wholly eliminated, that render these farm lands, even though at present they are far from market, so valuable to the home-seeker. In as healthful a climate as can be found anywhere, with toil well remunerated, with ample time after the day's work is performed for the cultivation of the mind and the finer elements of life, with the close neighborhoods and all the associations, relations and pleasures that are the concomitant of these conditions, it is a natural sequence that farm lands in these sections should attain to maximum values.

The very great advantages of irrigation have impressed themselves upon the country eastward to the Atlantic and southward to the Gulf. Three hundred thousand acres have been put under irrigation in Louisiana and Texas, where its services are added to the natural rainfall in the cultivation of rice. While the central and seaboard states have as yet done nothing in a large way, private enterprise has made beginnings in almost every one of them—Illinois, Michigan, Ohio, New York, Massachusetts, New Jersey—and the results reported are such that the practice is certain to be extended, how widely we cannot yet tell.

We have an authentic report that even in the dryest years
CHAPTER II, FIG. 20.—IRRIGATED PEANUT-VINES, NEAR STOCKTON, CAL.
enough water runs to waste in New Jersey to irrigate the entire area of the state, and that considering only the southern portion, where there are particularly favorable conditions for the storing of water, and neglecting what may be accomplished by the use of wells, fully 320,000 acres may be served by a canal system—enough to increase the value of the agricultural products of the entire state by 30 per cent. Thousands of farmers throughout all our humid regions are destined to find it practicable and profitable, by the use of windmills, gasoline engines and other prime movers requiring little attention, to pump water at first for the irrigation of a few acres and then for very much larger tracts before really extensive systems are put in under state control; this was precisely the sequence of development of irrigation in the arid West. It will yet be found to be good practice to drain a great deal of land in such a manner that the most persistent wet weather experienced in a given locality will be unable to do damage, while the same system which drains away any superabundance of water with which the clouds may soak the soil, being shut at the outlet and kept full of water either by gravity or the operation of pumps, will, by the escape of the water through the pores of the pipes, keep the soil sufficiently damp though the season should be one of prolonged drouth. This system of sub-irrigation, though more expensive in its first cost, has many advantages over a system of open ditches, not the least of which is its non-interference with the operations of cultivation.

Just how rapidly irrigation as a practice is to become general in the middle West, the East and the South depends upon a good many factors, and prophecies would be valueless.
A trial area of cabbage in Michigan gave a larger number of heads, with a total gain in weight of 11,325 pounds over a similar area similarly planted but left to be watered by the natural rainfall. In New Jersey an irrigated tract gave 45 pounds of beans where a similar tract of equally good ground, planted and cultivated in a precisely similar manner but left without the aid of irrigation, yielded only 17 pounds. Irrigated peppers yielded 1,277 pounds; peppers on a non-irrigated tract of the same size yielded 717 pounds. Two tracts of celery, the one irrigated and the other non-irrigated, yielded, respectively, 329 pounds and 136 pounds.

The examples above cited could be indefinitely extended. Of course, these results were obtained in a dry season, and it may be argued that such conditions do not prevail every year, but when it is remembered that drouths do frequently occur it will certainly be determined that for a certain class of products at least, irrigation is a paying proposition. Still another factor is the fact that different crops need different quantities to assure a maximum yield, whereas a natural rainfall pours an equal amount upon every field in the same locality without the slightest regard to the needs of the particular crop. To leave these crops to the haphazards of a natural rainfall is plainly, for many crops, an improvident procedure, and we may look for a steady, if not a rapid, growth of the practice of irrigation in the humid portions of the country, particularly in the Eastern States.

It may well be that the great staples, corn, cotton and wheat, which have hitherto gotten along very well without irrigation, will continue to be cultivated indefinitely without this artificial aid, but in the main, extensive agriculture is to give place
CHAPTER II., FIG. 21.—AN IRRIGATED ORCHARD IN ARIZONA.
more and more to the intensive system in which the control of Nature in the mastery of her elements is a primary and important part. The extensive greenhouses seen in the neighborhoods of our great cities are the embryonic beginnings of much greater things, and the next stage of this evolution will be the inclosed farm. Better than 200 acres exposed to an unmitigated climate will be from 5 to 40 acres under cover, where the temperature will never be allowed to fall below the freezing point, and where water will be supplied as systematically as the pharmacist applies it in the compounding of a prescription.

In general, therefore, irrigation means smaller farms and a much denser population than we are accustomed to think of as living in the country. This means a more even and general prosperity, and the stimulated development throughout the country of every species of industry, and this, in turn, means the rapid accumulation of wealth.

It is thus that irrigation stands for the development of the highest industrial life in the regions where it has been found or may yet be found practicable. It reduces uncertainty in agriculture to a certainty; it removes restlessness and discontent. The compactness of its communities makes for better educational facilities and higher educational standards. It stimulates a higher political development, and is thus conducive of better government. Altogether it means better schools, better churches, better social opportunities, better roads and more rapid communication; it means telephones throughout the country districts, and electric lights and rural delivery of mails; it means, in short, the most wholesome, and, in many respects, the most attractive life in the land.
It seems likely that not many years will elapse before a change will show itself in the attitude of our young men of good ability and that they will, instead of crowding into the commercial and professional pursuits, settle upon the soil, where they will find the freest scope for the full play of their powers, and opportunities for keen and wholesome enjoyment unsurpassed in any other avocation.
CHAPTER III.

THE NEW FERTILIZATION

If what we are now safe in writing regarding the fertilization of the soil had been offered for public contemplation only a few years ago the information would have been received with incredulity, if not with derision. To-day, while wonder is still excited by the new knowledge, and the knowledge itself is but meagre in comparison with that which is yet to be learned, we know that what we have is fact and not fiction; that it is established truth not to be gainsaid.

Within the memory of young men who have not yet attained their majority the soil was considered as so much dead matter, inert and void of all vitality. It was a thing to be plowed and planted, and upon its surface various materials, as stable manures, ground rock, bones, ashes, etc., were spread from time to time, and stubbles and certain living vegetation were occasionally turned under because it had been learned by experience that these acts "enriched the soil," as it was said, and caused it to bring forth more luxuriantly and abundantly. The one thing considered by the husbandman was the growing crop. The weeds were kept down, that they might not "choke" the crop. The soil was cultivated, that it might be more readily penetrated by the delicate rootlets of the growing crop. The surplusage of water was drained off, that the crop might not be drowned, and the normal and regular rainfall was longed for, that the crop might have drink as well as food. But that all these labors and processes
affected the crop only indirectly, and often remotely, was beyond even the power of suspicion to suggest.

To-day the intelligent farmer knows that the soil is not a composition of inert matter, but that it is so peopled by active organisms as to entitle it to the consideration of a living mass, and that every man who owns a farm may become a master and a monarch, exercising dominion over the living and not the dead.

The basis of all soil formation is bald rock, the original mineral composition of which, together with the circumstances of its disintegration, determine the nature of soils in specific localities. The granites, with their composite constitution of quartz, feldspar, hornblend, biotite; the volcanic rocks, the limestones of different kinds—all have been acted upon by the alternate seasons of heat and cold, by the alternate periods of wet and dry. Furious storms have swept over them; sleet and hail have pelted them; under the influence of sun and frost they have contracted, expanded and split and the roots of plants have forced themselves into their crevices; the disintegrating influences of all Nature have crumbled them, and rains and winds have washed and carried the debris into the plain. Surface and rain waters and the moisture of the atmosphere, all charged with various acids formed in the laboratory of Nature, dissolving out certain substances, leave only silica and aluminum, which, with water, forms clay. The quartz, remaining undecomposed, is set free as grains of sand by the disintegration of other minerals, and, mixed with the clay, loosens the latter, causing it to take on the semblance of an arable soil.

When organic matter, either animal or vegetable, is permitted to decay, while a part escapes as carbonic acid gas,
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the greater portion abides, gradually changing its character until none of the original characteristics remain. Its color becomes dark brown; its odor ceases to be that of decaying matter and becomes that of garden loam, and its reaction is neutral or slightly alkaline. In its final state it is called *humus*, and is the essential part of loam or mold as distinguished from the mere mixtures of the clay and sand.

Where the ideal combination of all the underlying elements, for any reason, fails to take place, there, of course, the ideal soil is lacking. It is thus that we have localities of almost pure clay and others of almost pure sand. The original constituents of the basic rocks also determine the nature of soils. On the other hand, these variations in soil formations give us in different localities soils especially adapted to particular products, as corn in Illinois and wheat in Nebraska.

The most important agent, however, if not in the original formation of soils, certainly in the fertilization of them, is a tiny creation which would have to be magnified some hundreds of diameters before we could hope to see it with the unaided eye.

We have heard so much of destructive organisms in the air and in the earth, in the food we eat and in the water we drink, that popularly we are disposed to disregard the friendly and helpful germs which also are of incalculable importance in the economy of nature. Throughout the tissues of the human body there dwells an immense population of phagocytes friendly to our health and wellbeing, which, when certain destructive forms appear, as for instance those causing suppuration, immediately mobilize at the seat of attack and wage a terrible warfare for the integrity of our physical domain and the driving out and destruction of the enemy. The pus and putrid
matter thus formed and the stench arising from it are the evidences to our senses of the slaughter of the battle and the fury of the fray. It is true that the struggle itself goes on beyond the reach of our vision, for the combatants are too small to be seen by the naked eye, but by the aid of the microscope we may see the vast hordes of these tiny creatures conducting themselves with desperate valor, and find many of our little allies dead upon the field where they have fallen, but not before each had embraced at least one of his antagonists with the grip of death. They are never panicstricken, they are never out-generated; if they are beaten it is simply because they are overwhelmed.

It is not only within the living animal body that infinitesimal organisms live and have their being; they are ubiquitous. The whole vegetable world is alive with them. All organic matter swarms with them. They turn your cider to vinegar, they sour the milk and ripen the cream for the dairyman. They are the active agents in every process of fermentation. All decay and putrefaction are due to them. They gather and fix and feed nitrogen to the vegetation needing it. They evolve acids of various kinds—they are manufacturing chemists. There is division of labor among them: they turn out different substances. They are carriers, bringing food within the appropriating reach of plants; and the class with which we are at present chiefly concerned serve as an efficient and indefatigable commissariat for the innumerable armies of growing vegetation which would starve and die but for their ceaseless labors.

As may be imagined, bacteria are of many orders, families and species. If we should compare them with all the visible forms of animal life upon the earth—bipeds, quadrupeds and
CHAPTER III., FIG. 24.—GROWN IN THE SAME SOIL WITH AND WITHOUT INOCULATION.
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winged creatures; white men, yellow men, black men; giants and dwarfs; civilized men and savages; elephants, monkeys and mice; vultures, pheasants and flies—with all the various kinds of foods consumed by these different creatures, and all the different avocations, industries and modes of life which are found amongst them, we would find an equal, and perhaps in some respects a greater, difference existing among the minute objects of our study.

Bacteria vary in size from one twenty-five hundredth to one twenty-five thousandth of an inch in diameter, so that a great swarm of them might dwell within a single drop of water. In shape they are spherical, oblong, rod-like, straight, curved and spiral. They multiply by division; a part of the body protrudes and is cut off by a constriction of the mass, forming a second body, fully developed like the parent, both of which then proceed to repeat the process, thus increasing numbers with prodigious rapidity. A very small colony of bacteria placed in a hogshead of water properly prepared will, within a few hours, discolor the whole content with their presence.

A temperature of 130 degrees Fahr. causes bacteria to cease all activity, and at a somewhat higher temperature many of them are rendered inert forever. They are most active between 75 and 100 degrees, and this, as we shall see, is why plants make their most vigorous growth during the Summer, and why the Tropics are more prolific in vegetation than the other zones.

Though most active at nearly 100 degrees Fahr., they withstand extremes of cold better than extremes of heat. Freezing suspends their life, but does not destroy it. They have been found upon the bare rock of high mountains where the temperature never rises above freezing, and being brought
down into more congenial conditions, they have awakened from their sleep of a thousand years and gone to work with all the vigor of young maturity. When their amazing vitality is recognized, it is not so difficult to understand their prodigious activity when operating under the favorable conditions of our Summer months and in our cultivated fields.

If one were to unearth a buried city, the streets and structures—all the surveys and plans, the shops and homes, the storehouses and laboratories—would in themselves attract attention and challenge study, but their greatest interest would lie in the revelations which they made of the living beings who once walked and worked in them. So also is it with the soil. These parts of it which are not endowed with life attain their highest significance as the home and habitat of a living and myriad population. Upon and between the molecules of matter of which the soil is composed they live and labor and multiply and thrive. They are divided into classes which feed upon different substances and perform different functions. Individually also they differ in size and shape and capacity. They all, these soil bacteria, require warmth and air, and they are active in darkness but not in light. Some obtain their sustenance from the atmospheric air which is mingled with the particles of the soil; others from soil moisture, though too much water destroys their activity. Still others feed upon the rootlets to which they themselves furnish food, as slaves might live at the expense of the master whose farm they tilled; while others still prefer freedom though compelled to obtain their sustenance from the inorganic grit which for food purposes would seem to be as poor in quality as it is abundant in quantity. It is probable, however, that in the last analysis we shall find that all classes of soil bacteria lay the earth, the air
and the water under tribute at the same time, each class and individual selecting that which is necessary to the performance of its function.

The human body, in common with all other animal bodies, is made up of certain elements existing in unlimited quantities in the atmosphere and in the mineral world, but before these substances are available as human food they must pass through a transformation—they must be taken, utilized and transformed by the vegetable kingdom. Vegetables and suitable vegetation we may use as food, but not inorganic matter.

The plant which forms the growing crop must have its food prepared by a precisely similar process of indirection. We were accustomed to think that the rootlets of a plant, coming in contact with the inorganic elements of the soil, had the power to assimilate them directly, thence to build them into tissue for the use of man and beast. Within limits we still believe this to be true, but it is now known that, with the exceptions noted, plants and animals have in common, that neither can live directly upon the inorganic. The elements which serve as the crude food materials of plants must undergo a decomposition and transformation by the operations of some lower order of life before they can become available as nourishment, just as the inorganic must be broken down and rebuilt into plant life before it becomes available for the sustenance of man. Take the substance silica for example, which is most familiar to us in the form of common sand. It is an important constituent of plant food, yet it is highly insoluble and would seem to be the least suitable of inorganic substances to enter into a plant’s circulation—least likely to become available as a plant tissue-building material.

We may imagine a minute fragment of silica or any other
mineral to be presented to the rootlet of a plant as food. However microscopic, it would certainly find obstruction at the point of presentation; it could not be bodily transported through the cortical covering of the feeding member to be deposited in its integrity as a constituent part of the plant tissue. Such a movement of that part of a soil substance which is of mineral formation could only result in the clogging of the pores, the interruption of the circulation and the consequent death of the plant.

Upon analysis, however, we do find silica in the mature plant, chiefly in the leaves, so that silica has not only been taken in by the rootlets, but it has been carried by the circulation to those parts most distant from the point of entrance. Since, as we have seen, it is impossible that the particle, as such, should have entered into the plant, it is evident that from its first state outside the plant to its final deposition in the leaf it has undergone a double transformation: first into some soluble form in which the member could appropriate it, and then a reconversion into silica on its way along the plant’s circulation to the place of its final deposition.

Phosphorus also is an example. In plants, and especially in the seeds of cereals, phosphorus is found for the most part in combination, just as it is in the soil, but in the plant it is the phosphate of potash chiefly, whereas in the soil it is the phosphates of aluminum, iron and lime, showing that the originals in the soil have undergone a complete decomposition and a chemical transformation in the course of their translation to their constituent place in the substance of the plant.

The dissolving power of water upon many elements of the soil has been referred to in a preceding chapter. When we consider the enormous quantity of water which the growing
vegetation of a single acre draws from the soil in the course of a brief season, from one-eighth to one-fourth of a ton for every pound of dry substance produced, and that all but a small fraction of this water is simply passed through the plant from its roots where it is taken in to its leaves where it is exhaled, we cannot doubt that the process has much to do with the carrying in of certain tissue-building material; but this does not account for the presence within the plant of those substances like silica, phosphorus, nitrogen, etc., upon which water exercises no solvent action.

There are three forces which may be considered as capable of effecting the primary changes in these difficultly soluble substances: plant secretions, the "vital activity" and soil bacteria.

It was formerly believed that the resistant substances were broken down by the action of the secretions and juices of the plant; that these materials, coming in contact with those portions of the plant which project into the soil, in some manner not clearly explained drew them into the plant body, where they were then acted upon and digested and rendered suitable for tissue building in some such manner as the gastric juice and the succus intericus of the animal body digest and render available for tissue building the various food substances upon which they operate. In the light of present knowledge, however, it is no longer reasonable to suppose that a particle of mineral matter, however minute, could be normally drawn into the plant by any conceivable process of suction or absorption. A preliminary decomposition must take place, but the secretions of a plant, though they escaped to the surface and were found like perspiration upon the rootlets, we have no reason to believe would possess the power of effecting such a transformation. The sap, circulating within the plant as
blood circulates within the veins of man, certainly effects certain chemical changes, but these are constructive rather than destructive, and are concerned with the re-formation, transportation and deposition of elements which were broken down and decomposed before they had found entrance to the interior at all.

The "vital activity" of a plant is a term not clearly defined, but is meant to convey the idea of a subtle power possessed by the rootlets by which they appropriate from the soil these elements which are necessary to the plant's wellbeing. Just how "vital activity" operates in this regard we do not at present know. That it is much concerned in the appropriation of food there can be no doubt, but it does not seem at all likely that it has much part in the preparation of the raw material by which it is rendered fit for ingestion.

The matter of practical importance, and therefore of the highest interest, is the established fact that the prime factor in soil fertilization is the presence and activity of soil bacteria.

The composite elements of a plant are carbon, hydrogen, oxygen and nitrogen; and, in smaller measure, potassium, lime, magnesium and phosphoric acid. These last elements are usually abundantly present in almost all soils. If they seem to be lacking it is not that they are really so, but that they are locked in combinations which render them unavailable. By methods and systems of plowing and planting these elements may be unlocked and brought out into useful form, so that no soil need be permanently poor for the lack of them. As for the carbon, hydrogen and oxygen, they are all supplied by the water and by the air.

It is nitrogen, therefore, that the farmer is most solicitous to supply. It is for this that he accumulates stall manures
and makes composts and plows under green growth and buys commercial fertilizers. He knows that four-fifths of the atmosphere which submerges his fields is pure nitrogen, but he knows also that his plants can no more live upon this nitrogen than a man could quench his thirst from the waters which surrounded him if he were in the midst of the sea. With suitable apparatus, by distillation, purification, etc., this water might be made drinkable, but it could not be used in the state in which it first presented itself. And the plant, though surrounded by such an immense quantity of the very element

which is essential to its life, will die unless this element has been put through a process which will convert it into available plant food. Once the nitrogen has been worked over by the subtle chemistry of Nature, the growing plant feeds upon it with avidity and thrives luxuriantly; but nitrogen in its native state as we find it in the atmosphere is practically valueless to vegetation. On this account great quantities of nitrogenous material—nitrogen in combination—manures, composts, and fertilizers of various kinds are annually hauled to the fields and deposited upon them. The nitrate deposits of distant parts, as the guano beds of Chili, have been ex-
exploited at an enormous profit for years to supply, in suitable form, our soil with the very element with which, as a gas, it is so abundantly bathed. To-day a change is impending.

A few years ago it was discovered by investigators in the German laboratories that the swellings or tubercles which appeared on the rootlets of certain plants were neither diseases nor abnormalities, but were in some way related to the vigorous growth of the vegetation. Upon cutting open one of these enlargements or nodules and investigating it by means of the microscope a multitudinous and swarming life was disclosed; the nodules were nothing but nests or balls of bacteria. Further research showed that these bacteria were friendly to their host, and it was finally made out that their function was to perform the last act in a progressive process by which nitrogen was extracted from its original sources and finally fed in this predigested form to the vegetation. Plants, it was learned, could no more appropriate nitrogen directly from its combined forms than they could directly appropriate the nitrogen of the air.

Following the discovery of the nitrogen fixing and feeding bacteria, a widely extended investigation showed their wonderful fertilizing effect upon soils deficient in nitrogen, and as early as 1888 Professor Nobbe had begun a remarkable series of experiments looking to a practical method of inoculating the soil with them. His studies led him to believe that if the most unpromising planting-place, as, for instance, pure sand, such as is found at the seashore, were sufficiently furnished with these nitrogen gathering bacteria, certain leguminous plants—peas, beans, peanuts, clover, alfalfa and the like—would attract nodules or nests of these feeders, draw their
CHAPTER III., FIG. 27.—TUBERCLES OF VELVET BEANS PRODUCED BY INOCULATION.
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nitrogen supply through their bodies and produce vegetable growth with the luxuriance of any other fertile soil.

By successive steps Nobbe isolated the germs, obtained them in colonies of pure culture and bred them by the billion. His experiments with them in sheer sand were crowned with the utmost success, and it was not long before an enterprising but eminently respectable German firm was putting the germs up in packages and selling them broadcast over the Empire. The attempted commercial exploitation of the bacteria was, however, a disappointment in every way. A few purchasers reported good results, but in the great majority of cases they failed to fulfil expectations, and after a few months the preparations were withdrawn from the market.

It was at this stage that Dr. Moore took up the work in this country. He discovered that, while the organisms had a pronounced preference for nitrogen in the form of salts—nitrogen in combination, as in well-known fertilizers—they were perfectly capable of drawing their entire supply from the pure gaseous oceans of it in the air. Give them nitrogenous matter to feed upon and they would not touch atmospheric nitrogen. He learned that every investigator who had sought to cultivate nitro-organisms had supplied them with food in the form of nitrogenous material—nitrogen in combination, and that this form of feeding had the same effect upon these tiny creatures that young men suffer when they have every want and wish supplied without an effort on their part—they failed to develop their powers, and upon exposure, as in commercial exploitation, they soon deteriorated and died. Dr. Moore sought to develop a more hardy breed. He gradually deprived them of all nitrogenous combinations and compelled them to seek their sustenance wholly from the atmosphere.
They did it, and the cultures now to be had have such nitrogen fixing power and such hardihood that they are from three to eight times as efficient as their progenitors, and they may be transported to any distance and left in a dry and inactive state for almost any length of time.

In the preparation of these bacteria for agricultural use the interior of a root tubercle is cut out and mixed with a medium of water containing 1 per cent. of commercial agar-agar, about 1 per cent. of sugar, from .02 to .05 per cent. of magnesium sulphate, and approximately .01 per cent. of potassium phosphate. Pure cultures being obtained, they are then transferred to a second medium made of the same material as the first, one cubic centimeter (a drop) of the culture being sufficient to impregnate 100 liters (100 quarts of fertilizing fluid). In this solution, which must be kept in a warm place, the organisms increase very rapidly, though their food supply is furnished wholly from the pure nitrogen of the atmosphere. Large quantities of this culture solution will within a few days become milky in appearance, due to the presence of the immense number of the developed bacteria. For the inoculation of the soil the fluid is then sprinkled either over the surface of the area to be fertilized or upon the seed to be planted in it, but for distribution absorbent cotton or other suitable material is dipped into the fluid containing the organisms and thoroughly dried, etc., in a chamber free from dust or other forms of contamination. It is in this form that the organisms may be kept indefinitely, and safely and cheaply transported by mail or otherwise to any part of the country.

The planter, upon receiving one of these packages of impregnated cotton, simply soaks it out in a suitable vessel, and within a few hours he may have as many gallons of bacteria-
bearing fluid as he may desire to use. This is then sprinkled upon the soil or upon the seed, as he may prefer; or he may wet a quantity of earth with it and scatter this as manure over the field to be fertilized.

Where soil lacking in nitrogen is thus inoculated the results are little less than wonderful. A plot of ground producing 372 pounds of crimson clover, after inoculation produced 6,290 pounds, and an immense increase is common with all the leguminous plants. Equally remarkable is it that these bacteria enable the plants to which they are more particularly partial—beans, peas, lentils, clovers, etc.—to leave behind them in the soil from which they are gathered such a favorable condition of things that the next succeeding crop is almost equally benefited. An acre yielding originally 932 pounds of cotton produced, following a crop of inoculated clover, 1,364 pounds, a gain of 40 per cent. A patch of wheat following a crop of inoculated melilotus showed an increase of 64 per cent.; potatoes after crimson clover, 50 per cent.; oats after velvet beans, 300 per cent.; and rye after an inoculated crop of peas yielded the enormous increase of nearly 400 per cent. Some time and some labor are necessarily bestowed in the fertilizing of a field by inoculation, but this is not so great, and the money cost is ridiculously insignificant—only a few cents an acre.

The intelligent cultivation of the soil is thus seen to be largely for the purpose of providing favorable conditions for its bacteria. They must have air and warmth and moisture. Where the soil is too wet plants do not thrive. Drainage is therefore resorted to, which is wise; but the real reason why the plants did not do well in the wet soil, at least, one of the reasons, and an important one, was that the superabundance
of water kept the ground cold, and thus interrupted the activity of the soil ferments. The furrow plow and the subsoiler not only loosen the ground so that the rootlets may the more readily penetrate it, but they make it possible for the rains which descend upon its surface to more evenly permeate it for the purposes of gradual use without rendering it too wet for the healthful habitation of its bacteria. The harrow and the cultivator render various services, not the least of which is the aeration of the soil—the supplying of an abundant measure of air to the nitrogen-gathering organisms.

Various substances will doubtless continue to be deposited by scattering over the surface of the arable acreage of the farm, and these will serve a manifold purpose. They will affect the physical properties of the soil, securing its flocculation and facilitating its tilth. They will induce chemical changes, rendering needful elements available, but also, being accompanied by the evolution of warmth, they will stimulate the growth and activity of the living constituents of the soil. It has often been observed and remarked how rapidly the growth of a plant is diminished by a fall of temperature. Though light is necessary to the wellbeing of plants, they grow most rapidly at night, and sometimes on warm nights with noticeable rapidity. These phenomena are due to the degrees of activity manifested by the nitro-organisms of the soil. Hereafter one of the first considerations of the farmer will be the breeding and feeding and general care of these myriad and microscopic servants of his growing crops.

And thus, with the new knowledge and the new methods of fertilization, wornout soils and those which by nature are but indifferently fertile may be made to bring forth bumper crops and yield abounding harvests.
CHAPTER IV.

THE NEW TRANSPORTATION

The building of the Panama Canal is the making of great history. It is not only that it is a stupendous undertaking, requiring the highest engineering skill to construct; neither does its importance lie in the mastery of its manifold difficulties, nor in its cost in gold. Its significance inheres in the influence which it will exert generally upon the commerce of the world, and particularly upon American life in its totality, intellectual, social and economic.

Tremendous pressure was for years exerted to forestall and defeat the purpose of constructing this waterway by the powerful interests which are engaged in our trans-continental carrying trade. Daniel Webster called the movement for the liberation of the African slave a "rub-a-dub dub" agitation, but in spite of his or any other man's belittlement of the project it went forward to a mighty consummation. The president of a great railroad system, and other eminent gentlemen, have sought with sneers to discredit the Panama project, but it is being constructed and it will be completed, because the tongue of the Nation has spoken it. What the effect of this short all-water route from our eastern seaboard to the Pacific and Trans-Pacific coast means is, in outline, plainly apparent not only to our manufacturers, importers and exporters, but to every farmer from Maine to the Mexican border, and from the Carolinas to California. It is to be doubted, however, if any man at present fully foresees the breadth and
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depth and far reach of the forces which this handshaking of the seas will bring to pass.

While the linking of the oceans as now undertaken did not enter into the calculations of our forefathers during the early days of the Republic, the subject of navigable canals and national highways as agencies in the settlement, development and unity of the country was profoundly considered, and a great system of these means of intercourse and transportation was the dream of the most able statesmen of the time. Before the Colonies had become a nation, Washington had found occasion to visit the Ohio country, and, as a military man, saw the importance of good roads as a means for conquest, safety and peace. When, as the first President of the United States, the obligations to a broad statesmanship were constantly present to his mind and heart, his early experiences in regard to easy interstate communication were expanded, intensified, and insisted upon on all suitable occasions. "Do you not think," he writes to Patrick Henry, then Governor of Virginia, "Do you not think, my dear sir, that the credit, the saving, the convenience of this country all require that our great roads leading from one place to another should be straightened, shortened and established by law? To me these things seem indispensably necessary, and it is my opinion they will take place in time." Before this there had been some effort at systematic road-making, but knowledge and skill seem to have been woefully lacking, and the highways of the day were hardly worthy of the name. The Old York Road, as it was called, running from New York to Philadelphia, was at intervals throughout its length a quagmire during two-thirds of the year, where a number of stalled wagons could often be seen, the drivers unhitching and coupling up in order to
assist each other in pulling through. There was a regular stage route running from Elkton, Maryland, to the Susquehanna ferry, which was in a chronic state of bad condition. It was noted for its steep grades, its deep gullies, its stones, its ruts, its general irregularities and its sideling slopes, so that the coach seemed always in a state of unstable equilibrium. It is believed that catastrophes would have been much more common occurrences than they were but for instructions which the driver was wont to utter to his passengers to lean out of the lumbering carryall upon this side or that, as the nature of the road demanded: “Now, gentlemen, to the right. Now, gentlemen, to the left.”

As late as the middle of the century just past, the most comfortable means of making the journey throughout the length of Ohio was by stage coach. Charles Dickens had occasion to test this mode of travel over the route in 1842. His description gives us a good idea of the condition of many of the roads of the day. “At one time,” he writes, “we were flung together in a heap at the bottom of the coach, and at another we were crushing our heads against the roof. The drivers on these roads, who certainly get over the ground in a manner which is quite miraculous, twist and turn the teams about, forcing a passage, corkscrew fashion, through the swamps and bogs. A great portion of the way was over what is called a corduroy road, which is made by throwing trunks of trees into a marsh and leaving them to settle there. The very slightest of the jolts with which the ponderous carriage fell from log to log was enough, it seemed, to have dislocated all the bones in the human body.”

There were, however, in various parts of the country some roads which were better than the corduroy. About the mid-
dle of the state, the coach which carried Charles Dickens crossed a well-made road which ran east and west at right angles to the route which was being traversed by the eminent author. When Ohio came into the Union in 1803 the law of admission contained a proviso that the proceeds from the sale of public lands in the state should be used in the construction of highways. This was the origin of the National Road, so called by way of pre-eminence, the first contracts for which were let in 1811. It was to extend from Cumberland, Maryland, through southwest Pennsylvania, over the Alleghany Mountains to Wheeling, West Virginia, thence across Ohio, Indiana, Illinois to St. Louis, Mo. The clearing for this excellent turnpike was 60 feet wide, along the middle of which ran the roadbed, 30 feet wide. After the Monongahela was crossed the steepest grade was only a little above 4 degrees. It was built upon the principles advocated by Telford and Macadam, and was so well constructed that it remains to this day a monument to its promoters and builders. Stone bridges spanned the rivers which crossed its path, iron mile-posts indexed its distances, and iron gates were placed at its tollhouses. Ten miles an hour was the average speed of the stage coaches which traveled upon it, though over certain sections the remarkable speed of 26 miles in two hours was said to have been attained. There were also great wagons, capable of carrying ten tons each, which were burdened with freight from Baltimore to Wheeling, where it was transferred to boats upon the river for inland points all the way to St. Louis and beyond. These picturesque overland freighters were drawn by twelve horses, and the rear wheels were twelve feet high.

In 1817 Calhoun and Clay voiced the requirements of the
Republic by advocating "a perfect system of roads and canals" throughout the country. They wanted a road like the Appian way which should extend from Maine to Louisiana, and serve, as they said, "as the principal artery of the whole system." They advocated the connection of the Great Lakes with the Hudson River, and for the purposes of political well-being, as well as for those of commercial prosperity, they urged upon Congress the wisdom of beginning, at least, the connection of all parts of the Union by a great and well-defined system of waterways and highways. In a modified form these most statesmanlike demands were finally embodied in a bill which passed both houses of Congress, but it was vetoed by Monroe, who did not believe it to be in accordance with the Constitution to make use of the National treasury in the development of internal improvements. After attempting in vain to pass the bill over the President’s veto, the Congress reverted to its former method of providing for road-building by the appropriation of funds received from the sale of public lands. In 1811, 5 per cent. of such proceeds were given to Louisiana for roads and levees, as a like per cent. had previously been voted to Ohio. A like per cent. of a similar fund was given to Indiana in 1816, and the following year Mississippi profited in the same manner. In succeeding years Alabama, Illinois, Missouri and Iowa were all voted funds for the building of highways and waterways. During these years also the annual appropriations for the Cumberland, or National, Road were continued, the last order, amounting to $150,000, made May 25th, 1838, bringing the sum total for this road alone up approximately to $7,000,000.

Toward the plan of a complete system of National high-
ways twelve other great roads were projected, and more or less work was done towards their completion. A road was authorized from Georgia to Louisiana, and another from Nashville to Natchez, Mississippi. In the course of the thirty years following 1806 $1,600,000 was appropriated for road-making purposes, of which sum Florida got $200,000; $286,000 was expended for a road from Chicago to Detroit, and $206,000 was used for building a road from Memphis to the St. Francis River in Arkansas.

Equally with the building of highways, the construction of navigable canals engaged the attention of the early statesmen of the Republic. They saw clearly that the only means of carrying on a profitable and popular trade over the magnificent distances of the United States—the only means of securing prosperity to her prospective population, and of binding all securely into a permanent political unity—was the opening up of navigation by means of natural and artificial waterways throughout the length and breadth of the land. Toward this end Nature had done much. The Great Lakes placed an immense territory within navigable reach of the States bordering on the coast. The Alabama, the Chattahoochee, the Ohio, the Cumberland, the Tennessee, the Mississippi and many smaller rivers offered themselves for the bearing of a mighty freightage from state to state, and from interior points to the gulf and to the sea. The plan of the people, as expressed by their leaders, was to connect all these natural facilities by artificial means, and thus cover the land with a network of navigable communication. The carrying of freight by water was then, as it still is, incomparably the cheapest form of transport known. It was a magnificent dream.
CHAPTER IV., FIG. 30.—TYPICAL SCENES ON THE OLD CUMBERLAND ROAD IN NEW JERSEY AND PENNSYLVANIA.
The most important step in the construction of a system of interstate and local communication by water was the building of the Erie Canal through the state of New York, connecting the whole upper chain of Great Lakes with the Hudson River, and so with the sea. The Oswego Canal connects Lake Ontario with the Erie, and the Champlain connects Lake Champlain with the navigable waters of the Hudson. The Erie was 350 miles long, and as first built, 4 feet deep, floating boats of 80 tons capacity, to accommodate which also its locks were built. A towpath ran along the whole length of all canals in those days, since animal power was the only means of moving the canal craft. For this purpose mules were usually employed. They were hitched tandem, and drew the boat by means of a hawser. Before the opening of the canal, freight had been carried by wagon from Albany to Buffalo for $88 per ton. The canal carried it for $22.50 at first, afterwards for $6.50, and still later the tolls were abolished entirely. Before their abolition, however, they had more than paid for the construction of the canal.

From the moment of its opening the Erie Canal and its feeders had been a popular success. It was soon taxed to its limit and agitation was commenced for its enlargement. It was proposed so to deepen it and to enlarge its locks as to increase its possible tonnage by threefold, so that whereas it formerly accommodated boats of 80 tons burden, it would, in its new form, accommodate boats of 240 tons. The work of enlargement was begun in 1836, but two factors entered to delay it and the undertaking was not completed for thirty years. The first of these factors was the financial catastrophe which fell upon the country in 1837, and the second was the advent of a hitherto unheard-of means of freight and
passenger traffic which dazzled the imaginations of men, and for many years absorbed all public interest in the questions of transportation.

With the period of the panic of '37 we need not concern ourselves at this time. The fact of chief importance in this connection is that this same period saw the advent of the locomotive and the railway as a practical possibility in the development of local and interstate communication, and the scheme appealed to the judgment and swayed the desires of eminent and ambitious men. Highways and canals came to be looked upon as unworthy the consideration of the modern time—the dreams of an obsolete age. No more interstate highways were planned, no more canal systems were proposed, while those already constructed were allowed to suffer from neglect. Of what use, argued the men of affairs of the day, is the pike road and the towpath when for every purpose, military, commercial and social, the railway is so much better? And, truly, when the merchant and speculator could be whirled with swiftness and comfort from city to city, and particularly when the lawmakers of the land could for the same purpose draw mileage from the pockets of the people, of what importance could the country roads possibly be? They were certainly as good as they had ever been, and why, within reason, should the farmer who got his pace behind the plow desire to go faster? No one seemed to appreciate the fact that the body politic is like the animal body in this regard that a suffering member causes all the other members to suffer with it; that national prosperity and the prosperity of each class depends upon the prosperity of all classes alike. But the desire on the part of the people to penetrate the wilderness of the interior gave rise to thou-
sands upon thousands of miles of new roads made without money, surveys or engineering skill. The blazed path of the pioneer was followed by the wagon or cart of the tradesman, and as settlements were formed and the communities organized these rude roads were turned over to the tender mercies of the road supervisor and the pathmaster, who were not infrequently men of executive capacity and public spirit, but with equal frequency they were just the opposite, and in any event the means for permanently improving the highways under their charge were practically never supplied them. Citizens were allowed to work out their road tax, which meant rather more often than otherwise the squandering of time in the fulfilment of the letter of the law while absolutely evading its spirit, the consequence being that while the equivalent of thousands of dollars were spent upon the highways of the country they were not permanently improved, many grades were next to prohibitive, while the low-lying places were often impassable.

Thus it came about that the railroads were encouraged to the neglect both of the waterways and the highways. A railway world was evolved, and companies were formed for the promotion of great projects. Federal aid was solicited, the public treasury was pledged to the extent of millions of dollars, and fertile acres and areas of imperial extent and potential value were given outright to the ambitious men who proposed to build railways. That the accomplishment of these schemes has been a potent and compelling factor in the dazzling development of the vast regions through which they have passed there can be no doubt. Whether the promoters have profited unduly by the lavish beneficence with which the public servants of a past generation handed over public
funds under the guise of encouraging public improvements is another matter. We merely observe that the granting of government subsidies for the construction of railroads in this country is now a past practice, which will probably never be revived. The railroad was one of several stages in the evolution of the transportation problem. To-day we are at the beginning of a new advance.

The whole people are waking to the incalculable value of the highway and the canal, too long lost sight of in the wonder of the iron road and the iron horse. While New York holds an advanced position as regards her highways, she is far in the lead as regards her canals. Her Legislature has passed the necessary measure and her citizens have ratified it by a majority of a quarter of a million votes to practically rebuild the Erie, Oswego and Champlain Canals so as to enable them to accommodate barges of 1,000 tons capacity, while the locks are to be made of sufficient size to take care of two of these craft coupled tandem at one lockage.

Long before the Erie Canal was built the pioneers had selected for themselves a water route of rivers, lakes and streams by which they could almost cross the Commonwealth. It is true that an immense amount of labor was involved in getting their freight around falls and rapids, in transferring from river to river and in heading fierce currents, but the route served a most useful purpose and was largely used. When the canal was built it failed to follow the pioneer's course because of the difficulty of constructing dams and locks along it, and particularly because of the impracticability of edging it with a towpath, which at that time was an essential part of every canal.

The new canal will follow the old only in sections. For
CHAPTER IV., FIG. 32.—A GOOD ROAD IN THE MAKING.
the most part it is proposed to carry it along the valleys, utilizing in so far as possible the rivers and lakes, thus reverting to the route of the pioneers, a plan rendered practicable by the wealth, the engineering skill and the facilities of modern times. The number of locks will be reduced from

72 to 38, and no towpath will be provided, since the old method of traction has given way to steam propulsion. It is by far the greatest work ever undertaken by any state. It involves an outlay of more than $100,000,000, and takes rank in the very forefront of canal propositions. In many ways its commercial importance promises to rival that of the Panama Canal. We do not know when the tonnage of the ocean
canal will equal 10,000,000, but the entire structure of the
Erie is based upon that tonnage, with provision for greatly
enlarging its capacity at any time at moderate cost. The
carrying trade of the Great Lakes is approximately 90,000,000
tons per annum, and the new canal will furnish the cheapest
possible outlet for this vast commerce to the sea. While the
cost per unit is not nearly so high in the construction of the
Erie as in that of the Panama, more material must be ex-
cavated, more masonry used, and more dams built in the
former than in the latter, while the engineering questions
involved in the one undertaking as in the other are of the
first magnitude.

While these lake canals are intended to enable New York
to retain her prestige and increase the degree of her com-
mercial supremacy by the cheap transportation to the seaboard
which they will render inevitable, they will profit every far-
mer, and every merchant for that matter, not only within
the immediate reach of their rates, but, by tapping the Great
Lakes, they will carry the same benefits for more than fif-
ten hundred miles back into the interior of the country.

The Panama Canal, while promising to prove of immense
profit to the eastern and western seabords, will exert an
ameliorating influence upon the freight rates of the whole
country, but particularly will this be noticeable throughout
the states bordering on the gulf.

If one great movement may be prognosticated from what
we know of the inception and progress of kindred move-
ments, then there is reason to believe that the era of canal-
building in this country has but begun. We may look for
Chicago to be connected by a great canal with Detroit or
Toledo, as we know she is with the Mississippi and the gulf.
CHAPTER IV., FIG. 34.—EASY GRADES IN A MOUNTAINOUS COUNTRY.
THE NEW TRANSPORTATION.

Cities like Atlanta, Ga., and Denver, Col., are destined to develop ambitions for deep-water communication, and thus artificial waterways of immense carrying capacity will continue to multiply, primarily for the profit of cities it is true, but always with the effect of reducing freight rates for the farmer, enabling him to get his produce to maximum markets at a minimum cost, and we may expect eventually that almost every cultivable county in the country will find itself within reasonable reach of the buyers of the world.

While the work of canal building on the gigantic scale indicated, has already begun, light is breaking from a new quarter. It is being realized at last that, though we have railroads and waterways for the transporting of freight over great distances, the public highway and the common road are of equal, if not of transcendent, importance to the economic interest of the citizen, the townsman and the countryman alike. Difficult roads, whether because of hills, gullies, sands or quagmires, are bad business for everybody concerned. They have kept the farmer poor and made him discontented; they have curtailed the profitable activities of towns to an incredible degree; while the greater cities are in the end deprived of that abounding prosperity which would be theirs if the primary sources of their wealth and greatness were themselves rejoicing in the pleasures of plenty. It seems incredible that it should have required so long a time to wake up. Under the old plan of working out the tax it was calculated that 2,000,000 days' labor were annually spent upon the roads of the state of New York alone, an outlay purporting to be the equivalent of $3,000,000. Mud in wet weather and dust in dry weather, almost impossible grades and nearly impassable roads were the result in all too many localities. They
were duplicated in nearly every state in the Union. To-day cities, towns and rural districts realize that they are mutually interested. The building of good roads has been taken hold of in earnest by many state Legislatures. The privilege of working out the road tax is being rapidly abolished and a cash system substituted. The National Government has created the office of Public Road Inquiries, and made it a part of the Department of Agriculture. Several of the states have enacted laws by which the Commonwealth pays 50 per cent. of the cost of road-building, the counties 35 per cent. and the towns the remainder. The offices of pathmaster and road supervisor are being abolished and the work of construction is being placed directly or indirectly under the management of competent engineers. It has been found that the steep grades so often met with along our highways may readily be reduced or avoided. Indeed, the re-location of many of the old roads is an important part of the good roads propaganda. Recent surveys have shown that the sides of rugged mountains are often susceptible to their very summits of roads up which a horse could trot without difficulty.

The railroad people who so strenuously opposed canal construction have within recent years become warm advocates of good public highways. Every railroad is sustained by the business which it secures from a narrow strip of land running along either side of its right of way. In times past these puffing powers looked upon themselves as lordly benefactors, took such traffic as came to them, and felt sorry for the farmers who were not in a position to avail themselves of the general opportunities which were offered. To-day a wiser policy prevails. It has become apparent to the managers whose business it is to earn dividends for their stock-
holders that if farmers who would patronize their lines are limited by their highways to a wagon haul of eight or ten miles, the territory tapped by the railroad will be but sixteen or twenty miles wide, whereas if the wagon roads are in such a condition that a haul of fifteen or twenty miles is practical and profitable, the railroad may enjoy the carrying trade of a thirty or forty mile strip. In other words, the possibilities for business are doubled by the mere matter of reach alone. This is not all, however, for these increasing facilities for reaching the railroad double the tonnage of the wagon load, induce the farmer to plant larger areas, bring in more produce, make larger shipments, order more matter by express, buy more merchandise, machinery, etc., all of which must be brought to his local depot by freight, so that in many ways it is apparent that good highways are an unadulterated advantage to the railroads. The receipts of the Mobile and Ohio Railroad were 65 per cent. lower for February, 1898, than for the same month of 1897, and 80 per cent. lower than for the corresponding month of 1896, due, the officers declare, to bad weather and bad country roads. A very few years ago, when the matter was first attracting attention, the Illinois Central was asked to send out over its line a "good roads train." Such a train carries professional road-builders and laborers, and an outfit of road-making machinery which is furnished free by the manufacturers as being a good means of advertisement for their wares. The cost to the railroad company for this train was estimated at approximately $50,000, and an official remarked that it was a good deal of money to throw into the mud. The train stopped at selected stations along the route, constructed in each place a stretch of sample road, and returned home. The exhibition
of building and the subsequent experience of hauling over these roads stimulated a movement in many of the localities visited to continue the good work for themselves, thus proving the efficacy of the "good roads train." The wisdom of the enterprise is no longer questioned, and to-day there is not a great railroad company in the land but is actively and practically interested in the movement for good highways.

The National Good Roads Association is carrying on an active and effective propaganda. Conventions, county, state and national, are held from time to time, covering every section of the country; public speakers proclaim the advantages of good roads and the disadvantages of bad roads, and statisticians back up the argument by figures and facts which are not to be gainsaid; literature is scattered broadcast; governors and legislators, both state and national, are furnished with information, and pressure is exerted by every honorable means and in every conceivable direction, stimulating a sentiment for the scientific construction of our country roads.

The League of American Wheelmen, with its branches in every state, influenced tens of thousands of people to become advocates of good roads who had never before had occasion to consider the matter at all. And now that the wheel is no longer the popular property that it formerly was, the automobile is efficiently taking its place as a factor in the good roads movement.

When the highest authorities present the evidence to the taxpayers of a state that bad roads cause a loss to them of $10,000,000 every year, as in North Carolina, or $3,000,000, as in the little state of Maryland, or $10,000,000, as in New York, and that this loss falls on all classes alike, it is not
CHAPTER IV., FIG. 36.—ROAD SCENE NEAR DONALDSVILLE, LA.
to be wondered at that things are coming to pass. Already
the public till has been tapped in many states, and this time
not by the spoilsmen, speculators and grafters, but by the
will of the people, for a wise and beneficent purpose. It is
at last recognized that the interest in good roads is a common
one—that it is unjust and preposterous to shoulder the bur-
den wholly upon the rural population—that it is not even nec-
essary always that the present generation should bear all the
burden when future generations will be equally benefited.
Bonds, therefore, are provided for. In one state as much as
three-fourths of the cost of the new roads is met from the
state treasury; in another 50 per cent. is borne by the state,
35 per cent. by the county and the remainder by the town.
Strange as it may seem, the farmers themselves have been
the hardest to convince of the desirability of good roads by
the new method, but at last it may be said that they also are
fairly aroused. To haul one ton one mile on the New York
Central cost two and two-fifths cents in 1869; to-day it costs
approximately a half a cent. Upon railways in general the
cost is three-fourths of a cent. But the average cost to the
farmer for every ton he hauls a mile over the roads at his
command is twenty-five cents—5,000 per cent. more than it
costs the railroad. No wonder the latter can make money
while the farmer loses it. Means have not been found by
which he can reduce the cost of his ton-mile haul to the rail-
road figure, and this is not to be expected, but whenever he
has the advantage of a good macadam road, laid out with
engineering skill, he reduces the cost to eight cents, a saving
of seventeen cents on every ton he hauls over the unit dis-
tance. Moreover, there is much subsidiary saving in the cost
of repair, and the longer wear of his wagons and harness; in
the lessened exposure and lengthened life of his horses; in
the less limited restrictions in the time of his going and
coming. A Maryland farmer reported that from February
to April he could not have marketed his wheat if the price had
gone to $2 a bushel. In France it is customary to utilize the
stormy days to do hauling when other work must be sus-
pended; but then France, with a territory only about three
times the area of New York, spends, it is stated, $25,000,000
annually upon her highways, keeping up a system of roads
that is probably equalled nowhere else in the world, and she
considers that she is pursuing a profitable policy.

And thus the rural communities have fallen into line with
all the other classes of our citizens. Much is being done,
and still greater improvements are in prospect. Word comes
particularly from the Carolinas, Kentucky, Tennessee, the
Eastern states and California that improvements are rapidly
taking place. In New York $50,000,000 have just been made
available for the construction of good roads. Wherever the
work is completed the acre price of farm lands has advanced
by from $3 to $30. In New Jersey, which may be said to
lead in the new movement, a thousand miles of stone road
have recently been constructed, and this is recognized as be-
ing but the beginning. From 100 to 125 baskets of produce
now constitute a wagonload where 25 baskets constituted a
load before, and it is estimated that $27,000,000 has already
been added to farm values of the state. A road running the
whole length of the eastern seaboard is proposed, and an-
other one throughout the full length of California, with a
trans-continental boulevard connecting the north and south
lines from Washington or Boston to San Francisco.

Good roads mean more money for the farmer. They mean
the consolidation and betterment of the rural schools; they mean the economic use of the farmer’s time; they mean the manifold advantages hitherto enjoyed only by the residents of cities and towns; they mean social possibilities and the gratification of legitimate social desires; they mean freedom of movement and the daily delivery of mail; they mean self-respect and satisfaction with his mode of life; they mean the homestead, to which the married children will return with pleasure and which the young folks will not hasten to desert. Back to the farm!
CHAPTER V.

NEW INTERESTS.

NE of the most interesting features of agricultural development in this country has been that which has followed the introduction of new interests. The sugar-beet industry, the growing of alfalfa, the keeping of angora goats, the raising of milo maize—these are a few of the features of farm life which have only recently assumed commercial importance and are still capable of enormous expansion.

The growing of rice has been practiced along the Southern seaboard since early colonial times; but less than ten years ago, by the occupation of new lands, the introduction of new varieties and the application of new methods, this industry presented a turn of opportunity the like of which has hardly been surpassed at any time throughout the history of American agriculture. The methods of banking in and flooding the rice patches and the manner of cultivating and harvesting the grain were scarcely different from those practiced in China and Japan during the past thousand years. Though the negro labor employed by our Southern planters was cheap, the coolie labor of the Orientalist was cheaper, and so American growers were constantly and hopelessly beaten in competition with the Eastern supply. Add to this that in our mechanical threshing and other manipulation of the cereal, the grains were invariably so badly broken as greatly to reduce the market demand for the home-grown article, and there was nearly a free field for the foreign product.
A few years ago it was discovered that certain sections of the South, parts particularly of Louisiana and Texas, offered promising opportunity for rice growing by wholly novel methods. Perhaps the general resemblance of these regions to the great prairies of the middle West—the level reaches of country and the fertile soil, coupled with the fact that climatic conditions and lack of altitude prevented their use as a profitable domain for wheat, cotton or corn, while at the same time rendering the supply of water which rice requires in excessive quantities an eminently easy matter, suggested the idea of a revolution in the methods of the rice raising industry. Then came, about eight years ago, the introduction of a new variety of grain, the Kushu. The Honduras sort, the kind that had previously been grown, had three defects. It contained such a percentage of starch in the grains that they were invariably broken in the process of milling, it deteriorated so badly within three years as to be hardly worth saving, and the yield was light. The new variety is comparatively undeteriorating; the grain is short and so hard that there is almost no breakage in milling, and the yield is fully 25 per cent. over that of the old variety. The importance of the greatly enhanced yield is, of course, apparent. The importance of the non-breakage of the grains in mechanical manipulation is seen by a comparison of the price of whole and broken rice, the former selling at $5 per hundred while the latter sells for only $1.75. The use of the new variety has so reduced the supply of the broken, or brewers’ rice, as the inferior kind is called, that in south-western Louisiana the demand cannot be met by the local supply.

The inception of the new movement dates from the day
when a few enterprising men drove modern machinery into the country and undertook the cultivation of rice by the methods, modified to suit circumstances, which were bringing forth such incredible quantities of corn and wheat from the prairie states a thousand miles to the north of them. They were immediately and immensely successful, and the magnet of their success began to draw immigration from near and far. Farmers felt the influence in Illinois, Iowa, Minnesota and Michigan. They felt it in the Eastern States and in New York. And thus from widely separated and distant localities the tide is at this moment flowing in. New rice farms are being settled so rapidly that the rice-growing region is repeating the scenes of the wheat-growing regions of the middle North a generation ago. An immense aggregate number of acres will this year be planted with rice, but the new interest is at present only well under way. The belt especially adapted to this industry varies from 20 to 50 miles in width, and extends from the banks of the Mississippi to and beyond the Brazos River, a distance of more than 400 miles. Moreover, in many sections of Florida a little capital judiciously expended would bring profitable returns. In southern Mississippi also there are large tracts of land suitable for rice culture which may still be had at merely nominal prices. When it is remembered that lands devoted to new purposes have frequently shown multiplied valuation within a comparatively few years—wheat lands that were bought for $1.25 per acre, and others that were obtained merely for settling upon them have within a generation risen to $100 an acre, and other lands, obtained at the same terms, and planted as orchards, now selling at $1,000 an acre—it seems safe to say that the man who is adapted to the occupation of
rice raising will hardly make a mistake in the acquisition of these new lands.

Rice has a higher nutritive value than any other cereal, and the almost absolute certainty of producing a crop adds to the attractiveness of the industry. Rice straw is about equal to good prairie hay for stock, while the hulls are a better fertilizing material than the hulls of the cotton seed. Rice forms the bulk of the food of one-half of the human family. It has been claimed that the races fed upon it are small of stature and inferior in mental caliber, but this statement is now known to be without foundation in fact. The small stature of the Oriental races is due partly to their manner of sitting upon their legs, and much more to their inadequate nourishment, due to poverty. The wealthy and the well-fed among them are not deficient in bodily stature, neither are they wanting in mental acumen.

Rice is a grain which is more attractive to the eye than either wheat or corn. It is abundantly nutritious, easily digested, and when properly prepared and served, probably as universally palatable as any other known food. Its prevailing high price has hitherto prevented it from becoming popular as a regular article of diet, but there is reason to believe that the future will see a very great extension of the use of the cereal in this country; besides, it seems probable that the methods of culture and management now in vogue by the planters of the Southern States will make them invincible competitors in the rice markets of the world.

The angora goat, whose long, silky fleece is so highly prized by manufacturers, was unknown as a commercial factor in this country until within very recent years. They are
CHAPTER V., FIG. 39.—KEEPING GOATS FOR PROFIT.

CHAPTER V., FIG. 40.—SEPARATING THE GOATS FROM THE KIDS BY MEANS OF A BRIDGE.
now sufficiently numerous to be valued at several millions of dollars. While the raising of the angora breed is still capable of wide expansion, it is to the milch goat and to the common goat that attention is more especially directed. A good goat gives daily four or five quarts of milk, which contains a good percentage of butter fat and makes up into excellent cheese. It is estimated that Germany owns about 3,000,000 of these animals, that they are worth $12,000,000, and that they yield enough milk every year to pay for themselves three times over. Every traveler is familiar with these sturdy little creatures, which as readily and regularly climb into the attic, often two or three flights up, to get themselves milked, as the cows in our own country come home from the pasture for a similar purpose. Since they require next to no care, and find feed for themselves where almost any other useful animal would find it hard to live, they have very aptly been called "the poor man's cow."

In England the business of raising milch goats has been entered upon as intelligently and as systematically as any other branch of stock breeding. People of rank and influence have engaged in the raising of milch goats not merely for pleasure and as a fad, but, first, as an advantage to their own households, and then as a sound business proposition. Among the many prominent people who are thus engaged is the Baroness Burdett-Coutts. Her goats are annually exhibited at the fairs and compete for premiums.

But while the dairy feature of goat raising undoubtedly presents promising opportunities for profit, the raising of goats for their skins is in many respects much more alluring. If all the goats now kept in this country were killed for their skins they would not furnish a product sufficient to supply
the demand. The market value of the goat skins now annually imported is approximately $25,000,000. In the raising of goats for their skins, however, it is not the skins alone that yield profit, though these are primary. The whole animal is sold—flesh, tallow, horns, hoofs, bones, viscera—nothing is wasted, so that the by-products more than pay for the cost and keep of the goats, leaving the skins as so much clear gain.

If it is asked where the new industry may be inaugurated with a fair prospect of success, a conservative answer would be, "Almost anywhere in this country." The United States does not contain anywhere within its continental boundaries a region where the goat would not thrive. Of course, where the cost of his care is least, there is the locality where the profits of his raising are most promising. The goat is one of the most hardy, enterprising, agile and self-confident of creatures. He is quite capable of living in any reasonable condition of climate and country, though his choice is a rocky, wild and elevated land. Wherever, therefore, there is a rough, rocky, overgrown region the goat will pick up a good living and grow fat. They feed upon brambles, weeds and undergrowth of all kinds, are usually well able to take care of themselves, need less attention than sheep and are a healthy and long-lived race. Where large numbers are herded, however, they should be provided with an attendant, but since this work is merely that of watching and requires neither strength nor skill, it is apparent that this item of expense is nearly negligible. Likewise in rendering the various products marketable the labor called for is only of average quality, and this work, instead of being continuous, is seasonable, like the harvesting of grain. Practically all the work connected
with the raising of goats for their skins is of such a nature as to be not only congenial, but recreative, to many persons. In the South Atlantic States—Tennessee, eastern Kentucky, northern Georgia and Alabama—an economical and well-distributed labor element is available for the industry. In these localities also the climatic conditions are almost ideal.

As the greatest market demand is for the skins, but little care need be bestowed upon the breed of the animals. Common goats of this character are the hardiest sort, and thrive upon the most common and primitive pasturage. The skins, which are in world-wide demand, depend for their availability and excellence upon neither breed nor care. Good foundation herds may be purchased at $2 per head, and males at $10. Wherever they are ranged upon unused and unsalable land they are, aside from the slight expense involved for attendance, almost gratuitously profitable.

With the large and constantly increasing demand for figs in the American market, the comparative hardihood of the fig tree, the evident profit to be derived from the commercial cultivation of the fruit and the universally admitted acumen and energy of men among us for the production of the new and the promising, it is somewhat remarkable that only now should this large interest be attracting the attention of our people.

The early French and Spanish settlers introduced the fig throughout the Southern section of the country and in California, and in all these regions it thrives abundantly. Even in the lower Hudson River Valley it has been grown successfully and, where well cared for during the winter, has been
known to bear well for years. In the South the fruit is used almost wholly for household purposes, being eaten fresh from the tree, sliced and served with sugar and cream, or stewed and made into puddings and pies. In California a serious effort has been made to produce salable dried figs, but no success has attended these undertakings. As a matter of fact, they have never produced the popular fig of commerce, which is the Smyrna. The price of this fig in the New York market ranges from 10 to 20 cents per pound, while the price realized for the California variety is but a fraction above 7 cents per pound, and when the Smyrna figs arrive it is difficult to dispose of the home-grown variety at any price. The successful production of the genuine Smyrna fig is a new industrial interest.

A little more than twenty years ago a large number of cuttings of the best varieties of the Smyrna fig were secured from abroad and were widely distributed and advertised, and it was confidently expected that a new industry would be the outgrowth of the undertaking. When these trees came to maturity, however, they could not be induced to ripen their fruit. The trees seemed to thrive; no fault could be found with the climatic conditions under which many of the trees were grown and the fruit formed regularly, but when it reached the size of a cherry or a marble it invariably dropped from the tree. Many theories were advanced as to why this phenomenon occurred, the most generally accepted being that the Smyrna fig growers from whom the cuttings had been purchased, fearing competition if the Americans should become successful cultivators, had forwarded only worthless varieties.

The efforts to establish commercial fig culture were not
NEW INTERESTS.

abandoned because of the foregoing failure. Enterprising men could not see why, with the right climatic conditions and the trees themselves abundantly thriving, the fruit should not be made to mature. In the course of the investigations a fact already known, but which had not received the recognition it deserved, namely, that the Smyrna fig owes its peculiar and popular flavor to the number of ripe seeds which it contains, was brought afresh to notice. The fact was emphasized that these seeds are only to be produced by the fertilization of the flowers of the Smyrna with the pollen derived from the wild, or Capri, fig. It was known that in Oriental regions the natives were wont to bring fruit-bearing branches of the caprifig and tie them onto the branches of the edible fig. Whether the natives in the performance of this practice knew it or not, the efficacy of the procedure depended upon the fact that the worthless figs contained nests of minute insects which, covered with pollen, crawled into the flowers of the fig to be fertilized, and upon these minute creatures depended the ripening of the seeds, and hence the palatable quality of the Smyrna fig. It is seen, therefore, that the fig is not a fruit in the ordinary meaning of that term, but a seed pod with its contents.

Farther investigation revealed the fact that the caprifigs are the only ones which contain male organs, while the flowers of the Smyrna contain only female organs. The fig insect (blastophaga grossorum) hibernates in the so-called gall figs of the wild variety, and these and the insects which they contain are essential to the development of the Smyrna fig. Smyrna fig flowers hand-pollinated with pollen from the caprifig had proven as early as 1891 that the desired fig could be produced, and thenceforth it became merely a
matter of natural pollination. With the recognition of the part played by the blastophaga, the selection of suitable localities where this insect could withstand the climate was all that remained to establish beyond controversy that Smyrna fig raising is practicable in this country. Already there are a few profitable acres of them in California, and many orchards of them are now being planted. New Mexico, Arizona and Texas also offer especially promising localities. The blastophaga will flourish in any dry climate where there is little frost.

The relation of the Smyrna fig to that of other figs is analogous to that of the Washington navel orange to the common orange. The new home-grown fig is destined not only to supply the home market, but it will enter into competition with the Oriental variety everywhere. Moreover, there is reason to believe that the superior product, the modern methods of curing and packing, the cleanliness in handling—a condition unknown in Eastern lands—and the elimination and the prevention of the development of the disgusting worms so often found in foreign figs—will be a telling factor in the wider popularity of the fruit and the increasing of the demand.

The commercial cultivation of the date palm also is to be undertaken in Arizona, New Mexico, and in the extreme southern portion of California. This palm requires for the maturing of its fruit a long, dry, excessively hot Summer, but its roots must be constantly supplied with an abundance of water. Irrigation effects the latter, the climatic conditions being found in the regions named. There is a low-lying valley in southern California which may be readily irrigated, and where the Summers are long and cloudless and the reg-
CHAPTER V., FIG. 41.—CLEARING PINE LAND FOR A TEA-GARDEN.
istry of the thermometer, usually above 100 degrees, often indicates 120 degrees of heat. Our home consumption of dates is yet to be supplied by the home-grown product, and the money now scattered abroad for this purpose is to be retained in the pockets of our own producers.

There exists in the United States to-day just one commercially productive tea farm. It is known as the Pinehurst Tea Garden, and is located at Summerville, South Caro-

CHAPTER V., FIG. 42.—TEA-PLANT. ASSAM HYBRID TYPE.
lina. It is an expression of the faith of Dr. Chas. U. Shepard in the possibility of American tea culture. The difficulty has not been that of a want of hardihood on the part of the tea plant, which readily adapts itself to a great variety of climatic conditions, but to the labor problem which Dr. Shepard seems to have satisfactorily and ingeniously solved.

The wide areas over which tea is cultivated throughout the world indicate the range of conditions to which the plant will adapt itself. India, China, Japan, Formosa, Ceylon, Java, South Africa, the Russian Caucasus—these indicate the world-wide adaptability of the plant. Within the torrid quarters of the equator and almost down to the sea level, in Ceylon, it is in commercial cultivation; and again, on the same island at an elevation of 7,000 feet above the frost line, it is found growing luxuriantly. It is said to be cultivated also, though less successfully, in regions where ice and snow hold sway during considerable portions of the year, as in the valleys of the Himalaya Mountains and the interior of China. The different localities produce different grades of tea, and all are not equally good. There is one condition, however, which the plant must always have, namely, an abundant rainfall. A light, fertile, well-drained soil is also desirable.

During the last 100 years there has been an enormous increase in the use of tea throughout the world; an enormous increase, therefore, in the production of tea, and in its exportation from the lands where it is grown. There has also, for some reason, been a change in the grades demanded by the consumers, declining steadily towards the inferior and cheaper varieties, until to-day in many families even of the well-to-do the taste of high grade tea is unknown. Coincident with the change in the grades consumed, but whether as
CHAPTER V., FIG. 44.—IN A TEA-GARDEN AT SOMERVILLE, S. C.
result or cause it is not easy to determine, there has been an incredible adulteration of the staple, so that what is drank for tea in many countries is often not tea at all. It is not only undesirable, but it is useless to try to compete in this or any other market with these inferior and adulterated teas, but surely, with a trade of 100,000,000 pounds of tea, which is the amount annually consumed by the American people, with refinement and wealth and culture rapidly increasing among us, there must be a market which is ever widening for a really high grade and superior tea. On the Dragons Pool estate, near Hangchow, China, there is produced a grade of tea which commands a price in the local market so high that none of the product is ever exported. It has already been demonstrated that a quality of tea can be grown in this country which is the equal of the best that can be produced abroad. The tannin in tea makes it strongly astringent, but adds nothing to its stimulating qualities. At Pinehurst it has been shown that teas may be produced which contain but
little tannin while at the same time the stimulating property is markedly present.

The tea plant grows into a luxuriant bush several feet in diameter and from three to four feet high. The part used practically amounts to the very tip of each stem, together with one or two of the top leaves. At Pinehurst the picking is all done by a carefully trained corps of colored children, who are judiciously superintended in the field, and whose interests are in some measure looked after during the entire year. They have shown great aptitude in the work, and it is by their employment that the management at Pinehurst has solved the labor problem—the problem of competing with the coolie labor of the Oriental world. There have been instances at Pinehurst of fine pluckings of 50 pounds of green leaf per day, whereas the laborer of China, Japan or India will with difficulty pluck 30. In the case of the coarser pluckings 100 pounds may be gathered in a day.

It is, therefore, demonstrated that the cultivation of the tea plant in this country is an entirely feasible proposition. The Agricultural Department at Washington believes in the future of the industry and has not only aided the work at Pinehurst, but has established an experimental garden in Texas. With the known ability of our growers to eliminate the undesirable and increase the elements which are wanted in a plant, it is not surprising to learn that the per cent. of tannin in home-grown tea is very small, while the per cent. of theine, that nerve soothing substance which makes tea a really valuable beverage, has been greatly increased. We may expect, therefore, that eventually the best tea in the world will be produced within the boundaries of our Southern States, that the price will always be that of a fancy article, but that the de-
mand will for years, and perhaps for generations, exceed the supply as the quality of the commodity is more and more widely discovered and appreciated.

There is yet another interest which we believe is destined to undergo a considerable development in certain sections of our country, and that is perfumery farming. In France and elsewhere in the Old World this industry has attained very large proportions, in one case, at least, a whole city being built up on the business. Perfumery bearing plants may be grown here as well as there. Indeed, there is no place in the world which offers more favorable climatic conditions for.
the production of fragrance than certain sections of our South, Southwest and far West. One must visit the rose shows of the Pacific Slope, or walk along the flower-bordered streets of a Portland, a Stockton, a Sacramento, a Los Angeles, and note how lavishly Nature pours her perfume on the air to appreciate the facility with which perfumery farming may be carried on here.

As for the methods of manufacture, they differ according to the substances to be treated, but they are all simple and easily undertaken by the most inexperienced. As an example, consider distillation. This differs in no essential respect from that now practiced for the extraction of peppermint, sweet birch and sassafras. Of course, where one is producing a substance worth $4 or $5 an ounce more delicate and better constructed apparatus should be used than if the product sought is worth only half that many dollars a pound, but the principle of operation is the same. The essential parts of a still are a boiler in which the rose leaves or other material are placed with water; some means of applying heat, preferably steam through the medium of a jacket, but frequently merely a fireplace under the boiler and a piece of coiled tubing through which the distillate passes off from the boiler to the receptacle. The coiled tubing, or worm, as it is called, is kept constantly immersed in cold water, so that the distillate as it passes through is condensed and issues from the worm in the form of a liquid. Distillation is available for a large number of plants, but not for all.

Maceration is another method which is frequently used in the production of perfume. By this method the flowers are immersed in melted grease (lard or tallow which has been thoroughly purified), the charge being renewed a dozen
times or so at intervals of twelve to forty hours. The sub-
stance thus obtained is either used as a pomade, or, being
digested in alcohol, the perfume is taken up, forming an
extract.

Still another method is that of enfleurage or absorption, in
which thin plates of glass are evenly spread with coatings of
grease upon which the flowers are placed. The glass plates
are placed in frames which support them one above the other,
and the flowers are renewed from day to day. Enfleurage is
the most delicate of all methods of perfumery extraction and
gives the best results.

In a consideration of the most suitable substances for treat-
ment, roses probably come first. Of perfumery articles im-
ported the highest value is that of the attar of roses. More-
over, every traveler throughout the South and the far West
is impressed with the abundant floral growth and the odorous
air of those regions, while the distillation of the attar may
be begun by anyone with no more than the most meagre out-
lay of capital. It is not meant that rose growing for their
perfume might not be made profitable in other regions than
those named. Turkish attar of roses is mainly produced upon
the southern slopes of the Balkans, and there there is an abun-
dance of cold and snow, rainfall and drouth, as the seasons
follow each other. There the rose harvest begins about the
last of May and continues only for a month. In comparison
there is, therefore, almost no section of this country where
rose growing for perfumery might not be entered upon with
some hope of success, but other sections seem particularly
adapted to this industry. There are wide regions where odor-
ous roses may be grown from six to nine months of the year,
and since it is known that their fragrance may be increased
by breeding, the prospects of success would seem to be not only fair, but flattering.

The art of distillation is simplicity itself, and the process of maceration and enfleurage may easily be learned. To know what flowers to grow in a given locality and how to grow them would, of course, require experiment, for indeed there is a great variety of flowers which may be grown for their yield of perfumery. People of small means deriving their sustenance from other sources of income may, especially in favorable localities, wisely embark upon the business in a small way, looking to the enlargement of their operations later on. A woman might farm for perfumery when no other occupation was available to her.

The cultivation of the opium poppy and other drug plants, the growing of chicory, of limes and of nuts, forest raising for timber—these and other interests suggest themselves in connection with the present discussion; but enough has already been said to indicate the breadth of new opportunities which still await the pioneer, if pioneer work be the kind which appeals to the taste. Many of the interests suggested may be inaugurated and carried on in connection with general farming, and one, the production of perfumery, should be widely undertaken by the women folks of farming families.
CHAPTER VI., FIG. 48.—THE WHITE BLACKBERRY.
CHAPTER VI.

NEW CREATIONS

The ever-widening demands of agriculture, together with the daring ambitions of men stimulated by their own past achievements and the success of their fellows in other lines of human activity, have induced demands for new products in the plant world, and, one after another, these are heed- ing the voice of their masters and coming forth from the hidden recesses of Nature where hitherto, from the beginning of time, they have successfully concealed themselves from the eyes of men. The white blackberry, the cactus fruit, the seedless apple, the pitless plum, the citrange, the pomato, the tangelo—these and other wonderful human creations are al- ready accomplished facts, the prophecy and the assurance of still more wonderful things yet to be revealed. The jugglers and prestidigitateurs of the natural forces in the realm of agriculture are unwilling that anything should escape their manipulation. They seek to subject to human control the size and shape, the color and odor, the hardihood and fecundity, the general appearance and the inherent qualities of trees, grasses and grains; leaves, flowers and fruits.

In the animal world but few new species have been pro- duced by human intelligence, the mule being the most noted, though the possibility of such productions must have been recognized from the earliest times. With animals and their immense improvement by breeding we are, how- ever, not now concerned. The sexuality of plants, while un-
suspected down to the most recent centuries, has during the period in which it has been known been utilized to obtain an equal perfection in type and a much larger number of species than has hitherto been brought about in the animal world. The first published information on plant gender was by Camerarius in 1692, and it was not till twenty years later that Thomas Fairchild brought about the first recognized hybrid by crossing a carnation with a sweet william. From that time on studies and experiments in plant life were steadily continued, but the last fifty years brought forth with an ever-increasing momentum more results than all previous time, so that to-day we are in a tide of achievements which promises to spread over all the face of the earth, causing it to fructify like Egypt after the annual inundations of the Nile.

The white blackberry is precisely like the well-developed blackberries now to be found in our markets except that it is, as its name implies, white in color. The one fruit is no better than the other, though the white berry is certainly more pleasing to the eye. Of more importance than the color is the fact that the thorns with which the ordinary blackberry and raspberry stalks are covered, and which so interfere with the pleasure and rapidity of gathering the fruit, are in process of suppression. Indeed, it is now certain that the elimination of the briars from the stalks of the whole species is an absolutely feasible proposition, and thornless rose and berry bushes are very soon to become so common as to excite no comment.

The fruit industry of Florida has in times past frequently suffered from spells of severe cold, the disastrous freezes of 1894-5 killing or severely injuring nearly every tree in the state and bringing a shocking and irreparable ruin upon very many of her citizens. Out of the efforts of Webber and
NEW CREATIONS.

Swingle to produce hardier varieties of citrous plants suitable for cultivation in this and kindred localities have sprung some absolutely new creations. The citrange is one of these. Its name is made up of the first syllable of the citrus, the general family of fruits to which the new product belongs, and the last syllable of the word orange, the particular fruit which it most nearly resembles, though it is not an orange. While we have a great number of interesting varieties of apples, due to the efforts of nurserymen and fruit-growers for a period of 200 years, the newness of the citrange is indicated not only by the fact that it is as yet unknown in the world's markets, but that up to the present it has not gotten beyond three varieties. These are the Rusk, the Willits, and the Morton. The Rusk was named for the Hon. J. M. Rusk, the first Secretary of Agriculture, under whose administration the initial work on citrus fruits in Florida was undertaken in 1895.

The citrange is a beautiful little product, nearly round, and when fully matured, deep orange in color, with a reddish flush about the apex. The surface is smooth and glossy, and in weight it is very heavy, frequently sinking in water. The skin, which adheres closely, is thin and tender, while the yellow pulp is tender, melting and exceptionally juicy. The pulp cells are small and similar in shape to those of the orange, but the membrane of which the cell walls is composed is tender, making very little rag. The fruit is acid in flavor, too sour to be eaten unaccompanied or unprepared, but with sugar it is most palatable. It is also slightly bitter, but this quality is no more pronounced than in the grape-fruit and its aroma is strong and pleasant. It may be used to make citrangade, similar to lemonade, and it may also be eaten with
sugar as an appetizer. It makes excellent pies, preserves and marmalade, and gives every promise of becoming a common article for general culinary purposes.

The Willits citrange is somewhat larger than the Rusk, and its skin is rough and serrated instead of smooth. It is sprightly acid, rivaling the lemon in this particular.

Both of these fruits are juicy, the Rusk particularly so, yielding a larger measure than the best lemons of corresponding size. They are also nearly seedless, averaging only about one seed to every four fruits. The Willits is an excellent substitute for the lemon for many purposes, as for the making of a refreshing drink, and for use with fish, oysters, salads, etc., its seedlessness being one of its recommendations in these relations. Both varieties are equal to either the orange or lemon for pies, preserves or marmalade, and, fortunately, when used for these purposes the flavors of the products made from the two fruits differ distinctly from each other, and both differ from all other citrus products.

The Morton citrange more nearly resembles the orange than either of the other varieties. It is from three to three and one-half inches in diameter, and nearly round, being slightly compressed at the stem end. The surface is nearly smooth, being somewhat pitted at the base and containing a few slight furrows, which run from the base to the apex. The rind is medium thin and does not cling so closely to the fruit as in the Rusk citrange. The pulp is translucent, light orange in color, tender and divided into segments, the separating membrane not so thin or tender as in the other two varieties. It is, however, much sweeter than either the Rusk or the Willits, though it is still too sour to serve as a substitute for the sweet orange of commerce. It is an admirable pre-
CHAPTER VI., FIG. 52.—MORTON CITRANGE 2-3 NATURAL SIZE—LATEST RESULT OF EFFORT TO PRODUCE AN "ORANGE" WHICH MAY BE GROWN THROUGHOUT THE SOUTH.
BREAKFAST FRUIT WHEN SERVED WITH SUGAR, THE FIRM SEGMENTAL MEMBRANE RENDERING IT EASY TO REMOVE THE PULP WITH A SPOON.

WHEN IT IS REMEMBERED THAT THE CITRANGE TREE IS SEMI-EVERGREEN, SHAPELY, ABUNDANTLY FOLIATE AND IN EVERY WAY ATTRACTIVE, AND THAT IT CAN BE GROWN WITHOUT PROTECTION THROUGHOUT THE WHOLE REGION OF THE GULF AND SOUTH ATLANTIC STATES, WHERE THERE IS AT PRESENT A DEARTH OF ACID FRUITS, ITS VALUE WILL READILY BE UNDERSTOOD. IT IS RECOMMENDED THAT THROUGHOUT THE REGION OF ITS ADAPTABILITY A FEW TREES SHOULD BE PLANTED IN EVERY YARD. THE ATTRACTIONS OF A HOME WILL CERTAINLY BE ENHANCED IF, DURING THE WARM DAYS WHICH PREVAIL IN THIS REGION BETWEEN THE 1ST OF SEPTEMBER AND THE 1ST OF NOVEMBER, A FEW FRUITS MAY BE
gathered at any time to be used in the making of a refreshing beverage. It must be remembered, moreover, that the cultivation of this tree has as yet hardly begun. From what we know of the possibilities of improving nursery stock, it is confidently believed that striking and valuable modifications will be made in the citrange also, and that the whole southern half of the country will yet be beautified and enriched by this new fruit bearing tree.

In the course of the experiments which led to the creation of the citrange another new product came into being. It was not a pomelo or grape-fruit, as the pomelo is frequently called, neither was it a tangerine, but having some of the characters of each of these, it was decided to call it the tangelo, a word formed from the first syllable of the latter and the last syllable of the former. It is a fruit reaching a diameter of three inches, somewhat compressed spherically and slightly drawn out at the end. In color it is of a shade darker yellow than the grape-fruit—not so red as the tangerine. The skin is thin and easily removed. Its pulp or meat is divided into segments, from nine to eleven, which are easily separated, and the membrane of the cells is thin and tender. The taste is sub-acid—more acid than the tangerine, but sweeter than the pomelo. The meat is tender, juicy, and of excellent quality. The grape-fruit owes its popularity to its appetizing qualities, and is largely used as a pre-breakfast food for this purpose. Its somewhat bitter taste, which is probably due to the presence of an alkaloid, renders it a health stimulant, and it is highly recommended for invalids. There is, however, too much acid and too much bitterness in this fruit to suit the taste of a great many people, and with these it is believed that the tangelo will be popular as soon
as its qualities become known, for it is mildly acid and its bitter principle is barely perceptible. There is no doubt, therefore, that the tangelo, which is capable of being grown throughout the orange bearing belt of Florida and California, will become an important commercial product from these states. And who shall say that with the steady and rapid progress now being made in the creation of new products of plant life, we shall not during the present generation see a luscious fruit in every way rivaling the largest, sweetest, most tender and seedless oranges of our day successfully grown throughout the entire area of the Southern States? The first step towards such a consummation is hybridization. This has already been taken, and we have the citrange and the tangelo, the former too small and sour to serve as a substitute for such an orange as we have suggested, and the latter too tender to be grown so far North. The next step is selection. That is, out of all of these trees that are grown under observation those only are selected whose qualities it is desired to perpetuate and improve, as size, flavor, hardihood, texture, etc. This is the process by which odors have been given to flowers, colors have been bleached from berries, seeds been eliminated from apples and plums, briars from bushes, and poisons from plants. With care and cultivation and selection scrupulously and persistently carried out through the years, who shall say what the citrange and the tangelo may not do for the whole South? One sweet citrange fortuitously discovered, and serving for the initial act of a process of selection, may work a revolution, and such a citrange has already been found.

Another novelty, destined, in the near future, to cut a decided figure in the fruit markets of the world is the seedless apple.
So convenient and advantageous is seedlessness in any fruit that this characteristic appeals at once, not only to the farsighted grower, the shrewd dealer, the multitudinous consumer, but to the casual observer as well. With the single exception of use as food for animals, to which various kinds of fruit is sometimes put, there is, perhaps, not another service in which seeds and core is not a distinct detriment and disadvantage. The great navel orange is an example of what seedlessness means in the world’s fruit markets, since this variety is not only a pronounced favorite with everybody concerned,
but, for certain purposes and with certain classes, it has well nigh driven the seed-bearing kind out of the field of competition. It seems to be a fixed law that in the development of seedlessness any membrane found in the body of the fruit, such as that forming seed pockets and segmental divisions, either gets to be so tender as to become negligible or disappears en-

CHAPTER VI., FIG. 56.—SPENCER SEEDLESS APPLE—SECTIONAL VIEW.

tirely. Thus, in Webber's new creation, the citrange, the membrane is exceedingly tender and is evidently in process of obliteration. This means the removal of an indigestible substance from an otherwise edible pulp; it means, therefore, a more healthful fruit; and it means a more economic fruit, since in the preparation of a seed-bearing variety for human food there is much waste matter to be removed and time and labor
are required in the process, so that the seedless kind results in an enormous aggregate economy.

The work of Spencer, whose name the specially cultivated apple bears, has been no more unique in method than that of other stimulators of horticultural evolution, but the fruit upon which he has chosen to expend his labors is of very great commercial and economic importance. Indeed, in these respects it is unsurpassed. The apple is everybody’s fruit. Besides the millions of bushels annually consumed at home, millions of barrels are annually shipped abroad. Already there is an advanced guard of fruit growers and farmers who have learned what our most successful manufacturers have found out, that the way to invade and capture and control the world’s markets is to replace old methods, old machinery, old varieties of grain and root and fruit with the latest and the best, pinning their faith to the unshaken law that whatever meets the universal demand and is most economic must meet with the most certain financial success.

The tree bearing the seedless apple is blossomless. In its stead is a cluster of small elongated green leaves, in the midst of which the fruit is formed and sheltered. It is claimed that on account of the protection thus afforded early frosts pass these apples harmlessly by; but, while this statement seems reasonable enough, I am not able to speak from personal knowledge regarding it. I have, however, had the privilege of seeing and cutting these apples and it is certain that they are seedless and practically coreless, there being only a thin membrane, and this in process of obliteration, to indicate the former existence of the seed pockets. The apple is a winter variety, a good keeper, about the average size of the Baldwin, while in flavor it has been compared both to the Baldwin and to the
Winesap. It is a beautiful fruit, its red surface being sprinkled with strawberry dots. Since each unit contains at least one-fourth more edible substance than the seed-bearing kind, and since more convenience is enjoyed, and less time and labor are consumed in preparing it for culinary purposes, it needs no prophet to foretell its speedy popularity with the consuming
public. The phenomena of the Smyrna fig newly developed on the Pacific Slope furnishes excellent data for forecasting the market demands for the seedless apple.

On the Western slope Burbank is attracting the world's attention by his wonder-working in plant creation. He found by chance a little, ugly, worthless wild plum, having its stone almost obliterated by a fortuitous variation. This he proceeded to cross and cultivate and select, until now he has fixed this pitiless characteristic. Its flavor is not yet satisfactory, and he is continuing the breeding to improve it in this regard also. Progress is not rapid, but it is steady and certain, so that a plum of solid meat which one may sever with a knife as if it were a potato is among the new fruits which the growers of California and districts of similar climatic conditions will some day be able to supply by the car load to the consumers of the world.

The plumcot, a three-parent hybrid, but so distinct from any known fruit as to deserve a distinct name and be known as a new creation, is a large and luscious fruit, beautiful, nutritious and delicious, and bound to become popular, and hence of both commercial and economic importance.

The potato is, in so far as the manner of its bearing is concerned, a tomato, but the vine is like that of a potato, and in several respects it would seem to be a potato growing bottom side up. In shape the fruit is about that of the tomato, but it is white instead of red, and it is fragrant and juicy. Its flavor, unlike anything known in this country, is somewhat similar to that of the po-ha berry of the Hawaiian Islands. It makes an excellent article for cooking, and it may also be eaten out of hand.

It is impossible within the limits of a single chapter to give
CHAPTER VI., FIG. 58.—SAMPSON TANGELO MUCH REDUCED.
more than a mere outline of what has been accomplished in the realm of human creations in agriculture. The blackberry-raspberry, which is neither blackberry nor raspberry; the strawberry-blackberry, as distinct from one parent as from the other; chestnuts with the burrs bred off; peach-almond trees, attaining a growth of ten times that of the peach or the almond during a corresponding length of time; the baby bearing chestnut, not that the fruits are of diminutive size but that the little plant begins to bear when only six months old and not more than three feet high; walnut trees which do not bear at all, but which grow fully four times as fast as any walnut known, faster, indeed, than any other tree of any kind in the temperate zone; the walnuts which do bear, the shells of the nuts of which were bred down so thin that the birds picked holes through them, whereupon it was decided to breed them backward to a slightly greater thickness in order that the facility with which the shell might be broken should not be a defect; the ten-inch poppies; the giant seven-inch calla, as well as the smallest calla, only about an inch in diameter; the ill-smelling dahlia deodorized and recharged with the odor of the magnolia; the magnificent five-inch daisy, brought up from the dime-sized pest of the farmer's field; the perennial rhubarb, tender in structure but giant in stalk and leaf; the great prune, fully five times as large as the French variety—these are a few of the many things which are of interest in this ever-extending field of investigation.

Before closing this section of our story, however, the changes which have been wrought in a desert plant, the cactus, are of such possible economic importance as to deserve something more than mere mention. The Great American Desert, as the wide regions of our arid West have been
called, is by no means devoid of vegetation. With the profound changes which it is now known are possible to be brought about in plant life, this is a fact of far-reaching significance. In these inhospitable regions where there is but a very scanty rainfall, and in the even more inhospitable regions where no rain ever falls, the sagebrush, the greasewood, the polo verde, the polo christi, the yellow-flowered opuntia, the prickly pear, and the many other varieties of cacti—all are found, if not in abundance, at least as frequently as we could expect. Many of these plants are worthless as food both for man and beast, but they prove one thing, namely, that the desert is capable of an abundant production, such as it is. At present the most of them are not only uninviting, they are positively repellent. They are fibrous, they contain poisonous principles, they are covered with briars and spiculi. These characteristics are evinced in the popular names: "the prickly pear," "the creosote bush," "the green thorn," "the Christ thorn," "the catclaws." If, now, one of these plants, the cactus, for example, were something different from what it is; if only it had no thorns; if its thick leaves and bulbous fruits had an edible pulp instead of a fibrous formation, bringing death to any creature feeding upon them; if, ah! if and if—what a change might be wrought in those millions and millions of desert acres which we are hopeless of ever bringing under irrigation because the water is impossible of being procured for the purpose. When the oil is eliminated from the growth of the greasewood; when the sagebrush is turned into a shade tree; when poison, fiber and thorn are bred out of the nature of desert plants and the serviceable and the edible and the nutritious are bred into them, then economic changes of the first magnitude will be impending.
CHAPTER VI., FIG. 59.—POMELO OR GRAPE FRUIT, MOTHER PARENT. DANÉY TANGERINE, MALE PARENT. ŠAMPSON TANGELO AND HYBRID FROM SEED OF SAME.
NEW CREATIONS.

Something over ten years ago Mr. Luther Burbank, whose work is only now attracting the attention it deserves, began cultivating the cactus. It has, therefore, been a long process, has entailed great labor, and has required an exceptional degree of persistence and patience, but to-day the work is practically done. "For fifty years," writes Mr. Burbank, "I have known of thornless opuntias (cacti). Among the thousands of varieties which I have produced, the variations of fruit, foliage and growth are as distinct as among apples, peaches, etc." In the variety here illustrated the hard and deadly fiber has been eliminated and a pulpy substance substituted, toothsome and nutritious. The fruit is in shape sometimes nearly that of the apple, sometimes that of a short, thick cucumber covered externally with slight protuberances—all that remains of the once forbidding thorn. Within, the meat is of a yellowish, golden hue, and its flavor gives a new experience to the human tongue. To one man it suggests a melon, to another a peach, to another a pineapple, to another a plum, but no one can define it because it is like nothing hitherto known. The new fruit may be eaten raw, but it also serves many culinary purposes, while its leaves, those thick, fleshy lobes which grow so oddly the one out of another, make excellent preserves.

Cattle devour this cultivated cactus with avidity, and since analysis shows that it is full of nutriment, if offers great promise as a forage food where herds and flocks have never found forage before. It grows with great rapidity, scores of pounds of healthful fruit being the product of each plant during the year, and the plain possibility of planting and cultivating it throughout a region where animal life has hitherto found but scanty sustenance and where the solitude and
THE NEW AGRICULTURE.

silence has remained unbroken for unnumbered centuries is extremely stimulating to the imagination.

But this is by no means all of the promise that is bound up in this new creation. It has during the process of its development acquired an exceptional hardihood, so that it may now be grown in almost any climate from the tropics to the northern limits of plant life. It is not only a vigorous and hardy grower, but a ready one as well. No drouth will affect it, no freeze will kill it, and on this account it may come to take its place on the farm as a kind of insurance crop—a crop always sure, no matter what else may fail. A leaf of it stuck into the ground will grow; either end may be planted, the effect is the same—a vigorous sprouting. A leaf carelessly thrown upon the ground will indeed dry out in the sun, but in due time it will be found to have taken root nevertheless. All it asks is that it may be permitted to come in contact with the soil. It will grow either from the sprout or seed. After a thorough investigation of the economic possibilities of this cactus, Mr. Burbank was paid $1,000 a leaf for it, the intention of the purchasers being to transplant it in one of the semi-arid sections of Australia.

Now, it may be asked, how are these new creations in agriculture effected? Not by the wizard’s wand nor the exercise of occult powers, as we are wont to say in figures of speech to express the wonderful, but by the patient, persistent, intelligent handling of material factors in such a manner as to permit the ever-present and universal forces of Nature freely to operate. No new laws are brought into being, but facilities are offered for new manifestations of those laws which have ever been. It is as if a man should speak into a telephone and be unable to make himself heard, and, listening
at the receiver, get no reply. If now he bring certain parts into contact, either automatically or by an order to central, the vibrant current will work with facility throughout the length of the line, with what were, not long since, considered new and wonderful manifestations.

One of the most potent practices of the botanists and horticulturists in the work now under consideration is hybridization—the crossing of different species, as the chestnut and peach, the potato and tomato, the tangerine and the pomelo. This breaks up the life habits of the plants, produces greatly modified forms, and opens the way to new creations by additional breeding and culture.

Another means used is that of cross-fertilization—that is, breeding between individuals of the same species, so called, but of different varieties. Selection also plays a most important part; and besides this, there are all the variations of environment, as food, temperature, water supply, and so forth, which plant breeders know so well how to regulate to their purposes.

It was by selection alone that Burbank bred the fragrance of a sweet Southern flower into the dahlia. By chance he found one dahlia which, instead of having the characteristic unpleasant odor of its kind, bore a faint, indefinable, but pleasant fragrance. This flower was isolated; its seeds were carefully saved and planted. The second generation was numerous, but not one flower in fifty gave promise. Some had almost no odor, some had reverted to the odor of their more distant ancestors, but a small number had the pleasant odor that was wanted, and a very few had this fragrance in a perceptibly greater degree than the parent flower. These latter were then selected and the seeds planted; the others were de-
stroyed. Thus generation after generation were grown, only the most fragrant being selected for the successive plantings, until now a dahlia with the fragrance of the magnolia is an existent thing.

In precisely the same way may any color and any hue be given to a flower. The white plumes of the pampas grass have been bred from white to pink. A California poppy was found which by a fortuitous variation had a crimson thread like a thin stream of blood running down its inner surface. In succeeding generations, by selection, this red has been more and more increased, until out of it has developed the crimson poppy. We are authoritatively assured that a blue rose is attainable. Burbank declares that we may have any color we wish. Pink flowers and white have been cross-fertilized, and the result has been an offspring in which both colors appear and are beautifully arranged. Some of these days, when to the red rose and the white rose there is added a rose of blue, some patriot plant breeder will cross the three and then Nature will give us an American Beauty which will set at rest forever the discussion as to which shall be considered our National flower.

These wonderful works in the plant world are fraught with a large meaning. They mean the addition of many millions of acres to the available domain of man. They mean the aesthetic improvement of the world and the enormous enrichment of the race. They mean the discrediting and rejection of a great body of hoary doctrine. They mean that Mendel is an authority no longer, and that Hubrecht and De Vries must reconstruct their theories. They are profoundly affecting philosophy, and are battering at the very
foundations of chemistry. They mean that heredity is only the sum of all past environment, and that acquired characteristics not only may be transmitted, but that they are the only characteristics which are transmitted. They mean the mutability of species and the certainty that Darwin, in large measure at least, was absolutely correct in his conclusions. They stimulate the imagination until man dreams of the fu-

CHAPTER VI., FIG. 6I.—A PITLESS PLUM, PIT SOFT, EASILY SEVERED AND IN PROCESS OF OBLITERATION.

ture as if he were intoxicated with the fumes of opium. They also reach backward and lay their touch upon the first hour of time. Darwin did not attempt to define the vital principle which carried forward his evolution. Huxley declared that matter was a "magazine of force." David Starr Jordan believes that the theory of ions will be thrown aside and no line left between force and matter—a universe which is all force. Burbank believes in a universe which is all life, soul,
thought—a universe not half dead, but all alive. The sacred book of the Hebrews has it, "In the beginning—God."

Speculations regarding the Infinite we will take up as we have inclination. In the meantime, the new creations in the plant world have a practical significance which appeals to the present and is readily understood.
CHAPTER VII.

NEW VARIETIES

WHILE new creations in agriculture give promise of enormously enriching the race and throw open the door to an unlimited vista of speculation, new varieties in agriculture are equally promising, and scarcely less interesting. Within large limits varieties and species alike are now known to be subject to human control; both may be the product of similar processes of manipulation, just as old varieties and age-established species are the product of natural selection. As a matter of fact, new human creations in the plant world are nothing more than varieties which have been intentionally pushed beyond the semblance of their former characteristics; while the new varieties, of which we would now speak, are new creations which still retain in great measure their ancestral form and quality.

Throughout an inconceivable stretch of time Nature has continued to create varieties, a comparative few of which she has pushed on into species. By tremendous geological upheavals—by Titanic physical phenomena: by flood and glacier and cataclysm, by the sum total of all the actions that have gone to change the climate and soil of localities, sections and regions, and by all the myriads of subordinate and minute mutations which she has ever exercised—has she carried forward the work which has resulted in the production of an innumerable variety of plant and animal life. But the more direct and immediate means which she has applied to this end are
three: hybridization, or the cross-breeding of species; cross-fertilization, or the inter-breeding of varieties; and selection, this latter being by far the most potent factor of her process.

Owing to the fact that almost all plants produce seeds and almost all animals annually pair, there is ever a tendency to increase in a geometrical ratio. From this exceedingly rapid multiplication of numbers comes inevitably a struggle for existence—for food, water, light, air; for protection, and for the privileges of propagation. If we bear in mind that individual specimens of the same species are continually showing slight differences of structure, character, etc., and that by means not always readily apparent she occasionally produces sports and monstrosities, the manner of her procedure becomes immediately apparent. A series of frosts will sweep over a region killing almost all the plants of a given kind; only those which are sufficiently qualified to survive the test are spared. Nature has made a selection. Plants thus spared mature seed and another generation comes upon the scene. The same climatic conditions again prevail; not so many plants die, but all the weaker ones perish. Or the second visitation may be more severe than the first, in which case again only a few plants will survive, but these will be still hardier than any hitherto grown. It is thus that forms which could at first bear only a temperate climate ultimately become able to endure a very severe one.

Again, natural selection may be made by the desert character of climate and soil. Long continued drouth may destroy millions of plants where one is permitted to survive because of some slight variation of form or constitution which enables it to obtain sustenance where the others have failed. The living plant will mature seed, and to some of its offspring
CHAPTER VI., FIG. 62.—AN EDIBLE CACTUS PLANT, THREE YEARS OLD.
at least it will transmit those advantageous characteristics which enabled it to live during its days of famine, and in many cases these characteristics will be intensified. It is thus that drouth-resisting, and even alkali-resisting, plants have been developed.

Climate and soil are, however, by no means the only agents which Nature employs in securing selections. The earliest shoots may escape the slugs, and thus an early variety of some plant may have its beginning. The most honeyed flowers may attract the largest number of bees, and so be ensured a better prospect of propagation. Indeed, it may be said that literally in a thousand ways Nature proceeds constantly to perform this work. She exposes her plants continually not only to the direct competition of other plants of the same kind, but of many kinds. They are subject also to the ravages of their own particular diseases, and to destruction by animals. If an exact likeness always characterized all the individuals of a species then we could only ascribe to blind chance the fact that some survive while millions perish. But they are not alike. Some are hardier, some stronger; one has a longer or more efficient root, enabling it to get water where its fellow has failed; another has a rougher leaf and a tougher fiber, causing it to be spared where its fellow has been devoured. The slightest difference among plants may mean the difference between life and death, and it is this fact that enables Nature to continue her selections. Upon those comparatively rare occasions when a sport or a monstrosity appears Nature may, by the perpetuation in the offspring of the remarkable characteristics of the parent plant, seem to work rapidly in the production of distinct varieties, or even of species, but these are not her normal modes of action.
Now all the means which Nature has made use of in bringing about these marvelous variations in her creations in size and shape and color and quality, whether of grain or fruit or root or flower, aye, all that she has used in producing an oak or a willow, a pine or a palm from a common ancestor are to-day, with one exception, within the knowledge and practical possession of man. The one respect in which Nature has the advantage is Time, a tremendous advantage, indeed; but on the other hand, man has some compensations which, while they do not balance Nature’s advantage, are nevertheless of very great importance, and are certainly pleasing to contemplate.

In the first place, then, “natural selection acts slowly by accumulating slight successive favorable variations, and can, therefore, produce no great or sudden manifestations; it can act only by very slow and short steps.’’ On the other hand, man, whatever may be truthfully said of him in time gone by, now acts quickly. He does not, as an illustration, sow a seed and then wait years for it to grow and come into bearing, in the mean time risking its preservation from frost and heat and slug and browsing animal. He protects it from every harm for a season and then cuts it up into small pieces, grafts it onto an appropriate host—a full-grown tree—and thus in two seasons he has fruit from the seed.

In the second place, Nature acts only and solely for the good of the being which she tends. To enable the species to live and propagate—this is the end and aim of all her work. If she has man in mind at all, it is only that she may supply him with the raw material, as it were, out of which he may cultivate and manufacture that which contributes to his well-being and is pleasing to his taste. But man’s whole purpose
is centered in himself. His care for the perpetuation of the plant is only secondary. If he cannot make it useful to himself he does not want to perpetuate it. His purpose is not general, like that of Nature, but specific; it relates only to human needs and human uses. His work is far less diffuse than that of Nature, and to the exact degree of this concentration is his work more rapid than hers. How long would it have taken Nature to have produced a primus berry, a citrange or a plumcot? The chances would seem to be as a billion to one that she never would have produced these species, judging by the ages throughout which she has already left the work undone.

In the third place, while Nature goes forward towards the completion of her own great plan with unerring accuracy, she seems to have such a superabundance of material—a million seeds are probably lost where one takes root and grows to maturity—and such immeasurable time, that very many of her acts are what we term fortuitous. From our standpoint she depends largely upon chance, often upon the remotest chance. The fertilization of plants, for illustration, is left to the bees. In seeking honey they become dusted with pollen, the fertilizing element, carrying it from flower to flower. Or again, this work is left to the wind. We must admit that within limits, and for those purposes which Nature seems to have in view, these means are marvelously effective; but considering man as removed from the scene of action, and leaving Nature wholly to her own devices, how long would it have taken her to establish sea-island cotton on the coast of South Carolina from its home in the islands of the Southern seas; how long to have brought grain from the wheat fields of Russia and crossed it with wheat which
was growing upon the prairies of the Dakotas; how long to have cross-fertilized the English walnut with the variety which grows in a state of nature on the Pacific Slope? No time could be set when these and similar phenomena would be likely to happen, but man brought them about almost within a twelve-month.

While, therefore, Nature has the advantage of time in bringing about the striking differences which we see about us in the animal and in the vegetable world, we have to remember that the purpose of her work and the purpose of man's work are not identical; that she has produced many changes which he will never want to produce; that she has been intent upon preserving many forms which he will not care to preserve; that much of her work, as of the production of climate and earth surface, he simply utilizes as it is or modifies to suit his convenience; that his work is incomparably more concentrated in scope, having to do only with his own personal wellbeing and pleasure; and that he works by methods infinitely more direct, precise and certain than Nature usually employs for the purposes now under consideration.

We have seen that the most important principle which Nature employs in the development of varieties and species is that of selection. This also is man's chief resource. Fifty years ago Darwin could write: "It is certain that several of our eminent breeders have, even within a single lifetime, modified to a large extent some breeds of cattle and sheep. Breeders habitually speak of an animal's organization as something quite plastic, which could be moulded almost as they please. Youatt, who was probably better acquainted with the work of agriculturists than almost any other individual, and
CHAPTER IV., FIG. 63.—LEAF OF THORNLESS, FRUITING, EDIBLE CACTUS.
who was himself a very good judge of an animal, speaks of the principle of selection as 'that which enables the agriculturist not only to modify the character of his flock, but to change it altogether. It is the magician's wand by means of which he may summon into life whatever form and mould he will.' Lord Summerville's remark about the sheep breeders of his time was this: "It would seem as if they had chalked out upon a wall a form perfect in itself, and then had given it existence." And the pigeon fancier, Sir John Sebright, once declared that he would produce any given feather in three years, but that it would take him six years to obtain head and beak.

Consider what this principle of selection which Nature has employed for ages has, when utilized by human intellect, done for the horse within very recent years: the Percheron, ponderous and powerful; the trotter, with his slender limbs, his fine lines, his graceful movements and his wonderful speed; the hackney and general purpose horse, with his suitable characteristics—these are pertinent illustrations. Or among chickens, what extremes are now to be seen in spurs and sickles, in hocks and hackles, in comb, wattles and wings. Or among dogs, what striking differences between the bulldog, the beagle, the pug, the poodle, the pointer. The instinct of the pointer is a study and a delight which no one may appreciate who has never had one of these intelligent and faithful animals locate for him a bird or a squirrel, approaching it as near as might be without exciting its alarm, and then, standing with rigid body, tail extended and right foot gracefully lifted, staring like a statue in the direction of the game, "pointing" it with his eager muzzle. And yet every one of these strikingly different characteristics, the instincts even, have
been developed in these animals solely by selection and breeding, and we are only at the beginning of intelligent work along these lines.

Equally true is it that among plants all that has hitherto been done—and this is a very great deal—is probably only the prelude to the grand symphony which man is yet to play upon the great instrument of organized life.

Tracy tells us the origin of a certain variety of sweet pea. Nearly half a century ago a woman living in northern New York noticed and saved the seeds of a particularly bright-flowered plant of the old Painted Lady. These were planted in a garden, and each year the seeds of what were considered the best were saved and planted. She did not raise many, some years not more than a dozen plants, and never more than could be grown within the limits of three square yards. She was the wife of a quarryman, and her little garden was always over limestone ledges where the soil, though fertile, was very thin. Gradually the plants became sturdier and more compact, and after some years they were able to stand without support. A quarter of a century thus slipped away, the woman's only pay for her work being the pleasure which the flowers and their constant improvement under her hand gave her. Finally they attracted the attention of a seedsman, who obtained a few seeds, and from these came the noted sweet pea known as the Blanche Ferry.

Henry de Vilmorin conducted an experiment extending over a period of twenty years with a wild wort for the purpose of proving that its slender and badly-branched roots could, by selection alone, be made to take on the smooth, straight, thick, conical form of the parsnip. For ten years very little amelioration manifested itself, but after that the modifications be-
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came more and more pronounced, until at last the shape of the root he sought was attained.

Buckman took a wild parsnip and after several years developed an improved form, which he called the Student. This was taken in hand by the firm of Sutton and Son and, after some further improvement, put upon the market. It was of this variety that Henslow remarked: "It still remains, after more than forty years, the best parsnip in the trade."

The tomato offers a good example of what can be wrought by intelligent selection. Livingston, who did so much for the tomato, depended wholly upon this principle. Every man who is now of middle age must remember when the tomato was a very different fruit from what it is to-day—irregular in contour, deeply creased, in many instances appearing to be composed of several small units knotted into one. In looking over his growing tomatoes, which were still of all sizes and shapes, Mr. Livingston noticed a plant having distinct characteristics and bearing heavy foliage. It was unlike any other in the field, or that he had ever seen. Its fruit was uniformly smooth, but too small to be of market value. While meditating upon his discovery the thought occurred to him like an inspiration, "Why not select special tomato plants instead of specimen tomatoes?" This he proceeded to do, the result finally consummating in a blood-red variety subsequently everywhere known as "Livingston's Perfection."

But whatever human selection may have done during time past in the improvement of varieties—and doubtless all of our cultivated plants have been greatly improved by this means on their way down to us through the populous centuries—the subject seems only now to have become sufficiently understood and the practice only now to be carried on with a
sufficient reach and breadth to reveal the principle in the plenitude of its possibilities. Where the old experimenters labored with but few specimens, or patiently developed their products from a single plant, the seedsman and the horticulturist of to-day employs a hundred thousand, not infrequently half a million. Where the earlier explorers into this promising land waited, just as Nature has always waited, for the appearance of some striking fortuitous variation, for some sport or monstrosity that should be deemed worthy of serving as the parent plant in a process of selection, the human creator of to-day proceeds to throw a bomb in the shape of unaccustomed and unexpected pollen into the deep and secret recesses of a plant’s life, breaking up its old habits and exploding into actuality and visibility the new forms in an almost multitudinous prodigality.

Let us review for a moment the structure of a flower, for herein are the reproductive organs of the plant—the elements upon which, in the last analysis, both Nature and man must rely. Flowers of the more common form, as those of the orange, the pear and the tomato, will serve as illustrations, though of course, considering the vegetable family as a whole, there are many modifications and departures from these types. First then, taking the bud just before it has opened, there is the envelope, which consists of a double whorl of modified leaves, the outer, called the calyx, being commonly green like the foliage, while the inner, the corolla, is usually of some bright color other than green. Within the envelope thus formed are the essential elements—the stamens and pistils, the latter standing at the very center of the flower. The stamens, of which there are usually several, are composed of a slender stock or stem called the filament, which terminates
in an enlarged upper end, termed the anther. Each anther is filled with saccules of yellowish, powdery grains, and this is the fecundating material. It is called pollen. At maturity the saccules burst and the pollen is exposed.

The female element, the pistil is, in the flowers of which we are now speaking, a stem-like organ having a bulbous lower end, the ovary, occupying the receptacle in the base of the bloom, and a slightly enlarged and roughened upper end, termed the stigma. It is here, upon the stigma of the pistil, that the pollen must be placed if fecundation is to be effected.

Usually both stamens and pistil are found in the same flower, but this is by no means always the case. When, however, they are thus found, the stamens usually ripen first, giving ample opportunity for the pollen to become dissipated before the pistils become receptive, thus preventing self-pollination. Here again there is no invariable rule, since some plants are normally self-pollinated—the cotton plant, for example.

Now instead of depending upon the bees and the wind and such fortuitous means of carrying the pollen from plant to plant, instead of exposing flowers to the fertilizing influence of any grade of pollen whatsoever, as Nature habitually does, the plant breeder carefully collects in a saucer or upon a watch crystal precisely the pollen he wants and with his own hand places it upon the particular stigma he wishes to affect. He may even precede this act by certain surgical operations, afterwards attending his patient with all the care and skill of a physician.

Plants of different kinds exhibit different degrees of willingness or unwillingness to act and be acted upon by pollination. If they are of closely related varieties they usually
CHAPTER VII., FIG. 64.—DEPENDING ON NATURE.
CHAPTER VII., FIG. 65.—SCIENTIFIC POLLINATION.
unite readily, though great differences may develop, due to which plant serves as the male parent. As the varieties become more and more distinct the act of cross-fertilization becomes increasingly difficult, and between very distinct species it has hitherto been found impossible to bring it about; you cannot, as yet, hybridize an Indian corn with a lily. In connection with this phenomenon is another of equal interest: in almost exact proportion as hybridization and cross-fertilization prove difficult, if the difficulty arises from the fact that there is too great a distinction in kind, to that degree, if the fecundation is successfully effected, are the offspring apt to exhibit pronounced characteristics. Herein lies another one of man's great advantages over Nature. She is indifferent to such work. Often the bees upon which she so largely depends visit only one species of flower, in which case there will, of course, be no hybridization. It not infrequently happens that allied species which might be hybridized grow, so long as they are left in a state of Nature, in the most distinct and distant localities, so that no likelihood remains that these plants would be crossed within conceivable centuries. But man, realizing that hybridization and cross-fertilization are the means by which he may break up the life habits of a plant and secure at once marked and probably desirable modifications, is untiring in his efforts to bring it about. It is thus that he now frequently effects in a single season variation in type which Nature has failed to effect during all the previous years of her history.

We have already hinted at the advantage which man has over Nature in being able to bring together by means of swift, certain and far-reaching transportation facilities plants from the most distant sections of the globe. In this respect the
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plant breeder of to-day is favored above all his predecessors. Botanists, naturalists, explorers, experts in their profession, are scouring the earth for new varieties. From the equator to the arctics, in civilized, half civilized and in savage lands, on the coast, in the interior, in out-of-the-way places, under all suns, upon all soils, they are searching for new forms of plant life. Moreover, directly or indirectly, these men are all in correspondence with one another. The information which they gather and the specimens which they collect are at once forwarded to a few great centers, the governmental Agricultural Departments of the world, and these also being in sympathetic relations with one another, the work of the whole army of prospectors and scouts is at once systematized, developed and made common property. It was thus that the little, worthless, but hardy, trifoliate orange of Japan was found and sent to Washington, and thence to Florida, where, by crossing with the orange of that section, it gave birth to the citrange.

Sometimes these new-found varieties are not wild and worthless, but in a very good state of development, and need only to be planted and cultivated here in order to become profitable crops. In such cases their value usually arises from their hardihood, and in their ability to resist certain untoward conditions which our native plants of an allied kind are unable to withstand. Two or three closely related varieties of wheat, the Kubanka, the Velvet Don and the Yellow Gharnooka, have been imported from among the peasantry of Russia. These wheats are so hard of grain that the ordinary mills of this country cannot grind them, but they have shown themselves so wonderfully insensible to climatic and soil conditions that we have the best authority for believing that they will extend the prof-
itable wheat-growing area of this country for hundreds of miles into the semi-arid regions of our West and Southwest. When it is remembered that within recent years the wheat production of the country has not kept pace with the growth in population, the economic significance of these varieties becomes impressive.

Some of the best equipped scientific plant breeders of the world are putting forth their best efforts in the breeding of varieties of wheat. It is a complex process; many kinds are crossed, but a strain of the Russian above referred to is incorporated into almost all of them. The most important results to be remarked at this moment are that wheats may now be had which may be profitably grown in localities differing widely in soil and climatic conditions, and that others have been created giving a phenomenal yield. The farmers of the South who have hitherto imported their wheat no longer have any reason for doing so, since varieties may now be had which may be profitably grown throughout that entire region. Prof. Sanders of Ottawa, Canada, has been hybridizing with a view to the obtaining of an early ripening variety characterized at the same time by a hardihood which should render it suitable for that country. His "Preston" is reported upon by the Experiment Station of Minnesota as being "the most interesting and promising wheat procured outside of the State." The reason for this statement is the fact that in Minnesota itself a variety, the Minnesota, has been created which yields five bushels per acre more than any other sort. This means, without exaggeration, millions of dollars in the pockets of the farmers of those states to which this wheat is especially adapted. By an analogous work with oats a similar increase of yield has also been secured.
CHAPTER VII., FIG. 66.—LENGTHENING THE FIBER OF COTTON BY A PROCESS OF SELECTION.
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Until a comparatively few years ago no apple was known of sufficient hardihood to endure the severe climate of the Northwest. It was believed that no fruits could be grown in that region. About 1855 Mr. Peter M. Gideon of Minnesota began the undertaking of fruit culture. He planted fruit trees of various kinds, among them about thirty named varieties of apples, besides a bushel of seed apples. Each succeeding year he repeated his planting of trees, besides seeds sufficient to produce a thousand sprouts. When the winters killed off all his stock he would send East for more. His neighbors became discouraged, quit, and advised Mr. Gideon to do the same, but he persisted. After a continuous effort of ten years there was left only one small seedling crab. From this one wretched survival a variety known as the "Wealthy" was finally developed by a process of selection. This is the stock which is now being crossed with certain hardy varieties from Russia with results which our own Government reports declare will probably prove of "the greatest practical value."

Members of the Seed Corn Breeders' Association and others engaged in the same pursuit are applying the latest knowledge with a vigor and skill never before shown, and on a scale never before dreamed of. Many are developing varieties especially adapted to certain localities, and many others are breeding with a view of modifying the content. Some are striving for an increase of the protein, others for that of oil. To such an extent is it now known that these constituents may be increased in certain varieties that a new set of experiments has recently been undertaken to determine how far one or another of these elements may be increased in a corn without injury to the constitution, growth or yield of the plant.

While Professor Hanson of the South Dakota Experiment
Station was in Russia looking for specimens which might prove valuable to this country he found the "Malakhov" sweet corn. The stalks of this corn do not attain a height of above four feet, and the ears are too small to be profitable for market, but it is a hardy and prolific plant, yielding from one to four ears to each stalk, and its flavor is exceptionally sweet. Its most remarkable characteristic, however, is its time of maturity, which is so early that two crops of it may easily be grown upon the same field in a single season. One of the reports that came in regarding it was this: "It is two weeks earlier than any other sort, a mess having been gathered from it about six weeks after planting."

Another sweet corn, the "Apache," has been sent up from among the Indians of New Mexico by Prof. Fabian Garcia. A recent report of a trial cultivation of this corn in New Jersey tells us that it was planted in a plot that had received no manure for years. "Nevertheless," the report continues, "the stalks grew to a height of above 8 feet, and produced ears averaging 8 inches in length and nearly 2 inches in thickness. The rows upon the cob vary from 16 to 18, and the grains, which are closely set, are of a dark color. It is believed that this variety will prove of especial value in regions where the soil is sandy and where the corn often suffers from drouth."

The color of the "Apache" is, of course, a serious detriment to its market value, just as the diminutive size of the "Malakhov" is a detriment to its market value. Both are too new to have been modified by manipulation, but there is not the slightest reason to doubt that by interbreeding the undesirable qualities of both may be eliminated and all the desirable qualities may be preserved and united in one new variety. The
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"Black Mexican" has been crossed with the "Country Gentleman" and the objectionable black of that corn been modified to a lead color in a single generation, and we saw in the last chapter how the black of a berry had been bleached white by an intelligent and patient process of manipulation. If it were fitting that we should here digress to speak of men instead of plants, we would affirm it as our belief that it is in the application of this principle that the race problem of the South is eventually to be solved. The white man insists that his is the only color worth having, and the colored brother is very much of the white man's opinion. It may be unconscious on their part, but to become white is probably the most profound ideal of the black race in the South. Given the means, and the dominating desire of a race is always realized. There are no exceptions. It may require centuries, and these may be marked by struggle and hardship and abuse, by wrong and wrath, by lust and blood and death, but the race moves forward towards its chosen end. The average shade of the Southern black has been much modified since the Emancipation proclamation. Considering the difference between black and white as 100 per cent., the average shade of the African race in the South is at least 25 per cent. nearer white than it was at the close of the War, and thus, in spite of the most stringent laws and social customs against intermarriage, one-fourth of the work has been finished within a period of forty years. Thomas Dixon declares that one drop of negro blood makes a negro, but in view of all our knowledge upon the general subject here under consideration Mr. Dixon is certainly mistaken. Because of our habits of thought the consummation suggested is repulsive to our contemplation, but it may be that in the long run the white man, with his
mad speed and his tremendous expenditure of nervous energy, may be benefited by some of the qualities which might develop as the result of an amalgamation with this hardy and happy, but careless and ease-loving race.

The scientific plant breeders of to-day do not hesitate to try for almost any desired quality, and their confidence in attaining it would be amazing but for their past achievements. The phyloxera would absolutely have wiped out the grape industry of France had the breeders not developed a variety of vine resistant to the pest, and during the present season this resistant variety has been introduced into certain sections of California as the one efficient means of saving the industry there. One of the reasons for the enormous increase of the beet-sugar industry of this country is that new varieties of these beets have lately been created which carry a phenomenal content of sugar—as high as 25 per cent.; that is, that one-quarter of the root of each of these plants is pure sugar. Within recent years the planters of sea-island cotton were threatened with ruin because of the "leaf wilt" which had become epidemic among their plants. To-day there may be had a wilt-resisting variety of sea-island cotton which is absolutely immune to this scourge. One of the most interesting conflicts ever waged by the farmer against the natural enemies of his crop is at the present time on against the Mexican boll weevil. This beetle caused last year to the planters of the gulf states a loss conservatively estimated at $22,000,000. Several valuable suggestions have been made for the extermination of the pest, or for the mitigation of its ravages. An ant which feeds upon the beetle in one of the stages of its development has been imported from Guatemala, and cultural methods have been introduced which are known to be more or less effective
in combating the pest, and will continue as an immense advantage to the planter after the boll weevil has lost its terrors. But the point we wish to call attention to in this connection is that in some of the fields which had been absolutely ruined there was found here and there a plant which had matured its lint and seemed unaffected. Upon these it was found that the larva was there the same as in other cases, but that the plant had thrown up a kind of protective tissue under the influence of the irritation set up by the presence of the larva which had smothered it to death, after which the cotton had gone on to a normal development. The work of creating a variety of cotton which will do normally and regularly what is now done rarely and, as it were, by chance, by two or three plants in as many acres—this is the game now being played by some of the most skilful plant breeders of the world for stakes higher by millions of dollars than have ever been
placed on a single event by the sporting fraternity; and since the results will affect the pockets of millions of men, there is little wonder that the world is watching the progress and awaiting the outcome with the most eager interest.

In roots and fruits, but more particularly in the latter, size is often striven for and attained. There have been developed gooseberries which are as large as cherries, cherries as large as small plums, and plums—a variety from which the prune is made—which are six times as large as a corresponding French variety. As for seedlessness, we already have the seedless apple, the seedless orange, the seedless grape, the seedless plum and the seedless tomato. Now that the start has been made and the principles are thoroughly understood, it would be unsafe to deny that any of our edible fruits may be rendered seedless. A seedless peach is not beyond the possibilities.

Kaffir corn, which was introduced only a few years ago into Kansas, now adds $6,000,000 a year to the income of the farmers of that state alone. This plant, as well as the Turkestan alfalfa, have not yet become common crops upon one-fourth of the farms of the country, and may therefore be listed as new varieties, though not in the sense of many of which we have made mention in some of the preceding paragraphs. They are just widely enough cultivated to show what new varieties mean to the farmers of the country wherever an intelligent husbandry is the common practice, for they have already added millions upon millions of dollars to the wealth of such communities. Untold millions more are yet to be the result of other varieties of vegetation now being introduced: the Russian field pea and the hairy vetch, so valuable as a forage crop in the South; the Khiva Winter muskmelon; the
CHAPTER VII., FIG. 69.—KAFFIR CORN—THIRTY BUSHELS TO THE ACRE WITHOUT RAIN OR IRRIGATION.
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frost-resisting lime; March rape, yielding about thirty tons to the acre without fertilizer and without irrigation; Egyptian clovers, soy beans, sand lucerne, incredibly increasing the green forage and hay yield of every section of the country; the Japanese radish, the “best and sweetest radish ever grown”; a new cabbage, better than anything previously known; the new spelt, outyielding any variety previously grown; a buckwheat returning ten bushels per acre more than the best native sort.

“Not one man in a thousand,” says Darwin, “has accuracy of eye and judgment sufficient to become an eminent breeder. If gifted with these qualities and he studies his subject for years and devotes his lifetime to it with indomitable perseverance, he will succeed and may make great improvements; if he want any of these qualities he will assuredly fail. Few would readily believe in the natural capacity and years of practice requisite to become even a skilful pigeon fancier.” While this is strictly true, there is not a farmer within the boundaries of the Union but that may be benefited by the work of these eminent men. Varieties may be obtained which are especially adapted to his locality, and, if cultivated aright, will not fail to return him a generous compensation. Moreover, while everyone may not develop genius for plant breeding, there is not a farmer, a farmer’s wife nor a farmer’s child but that may do practical work in hybridization, cross-fertilization and selection which will be of distinct value. It is often affirmed that the farmer’s life is dull. Of all women who become insane the largest percentage, it is said, is from among those who live on farms, and the reason for this is laid to the lack of interest which the nature of farm life affords. But surely, this need not be so. To modify living things; to bring
them into being, indeed; to develop them to your ideals, to train them through generations and mold them to your heart's desire—these things were enough to arouse the interest of the dullest mind. Men look at the great city and the progress that is making there; they dream of the opportunities, and think of the wonderful inventions that are developed and set into practical motion there—and the city should, indeed, be visited for its educational advantages—but the creation of new varieties in the agricultural world, and the control of living and growing things which farm life demands, is invention of the highest type, is administration of no mean order, and makes the man who performs this work well, albeit in a circumscribed domain, a law-giver, a governor and a king.
CHAPTER VIII., FIG. 70.—THE ASPINWALL SPRAYER. "THE OLD LABORIOUS METHODS OF APPLICATION HAVE PASSED AWAY."
CHAPTER VIII.

NEW PRACTICE

BY NEW practice in agriculture we mean those methods of farm management which have within recent years been introduced and found to be both practicable and profitable. So far as rural life is concerned, those ways of doing things which have been introduced during this generation are new. A practice which can be made profitable and which should be engaged in by the many, though not now found upon more than half of the farms of the country, is new. A long-established practice which may have come to be looked upon as sensible and even indispensable in certain communities, if unknown or disregarded at present by all but a few of the most advanced farmers of a state or a section, is certainly new in those localities. It is with such practice that the present chapter deals. The use of electricity in stimulating the growth of plants will be explained, though this is a theory rather than a practice. The use of machinery in farming might also be discussed here, but this will find place in the succeeding chapter.

With the coming of the new knowledge into other departments of human activity, it was inevitable that the general methods of American agriculture should be invaded here and there, looking to its complete revolution later on. The phenomenal growth of our great centers of population, congesting millions of consumers within the limits of a few square miles under conditions tending to stimulate and multiply their desires and their demands; the wonderful development of
transportation facilities, making it possible to send farm products at a profit to markets however distant; the mighty movements of immigration which within half a lifetime occupied practically all the arable land throughout the thousand-mile valleys of the Mississippi and the Missouri rivers, developing vast systems of irrigation in the semi-arid regions, becoming the children of the morning on the Pacific Slope, since beyond them or behind them was alike East; the vigorous and highly efficient work of the Department of Agriculture and the Experiment Stations of the several states—these are among the basic factors which have tended to inaugurate and accelerate the new practice in agriculture.

The old remedies recommended to the farmer for combating the diseases of his animals and plants would hardly command attention to-day. It has not been so many years ago that an influential paper, The New England Farmer, recommended as follows for bot-fly on horses: "Scrape the eggs off every ten days with a sharp knife, let out the blood over the jugular vein, and use mild oils freely." In the Memoirs of the Board of Agriculture, State of New York, may be found, for caterpillars on trees: "Bore a hole into the tree about six inches deep and fill it with sulphur, a remedy which is said to have never failed." A prize essay published by the New York State Agricultural Society declares that for wheat midge nothing can equal "fumigation with sulphur, or smoke from any material. All pungent odors," says the essayist, "are offensive to the grain fly, as they are to the mosquito, and that most offensive of all odors, the one proceeding from the skunk, has been tested and highly recommended as a preventive."

Throughout the early career of our older farmers the bind-
ing of trees as a remedy for their various afflictions was the universal practice, and yet it must almost invariably have fallen short of expectations. One by one, bright men began to disregard the common custom. Here and there a man capable of wielding a facile pen used ridicule as a means of breaking up the old practice. "The worm in fruit trees," exclaims one, "as if fruit trees were not afflicted with hundreds of different worms, differing from each other in size, shape, color, habits of life, time of coming to maturity, etc., as much as a horse differs from a hog. Yet the universal bandage system is warranted to kill them all. Does the apple worm bore your apples? Bandage the butt of the tree, and he perisheth forthwith. Does the web worm spin his web in the branches? Bandage the butt, and he dieth immediately. Does the caterpillar, known as the red-humped prominent, or the yellow-necked worm, strip the leaves off? Bandage the butt of the tree, and hey! presto! he quittest his evil ways. Does the bupristis borer bore into the upper part of the trunk? Still you must bandage the butt with the same universal calico, and in a twinkle he vamooseth the ranch. Be the disease what it will, the universal, patent, never-failing pill is certain sure to extirpate it. In obstinate cases it may be necessary to bandage the whole tree, trunk, branches, twigs and all; but if you only apply bandages enough, the great bandage anthelmintic vermilifuge is sure to be a specific against the genus worm. The genus bug may, perhaps, require a distinct prescription, something in the nature of a cataplasm, or an emollient lotion. Long live King Humbug! He still feeds fools on flapdoodle, and many of them have large and flourishing families who will perpetuate the breed to the remotest generations."
But while specimens of the "breed" may still be found in the profession of farming, as in all other professions, the "large and flourishing families" of them seem hardly to have survived a generation, and one may well doubt if the language used was not altogether too severe, considering the state of the art of agriculture at the time the criticism was uttered. However, such writers did good work in combating the old order of things and in hastening the dawn of a new and better practice.

The Nineteenth Century was entering upon its last quarter when Professor Burrill of the University of Illinois, a pioneer in the field of plant pathology and therapeutics, began the publication of his views of the cause and cure of plant diseases, showing the relation existing between various organisms and "leaf blight," "rust" and other maladies. The importance of combating the pests of the field became more and more generally recognized. In many localities the undertaking assumed the proportions of serious business. The efficacy of paris green as an insecticide was discovered, and this substance long remained as the representative of its class. The method of applying it was by hand utensils—slow, laborious, costly, and in every way unsatisfactory. For all sucking insects a simple emulsion of soapsuds and kerosene was found to be a helpful remedy, and this preparation has been largely used. In the meantime, grape growing in France had been brought to a crisis by the ravages of diseases which threatened the very existence of the industry. In the darkest hour, however, an accident revealed a remedy.

For the purpose of saving from the depredation of pilferers some grapes which grew by the wayside, they were sprinkled with a solution of bluestone (sulphate of copper) and lime,
now world renowned as Bordeaux mixture. No one would have imagined consequences so far reaching from the application of means so simple. It not only saved a few clusters of grapes from the fingers of thieves; it healed the vines of their deadly diseases, it saved the grape-growing industry of France from extinction, and within a period of two years re-established it upon its former basis of prosperity.

Upon the arrival here of the news of the Bordeaux mixture and its remedial power upon the diseases of the vine there sprang up in this country one of the most remarkable series of experiments ever witnessed in the agricultural world. Progressive farmers became interested and tested out the efficacy of the new preparation, not only upon the grape, but upon other vines as well. The Agricultural Department of the General Government entered into the movement with a breadth and vigor for which no one may withhold his admiration who reads the story. The preparation was found to be efficacious, not only for those diseases for which it had been applied in France, but for many of the fungous and other afflictions of the plant world. Some plants, as the potato, for example, were found to thrive better after applications of the mixture, even where no disease had manifested itself, than when the substance was not applied. By the addition of an arsenical element it became not only a fungicide, but an insecticide. And thus it was that within the short space of about fifteen years the method of treating the diseases and pests of plants underwent an absolute revolution. The new century opened with the new practice practically universal in this country. When the conservative character of our farming population is taken into consideration, the millions of individuals who had to be convinced, and the tens of
millions of acres that had to be covered before the final result was attained, the new practice represents a change of truly wonderful magnitude and celerity. A universal specific for all the diseases, insects, worms, etc., which afflict plant life has, of course, not been found, but the old laborious methods of application have passed away and chemists, plant pathologists, economic entomologists and other scientists and experimenters of the highest attainments are untiring in their efforts to add to our list of efficient remedies. The present practice in combating plant afflictions has been a prime factor in rendering possible the magnificent scale upon which many of our agricultural industries are now carried on.

The method of dealing with the diseases of domestic animals is as revolutionary as is that which deals with the maladies of plants. Vaccination and inoculation, which any farmer with a little skill may practice, now saves thousands of animals where formerly thousands died. Texas fever a few years ago killed from 80 to 90 per cent. of the thoroughbred cattle that were shipped to the South for breeding purposes, and which are now rendered practically immune by inoculation. Thousands of farmers have in time past suffered the loss of valuable cows because of the disease commonly known as milk fever. Read the following record of a treatment: "Zola, a cow five years old, calved on the afternoon of September the 20th. Milk fever developed on the morning of the 22nd, and at seven o'clock the cow was down and unable to move. Iodide of potash—120 grains dissolved in a quart of previously boiled water—was injected into the udder, and in one hour the animal showed signs of recovery, and at twelve o'clock, five hours after the treatment, she was standing up and eating." Or this: "Princess, six years old,
CHAPTER VIII., FIG. 72.—ZOLA
CHAPTER VIII., FIG. 73.—INTERIOR OF A SANITARY COW-BARN.
CHAPTER VIII., FIG. 74.—CARING FOR THE COWS.
NEW PRACTICE.

Calved May 22nd, at noon. The following day she began to stagger about the stall and show signs of milk fever. In the course of an hour she became exhausted and lay prostrate in the stall, unable to raise her head. The iodide, or Schmidt treatment, as it is called, was applied, and in fifteen minutes after the injection the cow was standing, and a half hour later began to eat.” Schmidt's treatment for milk fever is not empirical, but strictly scientific. By the aid of the microscope the disease was discovered to be due to a minute organism which developed first in the udder, and then, passing into the blood, caused fatal symptoms. It was then only a question of finding a suitable antiseptic for injection into the udder. Iodide of potash was that antiseptic; and where the case is taken in time, it never fails to cure. The cases cited are indicative not only of the new method of treating milk fever, but of the scientific nature of the new practice in dealing with animal diseases generally.

Throughout fully three-fourths of the farm area of this country the conservation of the soil's fertility is a new practice, which, perhaps, not more than one man in a county on an average is at this moment introducing to his neighbors, not so much by his precept as by his example. This will doubtless be interesting reading to the farmers of the Eastern States, where the custom is common and where its importance is well understood; but instead of preening themselves upon their superior shrewdness they should remember that they were forced to the practice by the fierce competition that sprang up with the development of the new and fertile fields of the central West. Early in the history of agriculture in this country it was the custom to farm a piece of land until the soil was worn out. When it would no longer produce a
living for the man who tilled it he simply moved to a new place. Land was cheap, wealth was not sought for as it is to-day, and no effort was made to maintain the soil of the farm in its original productiveness. The use of commercial fertilizers, and all fertilizing material formed on the farm, decreases with amazing rapidity as we leave the older settled portions of the country. Throughout the South immense quantities of guano and substances which pass under that name, phosphates of various kinds, nitrates, etc., are purchased and paid for in hard cash; but there is almost no farm-formed fertilizer, while there is no part of the country which offers such facilities for its production as is found throughout that whole region where it is so badly needed.

The Agricultural Year Book for 1902 reports that there are extensive regions in the United States where barn manure is considered a nuisance. It may be had in a certain county in Oregon by any neighbor who will haul it away, and in another county of the same state it is burned, as the cheapest means of disposal. The report tells of parts of Kansas where it is buried or placed in a heap at one side of the field, as if the owner were in a quandary as to how to get rid of it. In North Dakota farmers may be found who haul this immensely valuable material to heaps, where it is allowed to remain until the elements wash it away and cause it to disappear. In Missouri it is piled by the roadside, and in Idaho it is scraped up into “piles as high as a barn.” In many counties between the Missouri River and the Pacific Ocean farmers not only find it a nuisance but they have a positive grievance against it, claiming that it produces dog fennel and other weeds, and in some localities that it “poisons” the soil.

With such views of valuable farm-made fertilizing material,
CHAPTER VIII., FIG. 75.—FILLING THE SILO.
it is not strange that the scientific rotation of crops for the conservation of soil fertility is absolutely new practice in nine-tenths of the cultivated counties of the country. The new rotation always involves one of the legumes—peas, beans, crimson clover, alfalfa, or some plant of this species. These have the power, through the bacteria which dwell in sym-

biotic relation with their roots, of transforming the nitrogen of the air into available plant food and, after the crop is gathered, of supplying to the soil for the benefit of the succeeding crop, of whatever nature, large quantities of this vital element. Since the supply of nitrogen is the main factor in the expense account where a fertilizer is used at all, it is obvious that if a crop can be grown which will bring into the soil this
constituent from the all-ambient air a thing of the very first importance has been done for the soil's enrichment. If the field has been cropped until even the legumes do not thrive, pure cultures of the nitrogen-fixing bacteria may be had, and these, sprinkled with water upon the seeds to be planted, or over the surface of the field to be sown, will, if the various acts of cultivation have been carefully done, assure an extraordinary yield. The proper preservation and utilization of all farm-made fertilizers and the scientific rotation of crops is the new practice which is crying for adoption throughout two-thirds of the farming communities of the country. It offers the returns of a gold mine to the farmers of any one of twice a dozen states. It is the solution of the problem of making two blades grow where only one grew before. Its universal adoption would double the farm products of the country without the planting of an extra acre. The path of every pioneer in this practice is bound to be bordered with waving fields and abounding harvests, because the response of the soil to the treatment proposed is not a doubtful result, but a demonstrated certainty.

The new practice in dairy farming is in striking contrast not only with the old, but with the recent, and in certain sections of the country with the methods of procedure which are still in vogue. "Certified" milk, that is, milk which receives the stamp of an official authority as to its purity, comes only from farms which are conducted according to the best scientific suggestion. The cattle are all of pure breed, or at least of high grade; they yield abundantly of milk rich in butter fat—it is just as cheap to feed a good cow as a poor one, and a good deal more profitable; they are kept scrupulously clean, whether grazing in the open or kept under cover. The
CHAPTER VIII., FIG. 77.—WHERE MILK IS CAREFULLY HANDLED.
NEW PRACTICE.

barn is provided with an abundance of light and ventilation, and is whitewashed throughout its interior at stated intervals; it is provided also with concrete floors, and on a line just back of the heels of the stock as they stand in their stalls a shallow trough is made into the floor, and this is sprinkled with lime daily and filled with earth or other suitably absorbent materials. Daily, also, the contents of the trough is removed and preserved as fertilizing material. Deodorizers are frequently and regularly employed, and the whole place is constantly kept sweet and clean. The cows are never "run" in being driven to or from pasture, if indeed they are ever turned out to pasture, for there are many dairies, especially in the proximity of great cities, where the price of land is high, in which the cows are stall bred and stall fed, and where they never see the open except as they are taken out for exercise. Under such circumstances a very small place may do a surprising amount of business. As an example, a farm of fifteen acres may be mentioned which supports thirty head of stock. The place was taken in hand some years ago by a retired minister who knew absolutely nothing about farming. At the time the new owner came into possession of the property it would not support two cows and the horse that was used to work the land. The close of the first year under the new proprietor showed a loss of $46. The owner continued his business in an intelligent and perfectly systematic manner. He read the best books that were to be obtained on the subject; he saved and applied every ounce of fertilizer formed upon the place; he made use of a silo for preserving succulent forage; he practiced the rotation of crops. Needless to say, the milk which all goes to one customer, the management of a public institution, brings the highest market
price. Such milk always brings the highest market price. No money was lost after the first year. A mortgage of $7,500 was paid from the profits of the place, and from last accounts, though the work was all done by hired help, the owner was clearing about $1,200 a year. A practice which prevails on this farm, and upon all others which are conducted along most modern lines, is that the cows are never spoken to in a loud or harsh manner, and a helper who was known to have struck a cow would be discharged without delay. Milkers go to their work with clean hands and in clean clothes, often of white duck. Udders and teats are carefully sponged off before a hand is laid upon them. The milk being drawn is immediately run through a cooler, whence it is canned and forwarded to the city.

In a Government report of the year of grace 1905 regarding the milk supply of twenty-nine Southern cities, it is stated that Richmond is the only place south of the Potomac River with a milk supply handled in any manner similar to that of the large cities of the North. Large quantities of condensed milk are shipped in from the Northern centers of this industry, and not only consumed as a common household article, but babies and invalids are often fed upon it by medical advice, many young doctors being surprised to learn that this practice is unknown at the North and often severely condemned. It is recognized that the milk supplied to the cities of the South, if used as an article of diet by persons in delicate health or as a food for young children, would be only too apt to result disastrously, and the people in general seem to feel that their milk supply is neither trustworthy in quality nor reliable as to its delivery. This feeling is reflected in the small amount which they consume. While the average daily consumption of milk
in New York City is above half a pint per unit, it is less than one-half of one pint in Richmond, one-fifth of a pint in Pensacola, and one-tenth of a pint in Mobile. Many explanations are made for these extraordinary figures, among them that the people do not care for milk. But if this were true, how shall we account for the large consumption of condensed milk? The comparative poverty of the people may be a partial explanation, but here again we are confronted with the fact that they find themselves able to buy condensed milk. The difficulty of getting the milk regularly delivered at the door undoubtedly has its influence; but one must see the positive filth in which many of the milch cows are kept, the dirty negro milkers and attendants, the utterly unclean utensils which are often used, to arrive at a just conclusion as to why so little milk is consumed and why the dairy industry has such a meagre development throughout the South where the best conditions imaginable prevail for the raising of feed and for the keeping and care of beautiful and profitable stock.

In the North the best practice is to milk the cows in the evening and in the morning. The milk is immediately reduced to a low temperature and placed in vessels which are as clean as water and brush and steam can make them. At least one milking is usually kept for twelve hours before it is started for its distant destination in the city, whence the cans are carried in ice. In this clean and cold condition it stands a journey of two or three hundred miles (milk is brought into New York from at least one station which is 325 miles distant from the city), and is sweet and good at the time of the house to house delivery, though this is not begun for twelve to thirty-six hours after it has been drawn from the cow.
At the other extreme of this practice are the filthy cows and the filthy barn, the unclean and careless attendants, and the uncared-for utensils and vessels. The milking is done at midnight and noon, and two deliveries are made by wagon direct from the dairy in order that the milk may be had fresh by the consumers, to whom, nevertheless, it is often consigned in worse condition, though but a few hours old and after a journey of only three or four miles, than clean milk is delivered elsewhere in the hottest weather twenty-four hours after milking and the hard conditions of a journey of 300 miles.

Needless to say, there are opportunities for dairy farming in the South such as are offered in no other section of the country. It must be remembered, however, that the demand for pure milk, butter and cream would have to be developed, and that the help would have to be taught "line upon line, precept upon precept." Some of these times enterprising men will go into the South and do this very thing. They will establish dairy farms and conduct them in accordance with the new practice. They will induce influential persons to come out and take a look at the manner in which the farm is kept, the herd cared for and the work done. They will secure as helpers bright young colored people from such institutions as Hampden and Tuskegee; they will thoroughly advertise their commodity, and they will see to it that it is delivered as agreed. The introduction of the new practice is destined to work a marked change in the dairy industry of the South within the next few years, and enterprising men who see the opportunity in time are the ones who will reap the reward.

Co-operation among farmers is a practice which is proving
CHAPTER VIII., FIG. 79.—AN UNEXPECTED INVESTIGATION—TESTING NEW YORK CITY’S MILK SUPPLY.
of much practical value to those who are engaged in it. The co-operation here referred to is in no sense socialistic, neither does it contemplate a multitudinous membership. Where the purpose is that of securing better freight accommodations or a juster freight rate the membership may comprise all the farmers of a township, a county, or a state who are engaged in

raising the same line of produce for shipment. Where such societies exist they exercise a powerful influence in obtaining the conditions sought for; they spread information as to the state of the market, and they mitigate the grasp of middlemen upon the producers. The co-operation to which attention is more particularly called as being new, however, is that which
relates to direct buying and selling. The associations which are now being formed for the purpose lend themselves to a comparatively limited membership. In New Jersey there is a society of a score or more of farmers who, instead of buying their fertilizer from established dealers, order the unground ingredients by the car load; grind and mix it themselves, and thus, besides the satisfaction of knowing at first hand precisely the composition of the fertilizer they are using, supply themselves at a saving of 40 per cent. on manufacturers' prices. For such a purpose as this, it is only necessary that the association should have a sufficient membership to enable the buying of the raw material in wholesale quantities. In Kansas there is an association of some 500 members who own a store and a small grain elevator. Each place is conducted by a superintendent who serves at a salary. It is immaterial whether the superintendent be a farmer or not. The one requisite is that he understand his business and conduct it in the interests of the association. The store sells its goods to the farmer at a very small advance over wholesale prices, while the farmer sells his grain to the elevator at the highest market, with the profits of the middleman eliminated. The consequence is that the membership constantly buy at lower prices and sell at higher prices than the outside farmer is able to do. It has been a hard struggle. Various great corporate interests, as the railway company, the farm implement companies—for the little store is a regular department store and handles everything the constituency requires—and other powerful bodies whose interests were invaded, have threatened and fought it, but it has been invariably victorious and is at present in a highly prosperous and flourishing condition. To what extent this practice is to become common no man may
CHAPTER VIII, FIG. 81.—ROOM IN CENTRALIZED SCHOOL BUILDING.
CHAPTER VIII., FIG. 82.—BASKET-BALL AT A CENTRALIZED SCHOOL, KINSMAN, O.
say. It probably depends in great measure upon the attitude of powerful corporations in their relations with the farming population. It has been charged that the powers that be in the money world are forcing the people inch by inch into socialism. This as it may, there can be no doubt that henceforth a fair share of the wealth which the farmer produces he will find means of retaining in his own possession.

There is another form of co-operation, known as consolidation, new in the history of this country and of the world, which has already established itself in half a dozen States, and the universal establishment of it we may foretell with great confidence of fulfilment. It is the consolidation of the rural schools. The difficulty of conducting an adequate public school system throughout the country districts has been keenly realized both by educators and by farmers themselves. It is the want of adequate school facilities for his children that has induced many a first-class farmer to leave the farm where he could make a success and which he loved as a home, and move to the village, the town or the city. The unsatisfactory status of the public school in the country districts, with its poorly paid teacher, its unsanitary building, its lack of numbers and consequent lack of enthusiasm, its meagre curriculum, has probably done more to retard the profession of farming, done more to discredit it in the estimation of the bright young men and women, both of the country and the city, than any other one thing. Now all this is to be changed. A new practice has been inaugurated which is certain to become contagious. The country school and the country schoolhouse are abolished. In its stead a central site is selected and a modern school building is erected. Here there is installed a corps of well-paid and competent teachers, and a
regular graded school of the best type is conducted. Public conveyances, as many of them as are needed, make regular trips, bringing the children to school in the morning and returning them safely to their parents' care at the close of school hours in the afternoon. The wagons are covered, and during the winter season in the Northern States, comfortably warmed. The new practice is popular with the children and with every intelligent tax-payer. That gap between the home and the school that solicitous parents have always recognized as exposing their children to both physical and moral ills is closed by the new order of things. There is better teaching, better attendance, less tardiness—almost none, in fact—greater pride in the school and less solicitude on the part of the parents than by any other system that has ever been devised. Add to this that high school courses are being provided in these consolidated schools, and that the elements of agriculture are to be taught practically throughout the entire grade just as the trades are now taught in the city schools, and there is presented to the farmer one of the most pleasing prospects that has ever dawned upon his view.

With the extraordinary activity in the exploitation of electricity during recent years it would have been strange indeed if its influence upon the growth and fructifying of plants had failed to receive attention. A considerable number of experiments have been performed with a view to settling the questions involved, but the whole subject is as yet only at the beginning of its discussion. Atmospheric electricity is, of course, admitted, but as to vertical currents this is, as yet, pure theory. It is supposed by some that the vapors of water serve as the transmitters of atmospheric electricity, carrying it into the upper regions of the air, where it meets a stratum
CHAPTER VIII., FIG. 83.—READY TO TRANSPORT THE CHILDREN FROM A CENTRALIZED SCHOOL TO THEIR HOMES.
of low pressure which forms with the earth a nearly spherical condenser. The auroral display in the distant North is believed to be due to the fact that this rarified air space, on account of the low temperature prevailing in those frigid regions, lies nearer to the earth’s surface than elsewhere, giving rise to visible phenomena. The pointed contour of leaves
net is spread over the experimental plot, and by means of uprights held at the desired distance above the growing plants. At a convenient location is placed the electrical generating device, one terminal of which is grounded by means of a metal plate, while the other is connected with the wire net. By this means waves are set up between the net and the ground upon which the plants are growing, very much in the same way that the same phenomenon is effected between the exciting instrument and the antenna at the receiving station of a wireless telegraph outfit.

Different results are reported by different experimenters, but the latest work on the subject reports an increased yield of corn of 35 and 40 per cent.; of oats, 50 per cent.; of strawberries, in one instance, 128 per cent. The yield of sugar beets is put down at an increase of 42 per cent., while the sugar content was at the same time increased by a fraction over 2 per cent. "In the greenhouse the strawberries under electrical treatment ripened in an average time of 30 days, while 24 days more, or in all 54 days, was necessary for the berries without the benefit of the electric current. The same was the case with raspberries on the open field in Brotdorp, though the difference of time was there only seventeen days. The development of sugar has been stated in an analysis made in France of white beets, giving an increase of about 18 per cent. of sugar, to which the remarkable augmentation of the sweetness of the strawberries, in the same place, is additional evidence."

The use of the wire net seems to preclude the application of this method to any but the most limited areas, as in greenhouses, for example; but there is a line of experiment that we do not know of as even having been tried, which certainly
offers an attractive field for investigation. It is well known that bacteria play an important part in the life of plants. It is also known that electric waves of sufficient power to reproduce the human voice may be generated and transmitted for considerable distances—a mile or more—with very little power simply by grounding one terminal of an exciting instrument and burying a zinc or copper plate at the distance indicated. How would the bacteria which are concerned in the elaboration and feeding of plant food to vegetation be affected by such a current? If they could be stimulated to redoubled activity the plant might display some surprising manifestations, while at the same time the system would be practicable for extensive areas.

It has been truly said that what is needed in agriculture today is not so much revolution in agricultural practice as improvement. Both are going on. Throughout the country the new and the profitable are being put into practice as never before, and the soil is being made to bring forth for him who tills it an abundance the like of which was neither deemed nor dreamed possible by the farmers of any bygone generation.
CHAPTER IX., FIG. 85.—THE HORSES "PUSH" THE HEADER UPON THE RIPENED GRAIN.
CHAPTER IX.

NEW MACHINERY

In the progress of Time's history there have been numerous revolutions—political, religious, economic. Some have been peaceful, many have been violent, a few have been mighty, but the investigator will search the records in vain for any industrial movement of whatever nature which for reach and depth and consequence surpasses that which has been and is being wrought by American machinery in the realm of agriculture. The change has been wholly pacific and beneficent. Its progress has been marked only by the whirr of industry. Its results have been prosperity and plenty. Together with modern methods of transportation, it has not only rendered secure the sustenance of 80,000,000 of people at home, but it has practically driven forever from the face of the earth the hideous terror of famine which in times past was wont unhindered to drive its hundreds of thousands of emaciated and staggering victims to the grave. With the mechanical means now at the farmer's disposal, if his desires and ambitions were limited to those of his predecessor of only two generations ago, namely, to secure the bare necessities of life for himself and his family, he would feel he had practically nothing to do.

Upon many of the great grain farms of the West the traction engine is used instead of horses as the motive power of farming implements. Plows, harrows and seeders hitched tandem are thus dragged across the field at one operation, and every time the trip is made there is left behind a strip of
land 24 feet wide prepared and planted with a celerity never before approached. Two or three men and an outfit of this character regularly plow and put in from twenty-five to thirty acres a day.

When the grain is ripe the reapers are operated in the same manner, a swath of 20 to 26 feet being cut as the engine proceeds. Automatic rakes gather up the fall, and at one operation the wheat is threshed and sacked, and, following the moving mill, is a trail of sacked wheat ready for the market.

Elsewhere throughout the country farming implements are everywhere in evidence. They are, of course, not so massive as upon the bonanza farms above alluded to, but they are equally efficient and hardly less wonderful. The corn planter drawn by horses has displaced the old method of hand dropping and hoe covering, the seed now being planted with great rapidity and at such regular intervals that the rows may be cultivated in either direction with equal facility, the cultivation itself being done by a riding plow, which more effectually shields the young plants than was done by any farm hand working with the old-fashioned hoe. The combination cutter and binder is driven into the field when the corn is ripe, and in one hour does the work which formerly required a day for one man to perform with the old corn knife. The husking peg is laid aside and the ears, perhaps stalks and all, are thrown into a hopper or fed into a devouring maw, whence disappearing, the husks are removed from the ears in a trice and the remainder of the plant—stalk leaves and husks—are torn and cut into fodder. The frying pan handle and the shovel blade no longer play a part in the shelling, neither are the grains wrenched off by the pressure and torque of a cob dextrously rubbed against the yellow ear.
CHAPTER IX., FIG. 86.—A CORN BINDING MACHINE.
NEW MACHINERY.

By this means hardly six bushels could be shelled by one man in a day. Now either by means of his own machine or one surely to be found in his neighborhood it is shelled at the rate of a bushel a minute, the cobs being carried to a heap or dumped into his wagon while the grain streams into the waiting sacks.

Mowers, tedders, rakes and stackers have revolutionized the making of hay. Formerly it required the work of one man for eleven hours to cut and cure a ton of hay. Now the same work is done by one man in 1 hour and 39 minutes. Potato-managing machinery of all kinds—cutters, planters, diggers; feed preparing machinery in great variety—choppers, grinders; manure spreaders, ditch diggers—these are but a few of the labor-saving devices now to be found upon the farm. There is hardly a feature of farm life that has not been profoundly modified by the introduction of some implement or machine.

It is the use of machinery that is rendering the culture of rice in this country the wonder of the world. A comparison of the number of days' work required to produce an acre of rice in the regions where it has been cultivated for untold centuries, and in the United States, where the industry has only recently been entered upon with the characteristic vigor of our people and with a view to great profits, is both interesting and instructive. In Bengal it requires the labor of one man 80 days and the use of a yoke of oxen 20 days to produce an acre of rice; in Japan, without the aid of any animal, 120 days; in the Philippine Islands, practically the same as in India, except that here the water buffalo is used instead of the ox, to the detriment of progress; but in the rice-growing region of Louisiana and Texas, with the aid
of machinery the maximum expenditure of human effort on one acre of rice is two days and the use of a team for a day and a half. The comparison, therefore, is that of 40 and 60 to 1 in favor of the American method, and the chief factor of this advantage is machinery and its intelligent use. Stated in terms of product and omitting animal aid, in India 80 days’ labor produces 1,000 pounds of rice; in the Philippines, 900 pounds; in Japan, allowing for the help of a team, 3,000 pounds; but in Louisiana and Texas, 64,800 pounds. Twelve and one-half pounds of paddy, or unhusked rice, are produced by a day’s labor in India. In the Philippines, 11¼ pounds. In Japan, 37½ pounds. In the United States, 810 pounds. In other words, the farm laborer in this country produces practically 64 times as much rice in a day as the Oriental, and could therefore be allowed, not counting several other items in his favor, as of methods of subsequent handling, quality of product and higher prices, $1.25 per day on a basis of 2 cents per day for his Eastern competitor. Such are the facts and the figures that make our growers confident that they will in the not distant future not only supply the home demand for rice, but that they will eventually export the cereal to the world’s markets and there successfully compete with the product of the penny-a-day laborers of the Orient.

What American machinery is doing for our planters in the production of rice is not unique, but typical. The human labor required in the production of a unit’s measure of almost any one of our staple crops has been, in comparison with our own achievements of a generation ago, incredibly reduced. The census of 1870 did not report crop acres at all, neither did it report separately the value of agricultural products, but the
CHAPTER IX., FIG. 87.—A HUSKING SHREDDER IN OPERATION.
NEW MACHINERY.

number of individuals engaged in agricultural production was given, and the quantity of product per individual worker was also reported. From these figures, therefore, a very accurate estimate may be made of the relative effectiveness of the farm worker of that day and of the present day. By this method it is determined that the yield per average worker in 1900 was greater than in 1870 by nearly 86 per cent.

The evolution of the plow has been by no means the least important of the improvements in farming implements. In 1836 Daniel Webster designed a plow which he helped to build at a neighboring blacksmith shop, for in those days every blacksmith shop was a plow factory, turning out an implement whenever ordered. The plow in question was of giant proportions, as befitted its owner, and like the old colonial plow of which it was a type, must have made the furrows "stand up like the ribs of a lean horse in the month of March."

The moldboard had a spread of 27 inches, was made of wood and protected with straps of iron. The landside was 4 feet long, the breadth at the heel was 18 inches, and the lower edge of the beam stood 2½ feet above the sole. The length over all from clevis to handle tips was 12 feet. The structure was designed to plow a furrow from 12 to 14 inches deep. With oxen to draw it and three or four men to help him, Webster was wont to delight in the use of this plow in stumpy and otherwise difficult land. He is reported to have said: "When in such a field as this I have hold of the handles of my big plow, with four yoke of oxen to pull it through, and I hear the roots crack and see the stumps go under and out of sight and observe the clean, mellow surface of the plowed land, I feel more enthusiasm over my achievement than from my encounters in public life at Washington."
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What would the great Webster say if he could lay his eye upon the plow of our day, with its graceful outline, its scientific design, its steel share, its cast moldboard polished to reduce friction until it shines in the sun like the helmet of an emperor? What would he say of the disc plow designed still further to reduce friction, consisting substantially of a series of circular knives, cutting the soil like cheese as it is drawn across the face of the field? What would he say of the whole wonderful line of agricultural implements now to be found in our markets and upon our farms—the self-binders that gather up a sheaf of wheat or of corn or of any other grain, hug it into a compact bundle, pass a piece of twine around its center, draw it into place, tie it securely into a hard knot, cut the string and throw the bundle aside, and all this with the rapidity of the passing seconds of time?

But rapidity, and therefore economy, is not all that has been secured to the tillers of the soil by the advent and perfection of farming implements. There is hardly a machine made the nature of the work of which requires it to move over the fields but is provided with a seat—a spring seat, often—enabling the husbandman to ride if he wishes to do so. Consider what this means to the farmer and to the farmer's boy. But recently it was the necessity of farmers to trudge all day over the yielding soil, their limbs grown heavy before the sun had reached meridian, and at evening they stumbled as they struck the beaten path leading to their homes. How pathetic is this authentic report: "To follow the team in the furrow day after day is very tiresome work, and has the effect of giving the boy a heavy, awkward gait by stiffening the lower limbs, a condition from which he seldom, if ever, recovers." Small wonder that the profession of farming
should have seemed unattractive to intelligent youth during the years gone by.

Flailing wheat, shelling corn and splitting rails practically went out of vogue with the last generation, but it was only yesterday that the slow and laborious axe was laid aside for the power saw. With such a saw, which almost any farmer may now afford, he can cut up enough wood during half a dozen rainy days to keep the kitchen stove going for six months. If there are trees to be felled, this is done by means of a saw. If there are stumps to be removed, it is done by a stump puller or with dynamite. The axe is indeed still found upon every farm, but the axe as a universal tool and as an instrument and representative of prodigious labor is nearly as non-existent as the flail. In short, everywhere and for manifold purposes machinery is invading the farm to the saving of human exertion. Doubtless to many farmers of the old school the new methods fail or fall short in many attractions found in the old order of things. "I don't like," it is facetiously reported that one said recently, "I don't like to set on a traction engine to do my plowin'. I want to have my two fists a holt uv the plow-handles an' feel as if I was a rippin' uv her up myself. I want to straddle the clods an' cuss the horses an' dodge the stumps, an' in other ways work my body as well as my head." All of which reminds one of the enjoyment which Daniel Webster is said to have expressed in regard to working rough land with his big plow and four yoke of oxen. "When I was a young feller," continued the farmer above alluded to, "I most gen'rally wore out my overalls at the knees, an' my calluses was all on my hands. Now I take notus when ther's any patchin' to be done it's the seat uv a man's breeches, an' the rest uv the wear
an' tear comes on his head. It's all labor-savin' inventions—contraptions to save a feller hard work. It may be all right to take life easy, but that ain't my notion of the way the Lord intended us to live. I don't feel natural with a lot uv machinery sawin' an' sowin' an' cultivatin' an' reapin' an' huskin', an' marketin', by gosh! an' snortin' an' explodin' all over the place. There ain't no satisfaction to me to do anything if it's too blamed easy. I like to go up agin a hard proposition an' beat it out. I don't want a machine depetized to do my fightin' fu' me while I set back in a spring seat an' see it done."

But, after all, the mastery of machinery—the transformation of the farm into a factory, with Nature serving now as a partner to consult and now as a servant to command, forcing from the soil a yield never before dreamed of and preparing and getting it to market with a facility and celerity never before approached, with all the acres plowed, planted and tilled with a movement which permits no sense of monotony, and all of these things done not so much by muscle as by mind—the old way of doing doubtless had its pleasures, but the new gives a sense of mental superiority never before found upon the farm, and the modern farmer would feel no more pleasure in trudging after a pair of plow-handles day after day than a general would feel in shouldering a musket and marching with his men. And it is just this display of mental power on the farm that has made American agriculture the amazement of modern times, and is forcing a recognition that farm life offers as broad a mental scope as almost any other occupation. Chemistry, biology, microscopy, engineering, bookkeeping—these and other accomplishments have their place on the modern farm, and the wonderful flexibility
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of the calling is shown in the facility with which men prosper in the business though the knowledge of these things is most meagre or non-existent. Practical experience has made and is making successful farmers, but "knowledge is power," and memory and imagination, judgment and foresight, reason and will, all schooled to a purpose, may find upon the farm all needful room for movement and play.

The modern method of farming by machinery has greatly lightened the labors of the farmer's wife. They are too long gone to mention in this connection candle-making, spinning and weaving, but the whole method of taking care of milk and manufacturing its products was changed but yesterday. It was the women who formerly did the milking—the men did not have time. And when the milk was drawn, it was poured into numerous shallow pans where, in a cool place, it was allowed to stand for twelve to twenty-four hours. The cream, by reason of its lighter weight, having risen to the surface where it formed a thick coating, was carefully "skimmed" off by means of a piece of perforated tin, and finally, when churning day came, was placed in a churn and beaten into butter by the tiresome and monotonous movement of a hand dasher. Then came the "Creamery," with its centrifugal cream separator, and for miles around the whole-milk was hauled to the factory where the "skimming" was done in a moment, the cream sold, thus eliminating the butter-making from the household, the farmer hauling back the skimmed milk for his hogs and calves. The cream soon came to be paid for by the per cent. of butter-fat which it contained, and the farmer could not feel sure that it was his own cream or that of some other man for which he was paid, and so an individual separator was put on the market, and is now immensely popular.
It is a beautiful little machine, containing a cup attached to a spindle which is geared up to run at a very high velocity. The whole-milk runs by gravity from its holder at the top of the machine into the revolving cup, and here, by reason of the difference in weight between the milk and the cream, the centrifugal force throws the former out of the latter and a steady stream of both substances issue from their respective orifices. This method of skimming is not only much more effective than the old way, but the skimmed milk yet warm from the cow is available as feed. Moreover, the farmer need not every day make a trip to the factory, but may defer doing so until a considerable quantity has been collected.

At threshing time also the women of the family are not now burdened as in former times. In the first place the threshing is much more quickly done, and with fewer hands. In that part of the country where large areas of wheat are the rule, the threshing gangs carry their own cooking outfit and the meals are served in a tent or in the open, as the conditions suggest.

The fact that farming is now so largely done by machinery has made the occupation available for women as never before in the history of agriculture, and a steadily growing number are turning to it as a means of livelihood and as a life work. Good roads, the thicker settlement of the country, the daily delivery of mail through the rural districts, the county telephone lines which are being so rapidly installed—all of these things are removing both the fact and the feeling of isolation, and with this feature eliminated and the heavy work capable of being mechanically performed, women are finding on the farm a good, wholesome and independent life.

There are many machines now on the market that do not
CHAPTER IX., FIG. 90.—"CRADLING" GRAIN.
strike one as being wonderful in their mechanism, but when seen in operation and compared with former methods of doing the same kind of work, convince the beholder at once of their admirable adaptability to the purpose for which they were designed. In a preceding chapter mention was made of the slow, laborious and ineffective manner in which fungicides were formerly applied. By means of sprayers this work is now done effectively, cheaply and easily. Indeed it is not too much to say that, but for them or something equally efficient, the strawberry, fruit and potato growing industry of this country would within a year be reduced to a minute fraction of its present magnitude.

The delivery of straw from the threshing machine and of ensilage from the cutter by means of the blower pipe is in many respects, especially in the latter machine, a matter of great advantage. In the illustration, Figure 100, the blower pipe, instead of being led into a silo or bin, as would be done in practice, has been erected vertically for the purpose of showing the height to which the product from the cutter may be blown by the fan. Another view shows this cutter at closer range, and in a preceding chapter the blower pipe is seen leading directly to the top of the silo.

The rollers, the pulverizers, the disc harrows built to accommodate themselves to the irregularities of the ground over which they have to pass, are illustrations of the efforts which builders are successfully making to provide the trade with thoroughly practical implements.

Drills and planters for every kind of seed that must be dropped and covered in the soil are now to be had for the efficient performance of this work. If the mechanism of reapers and mowers and threshers and huskers shows a high degree of
inventive skill, that of machinery for the dropping and planting of seeds is not less wonderful. The accuracy and rapidity with which these implements operate far surpasses that of the human hand, and the yield per acre is largely enhanced. For a long time the corn planter was unsatisfactory because the different sizes of the grains in the hopper interfered with precision in the operation of the dropping mechanism. This difficulty has been obviated by the use of a separating device which provides grains only of a uniform size, and the yield per acre has thereby been increased by 20 per cent. The potato planter insures a stand which leaves nothing to be desired in the way of uniformity. The potato harvester which scoops up and sifts the tuber from the soil and at the same time removes the vines, leaving rows of the clean esculents alongside of the trenches where they had grown, is an indispensable adjunct in the raising of a large acreage of this product.

Animals and windmills have long provided the chief power for the farm, and they will for an indefinite time continue in large demand. For many purposes the windmill is incomparably the cheapest form of power that can be suggested. For exceptionally heavy work, as for gang plowing, threshing, etc., the steam traction engine has a large and growing field of usefulness, but at present there is being introduced upon the farm a kind of power which is destined to become in one form or another practically universal in farming operations in this country. The gasoline engine is so safe, so simple, so efficient, so light, so ubiquitous in its utility, and at the same time may be so well and so cheaply constructed and sold, that its adoption, which may be said to be just now at its beginning, is practically certain in the near future to attain
CHAPTER IX., FIG. 91.—THE MCCORMICK REAPER OF 1831.
very extensive proportions. As a traction engine it is unsurpassed in efficiency and unequalled in economy of every kind. No licensed engineer is required and a boy may safely be put in charge of it. It carries upon itself the fuel required for a day's operation, and no extra wagon with a water tank is necessary. The difficulty of keeping up steam in cold weather is obviated; there is no water to freeze, and in every respect the engine may be run as readily and cheaply in the coldest winters of the Northwest as at any other time or in any locality. But the gasoline engine is not only made in traction form for heavy work. They are made as stationary engines of small units for pumping and similar purposes, and they are made portable, being placed upon trucks. In this form they may be hauled all over the place, out into the woods, alongside of the kitchen wood yard, into the barn lot to be belted to the feed grinder, the fodder shredder, the corn sheller or the silage cutter, as the case requires. They may be hauled into the barn or alongside of a strawstack and run without danger, for the process of ignition is wholly within the engine cylinder and the cylinder itself is kept constantly cooled by a jacket of water. The notion that a gasoline engine is dangerous is rapidly being relegated to the limbo of that other notion that the kerosene lamp is dangerous. As a matter of fact, the engine is far less dangerous than the lamp, and may be taken into surroundings with impunity and perfect safety where it would not be wise to take a lamp. It is indeed not wise to smoke a pipe or burn matches about a gasoline tank, but neither is it wise to build a bonfire in your cellar. With the exercise of reasonable precaution, the gasoline engine is an absolutely safe machine to have upon the farm.

When its facility of handling and wide utility is considered,
the reason for its present popularity is plainly apparent, but
we are only at the beginning of its application in farm manage-
ment and in farm life. There is no reason why the por-
table gasoline engine should not furnish its own portable
power—that is, be driven as an auto. There is no reason—
and this is of much greater moment—that an auto should not
be constructed which would do the work of horses in the
field, not only in drawing gang plows, harrows and seeders,
as is now done on the bonanza farms with 25 and 50 horse
power steam traction engines, but in drawing the two, four
and six horse plows, planters, cultivators and other imple-
ments now used upon the average farm. These motors drag-
ging their implements over the field at a pace from two to
three times as fast as a horse walks, would double and treble
the efficiency of human labor. Such a motor being a possi-
bility and offering such inducements to inventors and manu-
facturers, we may rest assured will not be long in becoming
a reality. The auto farm wagon and family vehicle are as cer-
tain to find their place upon the farm as the auto truck, run-
about and touring car are to increase upon our city streets.
The fact that a gasoline engine consumes fuel only while
doing work is immensely in its favor.

Attention is naturally directed in this connection to the cost
of gasoline and the probability of finding a practical substitu-
tute. With slight modifications in the carbureters of our
present gasoline engines, alcohol may be substituted as fuel
for the volatile oil. But alcohol may be cheaply produced
from potatoes and this is now being done on a large scale in
Germany. It has not been determined as yet whether potato
alcohol can be made and profitably sold for motor purposes
in this country at a lower price than that now charged for
CHAPTER IX., FIG. 93.—MODERN MACHINERY IN AN AMERICAN WHEAT FIELD.
CHAPTER IX. FIG. 94.—HE ALSO USES AMERICAN MACHINERY—STILL, THERE’S A DIFFERENCE.
gasoline. It is certain, however, that any attempt on the part of the controlling company to squeeze additional profits out of the people because of the increased demand for oil would be met by the development of the alcohol industry.

The manufacture of potato alcohol, or "spirit" as it is called, is a very simple and inexpensive process. The tuber is grated or beaten to a pulp and washed over a fine sieve. The starch, which constitutes about 18 per cent. of the substance, is carried away by the washing water, which is allowed to fall through the sieve into a suitable receptacle where the starch soon settles at the bottom. The water is then poured off, and the wet or "green" starch is spread out and dried.

In the next step of the process the starch is mixed with a large quantity of cold water which is carefully agitated to prevent the starch from settling. Boiling water is then added which at first converts the mixture into a paste, but upon the continued addition of boiling water a remarkable change is observed—the entire solution becomes transparent and clear.

At this moment a small amount of malt is added and the whole is vigorously stirred for ten minutes. The vat is then closely covered and allowed to stand for several hours, during which time the diastase of the malt acts upon the starch and completely transforms it into sugar.

This saccharine liquid—syrup—is then poured into the fermenting vats, more water is added, and in 36 hours the process of fermentation has been completed and the liquor is ready for distillation, which is the final process. This is accomplished by placing the liquor in a boiler of copper or other suitable material called the still, having a movable head or cover, from which proceeds a spiral tube termed the worm which passes through a tank of water constantly kept cold.
Heat being applied to the still, the liquid in it is volatilized and rises as vapor into the head whence it passes down through the worm in which it condenses, escaping at the bottom in a liquid state—that is, as alcohol.

The whole process is exceedingly simple and may be carried out with the crudest apparatus. To appreciate the truth of this statement one should see some of the illicit stills used in the mountains of Tennessee and north Georgia for the making of corn whiskey. The boiling pot with its cover and coil, cheap as they are, constitute the most costly portion of the plant, and even these may be improvised by the aid of a country tinsmith. For the rest a half dozen heavy barrels to be used as vats, and the crude equipment is complete.

Alcohol burns with a very hot but non-luminous flame. It is not so explosive as gasoline, but this slowness to inflammability which at first was believed to be a detriment to its use as fuel in combustion engines, has been found, when properly understood and provided for, distinctly advantageous. Now that Congress has made alcohol free for industrial purposes, it is estimated that potato alcohol of 94 per cent. proof can be manufactured for 10 to 15 cents per gallon. To think of our farmers producing from the soil the fuel which they use for power purposes, and perhaps for lighting, cooking, and other domestic uses, is certainly an interesting subject for contemplation. It is as if every farm had upon it an inexhaustible oil well. Or if the manufacturing is done at commercial distilleries, the farmer will haul his potatoes there as he now hauls his sugar beets to the factory or his cream to the creamery, receiving alcohol in exchange if he desires it.

There are other plants besides potatoes which give promise of yielding alcohol in paying quantities, most prominent
among which at present is cassava, and when the search is set up in earnest for the finding of the most profitable plant for the production of alcohol, there is little doubt that the industry will speedily establish itself upon a paying basis.

The use of machinery and mechanical power upon the farm is rapidly transforming it into a factory with regular and reasonable hours of labor, assured profits, and all that movement and play of intellectual force which mark the management of industrial trade.
CHAPTER IX., FIG. 95.—A MODERN DISC FLOW.

A MODERN SHARE FLOW.
CHAPTER X.

THE NEW INSPIRATION

THE WORK OF METEOROLOGISTS FOR THE FARMER.

IN THE year 1881 and again in 1882, property to the value of millions of dollars was swept away by the overflowing floods of the Ohio and the Mississippi Rivers—it was a catastrophe of the first magnitude. Men strove madly but strove in vain for the rescuing of human lives, the saving of property and the staying of the torrential waters. Two years later, in 1884, the Ohio was again out of its banks, and, in the region about Cincinnati alone, the loss sustained amounted to $10,000,000.

It is unlikely that the farmers and other citizens of this country will ever again be called upon to suffer in like degree from causes of this character. A body of men now foretell the weather with amazing accuracy, and millions of people whose interests are out of doors as the farmers' are, profit by the information which is both put on record and sent broadcast over the country. These seers are not astrologers, neither do they depend upon an inward light for their knowledge, nor yet are they in league with "the powers of the air." They are just plain scientists, devoted to the study of the atmosphere and its phenomena—its storms, and calms, and air currents, its clouds and temperature and rainfall, and indeed all the movements, modifications and interactions which go to make up the subject of their investigations—they are the meteorologists. They have been organizing for their work for some years, and by 1897 had become sufficiently well equipped to
gather and issue flood warnings of great value. In that year there was another tremendous flood throughout the lower Mississippi Valley, but for days before the river had risen to the point of overflow, warning after warning was telegraphed down to the threatened area telling of the heavy precipitation throughout the regions to the north, of the roaring rise of the Mississippi's tributary streams, and of the certain on-coming of the flood. The government statistician estimates that there was in the flooded district approximately $15,000,000 worth of live stock and other movable property, the greater part of which was gotten to places of safety mainly because of the information which had been gathered and disseminated by these meteorologists.

When the river had reached at New Orleans the highest stage ever known, and people were saying the worst was over and were beginning to relax their exertions for additional protection, the weather bureau, as the organization of the meteorologists is called, informed the city that the water would continue rising and within five days would reach a height twelve inches above any previous record. The statement seemed incredible and many were disposed to doubt the trustworthiness of the report. However, the work of strengthening and raising the levees went on, and the warning was justified upon the fifth day when the water reached the unprecedented height predicted.

Throughout the country where floods occur the whole river area is now mapped out in sections, each of which is in charge of a forecaster who daily, and, if occasion require, hourly receives by telegraph the reports of the rainfall, etc., over the watershed tributary to his river district, the gauge readings and other pertinent data also from the stations nearer the
CHAPTER IX., FIG. 96.—A GASOLINE ENGINE FOR THE FARM "THE LANSON."
CHAPTER IX., FIG. 97.—WITH CUT-OFF SAW ATTACHMENT, "THE LANSON" ON RUNNERS.
source of the river than his own. It is thus that the gathering of flood waters are noted in their incipiency, and long before the flood becomes a reality in any given locality, the threatened area is warned of the approaching danger. Moreover, so experienced have the forecasters become as to the rate of absorption, evaporation and ongoing of the waters that their predictions are usually fulfilled within a fraction of a foot and within a few hours of the time foretold.

But not only is the government now in a position to predict with accuracy in ample time the flooding of the river valleys, it is planning to render these floods impossible. It is building dams and forming reservoirs, and the day is not distant when all the flood waters of the country will be annually stored and either allowed to run down their channels gradually, or, wherever practicable, utilized as they are needed in times of drought.

This great company of experienced meteorologists stationed in 200 selected localities throughout the country, and provided with a full equipment of the best instruments for the purpose which scientific invention can devise and skill construct, gather the data upon which the forecaster bases his predictions, and which form the basis of the permanent records of the bureau. Besides the specially trained force employed at the stations, there are some 3,000 volunteer observers, provided with instruments by the Bureau, who add their quota to the general result. Twice a day, at 8 o'clock in the morning, Washington time, which is 7 o'clock at Chicago, 6 o'clock at Denver, and 5 o'clock at San Francisco—and at 8 o'clock in the evening, from these numerous and widely scattered stations, reports are flashed to the central office at Washington giving for the preceding twelve hours the air pressure, the
temperature, the wind velocity, the amount of rainfall, the appearance of the sky, the movement of the upper and lower clouds, etc. Within 25 minutes the reports have all been received, tabulated and corrected, and the results mapped out upon the chart. The areas of low barometric pressure indicate the storm center; the high, that of the cold wave. The region of rainfall during the preceding twelve hours is indicated, together with the temperature, and the appearance of the sky. It is thus that the forecast official gets a view as broad as the national domain of the weather conditions as they existed but an hour before, and all the changes which took place during the preceding twelve hours.

From the various conditions existing and from his knowledge of the phenomena concerned, the forecaster is able to deduce many things—the movement of the atmosphere for example, together with the temperature which it will bring to any given locality. He knows that the atmosphere under the influence of gravity presses downward and outward in all directions and flows, therefore, from the area of greatest pressure—marked "high" on the map—towards that of least pressure marked "low," and that the velocity of the wind depends largely upon this difference, which is indicated by the barometer. If, for illustration, the instrument reads 29.5 at Chicago and 30.5 at Bismarck, N. Dakota, the difference of an inch in the barometric column, indicating that degree of additional pressure at Bismarck, would cause the air to move towards Chicago at the rate of 50 miles an hour, making all allowance for the retardation caused by the friction and obstruction of the ground over which it passed. It is thus seen that the forecasting of conditions as done by the officials of the Weather Bureau is strictly scientific in its nature. Self-
CHAPTER IX., FIG. 98.—A STEAM DRIVEN SEPARATOR.
THE NEW INSPIRATION.

recording instruments of great accuracy and reliability are now at command; stations are numerous and are located in the most advantageous positions, as upon high buildings or upon natural elevations, and instrument-carrying kites which readily rise to a height of two miles are utilized wherever their use is indicated. As the laws involved are better understood, as stations are multiplied, not only in this country, but throughout the world, and as the weather bureaus of all nations are brought into closer communication and more harmonious relations, it seems certain that the forecasts will become more and more accurate, and that the length of time for which the predictions are made will be greatly extended, possibly covering an entire season.

But already, as has been indicated, the weather forecasts are
of very great service. The local rains of summer often find the farmer unprepared, as with his hay, for example, whereas, had he been forewarned, he would have managed differently. In a recent season a general rain fell in the great interior valley of California, and the first reports indicated that several million dollars' worth of raisins which are there dried in the open air had been ruined. Later reports, however, showed that the damage was really very slight owing to the rain warnings which had been sent out by the Bureau and widely disseminated by means of the telephone system which connects the principal vineyards. Warnings are issued of killing frosts and cold waves and these are not only of value to the general farmer, but especially to the fruit grower, the truck gardener, the cranberry interest and the ranch man. Millions of farmers now regularly receive these reports, and as the rural delivery routes are increased in number, and the telephone is more widely installed, other millions will be served, until the whole farming population of the country will receive these forecasts as regularly as citizens of the metropolis now receive the quotations of the stock market.

Forecasting, however, important as it is, is not the only service—possibly not even the most valuable service—which is rendered to the farming interests. The permanent records of the bureau are of incalculable service to the home-seeker. Glowing accounts are sent broadcast over the country by agents seeking to induce settlers to move in and buy land in the localities advertised. By consulting the official records, the general climatic conditions—the amount of rainfall by months, the percentage of clear days, the readings of the thermometer, and all the other data desired, are disclosed without self-interest and without prejudice. The home-
CHAPTER IX., FIG. 100.—SILO FILLER SHOWING THE POWER OF THE BLOWER.
seeker, thus furnished with official information, is enabled without the expenditure of a penny to arrive at a satisfactory conclusion as to whether the locality under consideration is likely to meet his requirements.

By these records also in connection with the survey of the soil, the localities are determined which are best adapted to the production of the various crops, and new plants are selected for production in the different sections of the country. The Weather Bureau is one of the powerful agents making for the wonderful development of the nation's agricultural resources.

THE WORK OF THE CHEMISTS FOR THE FARMER.

It is only some fifty years since the chemists began to give their attention to agriculture, and it is less than half that many years ago that the principles of agricultural chemistry were accurately worked out. As soon as the principles became understood, however, the application was sought with great assiduity, and never has this application been more vigorous than at the present time. It is conservative speech to say that chemistry is doing marvelous things for agriculture in the matter of soil fertility. It is teaching the farmer the most economical manner of securing and applying the principal fertilizing materials such as phosphorus, nitrogen and potash, and what fertilizing ingredients are calculated to produce maximum results in a given locality. It is the case of an abstruse science linked to a practical industry and harmoniously working out the most astonishing results.

Consider the sugar industry. The profitable growing of sugar-producing plants, such as cane and beets, is only pos-
sible in intimate relations with the knowledge of chemistry. It was only after a station had been established for the experimental growth of the sorghum plant where the work could be conducted under rigid chemical control that this interest was enabled to enter upon the attainment of its present proportions. After a continuous experiment of eight years, the percentage of sugar in the field crop was raised from 9 to 14 per cent., the additional profits thus made possible serving as a powerful stimulus to the business.

The raising of sugar-beets and the beet-sugar industry is another example of what chemistry is doing for agriculture. Barely ten years have elapsed since the beginning of sugar-beet culture in the United States. The industry is yet in its infancy and seems capable of indefinite expansion. It is not too much to say that but for the chemists the hundreds of thousands of dollars already realized by our farmers for their sugar-beets would not have been theirs to enjoy. In the first place the seeds were procured from abroad by the general government and distributed to the farmers free of cost, the only stipulation being that samples of the beets grown, together with an account of the conditions under which they were grown, should be sent to the department for analysis. It was from the analytical data thus obtained together with an analysis of soils that the conditions and locations best suited to beet culture were determined. This area—a great triangle with its base on the Pacific Coast and its apex on the Atlantic about New York—has been regularly charted, and thus not only has a profitable industry been made known and, literally, established throughout a vast area, but thousands of dollars have probably been saved to enterprising farmers in other parts of the country who would have been
CHAPTER IX., FIG. 101.—A SILAGE CUTTER.
trying unsuccessful experiments with sugar-beets but for this thoroughgoing work of the chemists.

It is the chemists who distinguish the edible from the non-edible, the useful from the non-useful plants. The varieties of “toadstools” which are healthful and nutritious have been determined by the chemists and it is them we must thank for the establishment of the mushroom industry in the United States. It is the chemists who have shown us the value of the sunflower—that a delicious salad oil may be made from its seeds, that the resulting “cake” is of the highest nutritive value as a feed for stock, and that the entire plant is of great economic possibilities. As rapidly as possible a soil survey is being made of the whole vast area of the United States, and when this is done the farmer will be enabled at once to determine what crops may be profitably grown upon his farm, and all the money hitherto wasted on “experiments” will be available for more profitable business. If any conceivable crop can be profitably grown upon any character of soil in this country, the chemists already know it or they are, with all possible diligence, seeking the information. The
inspiring thing about it all is that no farmer is more anxious to find the plants that he can most profitably grow than the chemists and certain other scientists are to find them for him. It is a remarkable condition of things. In no other time and in no other country have the interests of the farmer been so vigorously looked after by men of scientific attainments, and of all these the chemists are in the front rank.

Nothing can be more important in agriculture than the fertility of the soil. It is the chemists who analyze the fertilizers placed upon the market and see to it that the buyer gets the ingredients he bargains for. It is the chemists who have determined the elements which certain plants take from the soil in which they grow and the best methods to prevent the wearing out of the land. It was the chemists who first pointed out the value of phosphatic slag as a fertilizing material. In the manufacture of iron, the presence of phosphorus has always been a great drawback, a very small quantity rendering the iron unfit for most purposes.

A few years ago a process was invented by means of which nearly all the phosphorus was removed from the pig iron by means of a simple chemical process. In this operation the phosphorus is made to combine with lime, and immense quantities of slag heavily charged with phosphorus are thus produced. For many years this slag was considered refuse and of no value. When the chemists got at it, however, it was found that this worthless by-product of the manufacture of iron contained a higher percentage of phosphorus available as plant food than the natural phosphates.

A resource of even greater importance than these phosphatic slags is the nitrogen which chemistry has recently rendered available to our farmers as a fertilizing material.
CHAPTER IX., FIG. 103.—THE ASPINWALL POTATO PLANter.
It is this element which must be most largely supplied to the soil; it is this which has been most costly to supply. The unlimited quantities of atmospheric nitrogen, the earth being constantly bathed by the oceans of it, were unavailable as a fertilizing material until the chemists, the microscopists and the biologists found that certain minute organisms could be bred by the billion and that these had the power of extracting the nitrogen from the air and supplying it to the roots of the plants in the soil. The discoveries of the chemists mean an inexhaustible soil fertility.

WHAT BOTANISTS ARE DOING FOR FARMERS.

There are millions of acres of land in the western portions of the country upon which a hopeful people settled as farmers at the time when the phenomenal western movement was at its height. On account of the scanty rainfall in the region to which we refer, the staple crops as corn and wheat were usually a failure. Irrigation is now doing wonders for portions of this area, but vast tracts are not readily irrigable—perhaps are not irrigable at all. It seems inevitable that this entire region would have gone back into its original uncultivated state but for the botanists. They sought plants which were adapted to the conditions. They suggested Kafir or Jerusalem corn. They went out there and planted patches of it to demonstrate its adaptability to the region. They showed the discouraged farmers there that it would yield 30 bushels to the acre though not a drop of water fell upon the soil from the day of the planting to the time of harvesting. Now they are introducing the Durham wheats to the same region and the wonders which the eye beholds in western Kansas and
indeed throughout the entire semi-arid belt from Texas to the
Canadian border is enough to force the conviction upon us
that if the whole national domain should suddenly become a
semi-arid plain, our botanists would simply supply us with the
variety of vegetation suited to our changed condition and the
country would serenely continue at the head of the column
for agricultural production.

As the chemists protect the farmer from imposition in the
purchase of his fertilizer, so the botanists protect him in the
purchase of his seeds. They go into the open market and
buy, and they inspect samples sent to them from all over the
country. They have examined samples of seed sent out as
“extra cleaned Kentucky blue grass,” and found that it con-
tained only 26 per cent. of blue grass seed; and of Rhode
Island bent grass which contained but 2 per cent. of bent
grass seed. They have found upon the market timothy, 29
per cent. of which was the seed of weeds; and clover seed, 36
per cent. of which was the seed of weeds. So persistent and
thorough has this work of inspection been that to-day there
is but little danger of imposition if the purchaser will confine
his dealings to reputable firms.

Some years ago the Russian thistle attained notice because
of the widespread damage which it was causing in the North-
west. In one season and in one locality it destroyed wheat to
the value of $3,000,000. A botanist was sent to the region
and he at once proceeded to work out the life history of the
plant. It was found that by cutting the weed at a certain
season—August 1st to the 20th—the formation of its seeds
would be prevented, the march of its propagation halted, and
its ravages stayed. The losses from the Russian thistle which
but a year before had inspired consternation, were at once re-
CHAPTER IX., FIG. 104.—THE ASPINWALL POTATO DIGGER.
duced to insignificant proportions, and to-day practically all
that remains of the weed is a faint memory of the damage it
formerly did. Equally successful have the botanists been in
preventing the introduction of noxious weeds into uninfested
localities. By means of a wide correspondence, information
is constantly received as to the distribution of our worst
weeds, and maps plainly indicating their present range are
constructed and kept on file. If at any time information is
received that one of these weeds has appeared far from its
limits as shown upon the map, the local authorities are at once
apprised of the fact, and the importance of eradicating it to-
gether with the best means of doing so is suggested. The au-
thorities of California were informed that the Russian thistle
was growing at a certain railway station and were advised to
root it out. They complied with the suggestion at once, ap-
pointed a special agent to traverse the lines of the State upon
a tour of inspection, and wherever the thistle was found it was
extirpated. Nothing more has been heard of it in that State.
Similarly, the woolly mullein was found at a certain point in
Kentucky. A man was sent to look into the case and report.
The authorities of the State were notified and the region
cleaned. It is evident that if this method could have been
pursued in the Northwest when the Russian thistle first made
its appearance in that region, many millions of dollars would
have been saved to the farmers of that part of the country,
besides an immense amount of labor and apprehension.

It is the botanists who have made possible the extraordinary
increase in the forage crops of the country; the botanists who
are giving us our new and wonderful varieties of wheat and
other grains, our new varieties of roots and fruits and flowers;
it is the botanists who are giving freely to the farmers of the
country the results of their studies of plant life in all its varied relation to agriculture.

The entomologists obtain and disseminate information regarding injurious insects. They seek the introduction of beneficial insects, as those that prey upon the San Jose scale and the Mexican boll weevil. They conduct and make known the results of experiments with insecticides and insecticide machinery. Some years ago when the farmers were more conservative than they are now, many of them were actually paid to spray their trees in order that the results obtained might be an object lesson to the communities where the work was done. Last year $500,000 was placed at the disposal of the botanists with which to carry on the fight against the boll weevil, and they have gone down into the infested district and rented farms, the first time, it is believed, that such a thing has been done, in order that they might demonstrate the efficacy of the cultural methods which they have worked out.

Then there are the veterinarians who look after the health of the live stock of the country, investigate the existence of dangerous and communicable diseases, superintend the measures for their extirpation, make original investigations as to the nature and prevention of such diseases, superintend the interstate movement of cattle and keep a lookout for and disseminate the knowledge of the means of improving the animal industry of the country.

There are other scientists whose specialty is trees, their uses, care and cultivation, and still others whose sole business is the stimulation by free object lessons, education and advice of the good roads propaganda throughout the country.
CHAPTER X., FIG. 105.—STUDYING THE ATMOSPHERE.

CHAPTER X., FIG. 106.—INSTRUMENTS USED BY THE METEOROLOGISTS.
Now this great body of scientists the nature of whose undertakings for the farmer we have but imperfectly indicated, work, not at cross purposes, but harmoniously, for they are constituent parts of one of the divisions of the general Government—the Department of Agriculture. Besides the scientists, there are helpers, clerks, experts and executive officers. These, all working together with an enthusiasm seldom surpassed in a secular calling, are doing much to inspire and make possible to the farmers the progress and development which now characterize their calling—attainments never before equaled in the history of the world.

It is the Department of Agriculture which is searching the earth for new varieties of plant life and transplanting old varieties and so stocking every locality of the country with an abundance of the forms of vegetation which may most profitably be grown in it. It is this department which is stimulating an agricultural education which has never been approached among any people. It is this Department which represents the wisest and most powerful paternalism ever worked out by any government—a paternalism which assists and protects while at the same time stimulating the self-reliance and exalting the self respect of the beneficiary. Theoretically and actually the department is the servant of the people, but practically instead of being of the general average intelligence as the legislative bodies of the government always are, it knows as much as its most intelligent employer, while at the same time it serves with a fidelity which leaves nothing to be desired.

When the part which this Department is playing in the incredible progress of American agriculture is fairly considered it acts as a stimulant both to pride and patriotism. To such
an astonishing volume of production have our farmers attained, that in the course of every twenty-four months they reap from their soil a greater value than has been dug from all the gold mines of the world since the first white man set foot upon the western hemisphere. With the farm values of the country registering with every sunset an increase of $3,400,000 and the volume of farm products advancing by leaps and bounds, it is predicted that within three years the farming element, about 35 per cent. of the population, will have produced an amount of wealth for the decade equal to one-half of the entire national wealth produced in three centuries.

It is an unfortunate fact that in dealing with vast aggregates the average individual man feels himself belittled and that he has and can have no influence upon the mighty movement—that no specific profit comes to him from it—that he has no personal interest in it. While this feeling is too often strictly in accordance with the facts, it is not so in regard to the new agriculture. In order that the Department might carry on its work upon all soils and under all suns, and that it might come into the closest touch with all the people, experiment stations have been established in every State and Territory under the flag. In every way it is sought to bring the scientists and the farmers into the most friendly and confidential relations. There is not a question arising in any farmer's mind upon which he would like to have advice and expert opinion, but that he may get what he wants at the cost of a postage stamp. From how best to plant trees for protection or timber, to an inquiry concerning the most minute insect which he has found doing damage to his plants, the humblest farmer or farm hand may obtain the information he desires. I think I shall not soon forget a notice printed conspicuously upon the front cover of a bulletin of one of the
THE NEW INSPIRATION.

experiment stations: "In the language of the market," reads the notice, "if you do not see what you want, ask for it. If you fail to grasp the meaning of a word, a phrase or a proposition: if any matter in this bulletin is not clear, or if you wish any advice touching any phase of fertilization, or of agriculture in general, write to the Experiment Station." And this is the spirit of the Department of Agriculture, throughout.

Agriculture, however, is not an exact science and it never will be. It is not a calling that can be reduced to a series of well defined rules and precepts. Happily, as has been said "there is one vocation in which men engage which can never be bounded by methods or precedents—one occupation which is as elastic and untrammeled and unconventional as the blowing of the winds, the falling of the rain or the singing of the birds. The occupation is a business and an art founded upon the interplay of many sciences of which chemistry, botany, physiology, physics and climatology are chief; and these, and all the business methods are co-ordinated by good judgment and skilful management."

The new lights from science, instead of detracting from the romance and mystery that inhere in the constitution of nature, and these have always given an element of delight and inspiration to the calling of agriculture, simply give to the farmer that degree of authority and control which make for his highest profit and pleasure. They suggest philosophy to him and render it possible for him so to plan his work that he can afford occasionally to "sit on the fence and enjoy the fun of seeing things grow." His hours of labor are interspersed with hours of rest and his barns are filled with plenty. The peace of a well provided home is his and his heart rests in the fidelity of his family. Every season brings its trials and its tasks, but also its delights. When the winter storm howls without, his abode may be as warm and bright and as well pro-
vided with books and music and cheer as that of a citizen of
the metropolis. In the spring, the newly sown fields stimulate
his sense of expectancy, and later the clatter of the machines
as they mow the hay or reap the grain returns pleasure for the
toil of their operation; or if the summer shower drives him
to cover, the sound of the rain falling upon the standing corn
makes him glad with the prospect of its coming yield. Then
comes the early and the later autumn with its gorgeous garni-
ture of green and gold, red, russet and orange, purple, crim-
son and flame. The Thanksgiving season arrives. The sum-
mer’s work is done. The fields have become brown and bare.
The days are crisp and the hunter’s gun sends echoes on the
air. Within the spacious dining-room of the farmer’s home a
feast is spread. A sturdy company of honest folk gather about
the hospitable board, and the simple manners, the sincere and
sympathetic speech is as fragrance and balm compared to the
splendid artificiality too often found in many of the more pre-
tentious walks of life.

“God, make me worthy of Thy land
Which mine I call a little while;
This meadow where the sunset’s smile
Falls like a blessing from Thy hand;
And where the river singing runs
’Neath wintry skies and summer suns.

“And as the seasons move in mirth,
Of bloom and bird, of snow and leaf,
May my calm spirit rise from grief,
In solace of the lovely earth;
And though the land be dark or lit,
O, let me gather songs from it!”
SOUTHERN BRANCH,
UNIVERSITY OF CALIFORNIA,
LIBRARY,
LOS ANGELES, CALIF.