SOIL CULTURE

AND MODERN FARM METHODS

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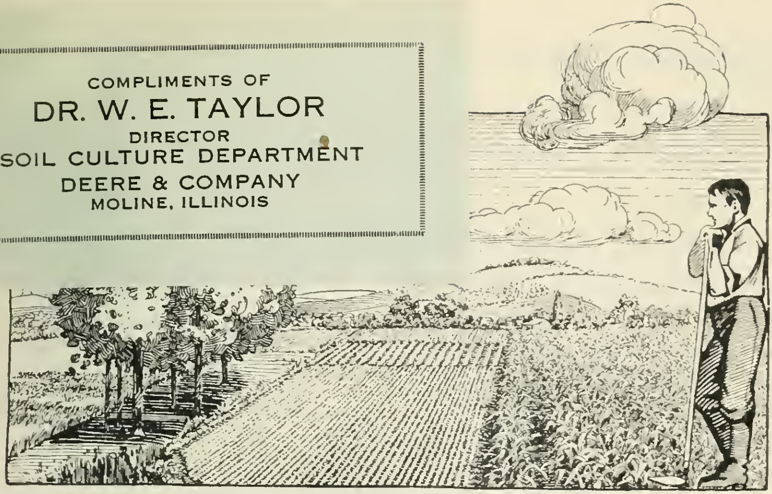

SOIL CULTURE AND MODERN FARM METHODS

BY
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MOLINE, ILLINOIS, U. S. A

SOIL CULTURE

SOIL is the source of all wealth. From the soil directly or indirectly human beings and all animate creatures obtain food. When the Creator planned this universe, He apparently provided every element necessary to sustain life and ordained that in the evolution of life and death there should be no destruction of elements. Complex compounds are formed by the union of these various elements, and they perform their function in accordance with fixed laws, and finally turn back in the form of gases, vapors and mineral salts to start anew their endless work of production.

While elements may be indestructible, they sometimes stray, some become lost and often many are misused. Were it not for such losses, nature's store of plant food would not be diminished. It devolves upon man, therefore, to co-operate with nature in order, first, to secure from the soil the full benefit of its fertility, and, second, to prevent depletion.

Most virgin soils contain a goodly amount of the essential inorganic elements, and in water and air we find the four great basic elements in abundance, namely, nitrogen, oxygen, hydrogen and carbon. Standing between these two groups of elements, we have the man we call the farmer, who is the active dynamic force intended by the Creator to make available the actual and potential power in nature's storehouse.

We find in the soil silica, phosphorus, potash, lime, magnesia, iron, sulphur and other elements which enter into the economy of plant growth.

Water is composed of hydrogen and oxygen.

Three-fourths of the atmosphere is composed of nitrogen. Carbon is found in combination with oxygen, and the store of free oxygen and hydrogen is inexhaustible.

When these various elements are brought together under the right conditions and are furnished with humus, which is the home of the laboratory workers of the soil, then plant food compounds are formed and made available.

If all of the elements and compounds which go to make up vegetable growth are returned to the soil and atmosphere, there could be no diminishing of fertility. There is, however, a discrepancy between the amount taken from the soil and that returned which may finally bring about absolute depletion in some of the elements unless scientific methods are enforced by the tillers of the soil.

The farmer, therefore, is confronted with these two problems: First, to make available plant food elements which exist in the atmosphere and in the soil, and, second, to return to the soil plant food and guard against wasting. The first problem involves several important operations, namely:

(a) Drainage to carry off surplus water, and to admit atmospheric oxygen to the seed-bed.

(b) A well-plowed, thoroughly-pulverized and compact seed-bed.

(c) A liberal supply of live humus.

(d) A sufficient quantity of lime to prevent soil acidity.

(e) Water in the subsoil in quantities to supply the needs of growing plants and to have the connection between the bottom of the seed-bed and the subsoils in such a physical condition that capillary attraction will not be interfered with.

(f) Rotation of crops.

Sources of Plant Food

In discussing the second problem, we will not attempt to offer any plan to maintain the original plant food content of all the lands of the globe, but will make a few suggestions with the view of maintaining to a high degree the fertility of our tillable soils.

How can we prevent the store of plant food in the seed-bed from becoming less and less with the removal of each succeeding crop? What can the farmer do?

We know that oxygen is necessary to make combinations or compounds of the plant food elements.

We know that oxygen exists in the air in unlimited quantities and that thorough tillage and proper drainage will place it where it is required.

We know that three-fourths of the entire atmosphere is composed of nitrogen, an element which cannot be dispensed with in plant growth.

We also know that the legumes, plants which can be grown in any latitude where vegetation survives, are equipped with bacteria upon the roots possessing the power to take this valuable element from the atmosphere and deposit it in the soil.

We know that carbon-dioxide, the product of decomposed animal and vegetable matter, also exists in the atmosphere, and that from it we can secure a sufficient amount of carbon to furnish most of the substance of the plant.

We know that in the evolution of the creation of the earth that there was deposited in the particles of rock, which through disintegration have become the substance of the soil, such elements as potash, sulphur, iron, lime, magnesia, sodium, etc.

We also know that through some mysterious process, phosphorus was formed and that in all soils which are regarded as agricultural lands, it exists in varying quantities from the surface down through the underlying strata, which are called subsoils.

We know that deep-rooting plants, such as the legumes and others, through their roots, which reach many feet down into those subsoils, carry with them water and air, and that when they decay, humus is formed which combines with inorganic elements, and the compounds thus formed are finally brought to the seed-bed, in a soluble form, by capillary attraction.

We know that the supply of potash is practically inexhaustible in most soils, and that it can be made available by tillage methods and the application of lime. If the supply of phosphorus or potash becomes exhausted or originally was deficient, it can be supplied in a commercial form.

Nature has in her storehouse, remote from our tillable lands, vast beds of potash salts, and in regions of our own country there is apparently an inexhaustible supply of phosphate rock containing a large per cent of phosphorus which can be made available by using the right methods. By guarding against unnecessary waste of both phosphorus and potash, the supply will last until the end of time.

Lime, a substance which is indispensable to all agricultural lands, is found in abundance in nearly every section of our country at a cost within the reach of all. Land which has been cropped for a long period of years becomes sour and needs lime.

Another source of supply of plant food is in the excreta from human beings and animate creatures which have eaten the food. About eighty per cent of the plant food elements required to make any of the feeds can be returned to the soil in excrements.

Again, the leaves and barks from trees and the decaying vegetation in our swamps and forests which are formed into moulds, are all rich in plant food elements.

In the Oriental countries, where intensive farming methods have been practiced for thousands of years, those substances are all utilized, and through them, to a great extent, the fertility of the soil is maintained. The sediment in pools, lakes, rivers and swamps is exceedingly rich in plant food elements, and when necessity demands will be utilized to enrich our tillable soils.

Wastes

We know the carelessness on the part of the farmers of the United States is responsible for an enormous waste of fertility. Manure piles are unprotected, organic materials are not husbanded, decayed animal matter is not utilized, fertility is often lost because of shallow tillage, and by the formation of ditches, it is permitted to wash away. In fact, millions of dollars' worth of fertility is wasted annually, either through percolation or by being washed in rivers, lakes and seas.

When our soils were new, bristling with energy and fertility, they produced without great effort more than enough to supply our needs. As our population has increased, new lands have been cultivated and new pastures utilized. Unfortunately, our land area is limited, but there seems to be no stay in the increase in our population; hence, the American people are facing a problem which demands their earnest attention.

Solution

There seems to be but one solution to the problem. Production must keep pace with the increase in our population if the nation is to survive and prosper. The cost of living depends upon the farmer's crops and flocks. The inexorable law of supply and demand regulates the price, and that law knows no favorites nor can it be repealed or modified.

The responsibility rests with the farmer. He is the chosen servant to produce from the soil enough to sustain the living. In view of the fact, however, that the soil has been producing for millions of years and that many nations have, by intensive methods, been able through their farming operations to keep pace with the increase in population, we are optimistic enough to believe that by imitating their methods and by applying the scientific knowledge, which is gradually coming to us, we can, in the United States, so manage our farming operations that we will be able, not only to keep pace with the increase in our population, but to produce a surplus for other nations of the world for many generations to come.

The potential power of our soils is beyond man's comprehension. The invisible and the unknown forces which have evidently been instrumental during the past ages in production, will, in time, as necessity demands, become playthings in the farmer's hands as are nitrogen, oxygen and carbon today.

In this treatise we will deal only with the practical side of farming. We will emphasize the two features, namely, stock-raising and tillage, which are inter-dependent, and will insist that both features are absolutely essential to profitable farming.

We will endeavor to show that to till the land and not return to the soil the manure from the stock, is simply mining, not farming, and each year the soil is depleted of its fertility.

We will treat of the seed-bed, fertility, seed selection and cultivation of the growing plants. We will give special attention to drainage, ventilation and the sanitary condition of the seed-bed. We will also emphasize the benefits of raising high-grade or pure-bred stock and feeding a balanced ration, at the same time will not overlook the benefits to be derived from giving the farm animals proper care.

We will not only give our own experiences, but utilize authentic experiments and demonstrations made by state agricultural experimental stations, departments of the United States government, and the results obtained by individuals who have used intensive and scientific methods successfully.

FORMATION OF SOIL

THE foundation or frame-work of soil is disintegrated rock. In those particles of rock are found essential inorganic elements of fertility. The process of disintegration began millions of years ago and will undoubtedly continue until the end.

The crumbling or disintegration of rock is caused by many agencies, the most effective ones being:

Atmosphere.
Water.
Changes in temperature.
Growing plants.
Insects and earth worms.

The Atmosphere

causes disintegration and changes by acting chemically.. Certain minerals, through oxidation, are transformed into more soluble substances, such as the carbonates, which are easily dissolved. Carbon-dioxide and other gases, and vapors are instrumental in bringing about disintegration.

Water

plays a very important part in the formation of soil from rock. It acts both chemically and mechanically. Water absorbs carbon-dioxide from the atmosphere. The acid thus absorbed acts effectively on rocks containing lime and the oxygen combines with substances not yet freely oxidized. New compounds are formed which in turn form others when they come in contact with water and new substances and elements, thereby disintegrating the various rock formations. The mechanical action of water is very marked. Drops of rain falling upon rock surfaces dislodge minute particles, and running water wears away rock formation very rapidly. The erosion is very pronounced in ravines, canyons and cataracts where the flow is rapid. Glacial action during past ages dislodged rocks, and were not only instrumental in disintegrating them, but played an important part in the formation of the contour of the surface of sections of the earth.

Changes in Temperature

causing contraction and expansion, tend to crack and dislodge rock.

Plant Roots

which either grow into crevices or are blown or washed there, form carbonic acid when they decay, which acts upon some rock formations, disintegrating and dissolving them.

Insects and Earth Worms

play a part in making soil. They burrow through loams and soft rock, admitting air and water, which further hastens disintegration. Micro-organisms on the surface and in crevices of rock residues and nitrifying organisms furnish nitrogen, which stimulate the growth of vegetation, hastening disintegration.

Briefly, rock disintegration is accomplished by the combined action of water, heat and cold, air and other gases, vegetable growth, micro-organisms, insects, earthworms, chemical elements and substances all working in combination both mechanically and chemically.

CLASSIFICATION OF SOILS

SOILS are classified as sedentary and transported.

Sedentary soils are those which remain where disintegration took place. There may be residual deposits, namely, gravels, sands, clays, etc., or cumulose. This sub-class includes peat, muck and swampy soils made so by the accumulation of organic matter, both by growth and decomposition.

Transported Soils

are called colluvial, alluvial, aeolian and glacial deposits. These soils, like all others, are composed of disintegrated rock and organic matter. They are transported or shifted by winds, water, drifts, glaciers and other forces.

Soils are further classified according to their characteristics, as sand and sandy soils, clays, silt and loam.

Sand

is disintegrated rock, the particles ranging in size between 0.5 mm. and 0.05 mm. in diameter. Sand is not cohesive nor does it retain moisture long if exposed to the sun or wind. Sand is useless for agricultural purposes unless mixed with clay, peat or large quantities of organic matter.

Clay

Pure clay is kaolin, which is formed by the disintegration of feldspar. Clay as found in soils is composed of silica, feldspar, limestone, mica, kaolin and other like formations. Particles are much finer than sand, being less than 0.005 mm. in diameter.

Clays are very compact, many being practically impervious to water. Clay soils are usually cold when wet, and the temperature remains lower than lighter soils in the same field. If cultivated while wet, they become puddled. When the moisture evaporates, they contract, crack and become extremely hard, rendering cultivation very difficult.

Silt

is composed of particles which vary in size between sand and clay. The particles being smaller and lighter than sand and larger and heavier than clay, they settle, when soil is roiled in a stream or ditch, on top of sand. The beds of irrigation ditches usually have an accumulation of silt, especially if the water carries soil in suspension. Silt soils are quite pervious to water, and usually, they are very fertile when they carry organic matter.

Loam

is a mixture of sand and clay. If clay predominates, it is called a clay loam; if the amount of sand exceeds the clay, it is called a sandy loam, and if organic matter exceeds in abundance, it is called black-sandy or clay loam, as the case may be.

Weight of Soils

Soils vary in weight according to the size of the particles and the composition. A fine sandy clay will weigh more than any of the others mentioned. Peaty soils, which contain a large amount of organic matter, are the lightest. The more organic matter soil contains, the more water it will absorb. The weight of soils as given by Snyder is as follows:

Soil	Pounds Per Cubic Foot
Clay Soil	70 to 75
Fine Sandy Soil	95 to 110
Loam Soil	75 to 90
Peaty Soil	25 to 40
Average Prairie Soil	75
Uncultivated Prairie Soil	65

A Deere Model Dairy Farm, Moline, Illinois

SOIL

SOIL is the substance in which plants grow. Fertility or plant food is composed of compounds made up of organic and inorganic elements. The essential inorganic elements are found in varying quantities in the particles of disintegrated rocks. They are silica, alumina, iron, phosphorus, lime, sulphur, magnesia, soda and potash. All exist in most soils in great abundance except potash and phosphorus. Other elements of fertility are oxygen, nitrogen, carbon and hydrogen. These elements exist in the atmosphere in inexhaustible quantities and are utilized by the growing plants in a greater or lesser degree.

It must be understood that growing plants are very exacting in their requirements. The laws governing their growth will permit of no radical interference. A deficiency of any one element will be reflected in the production, and an excessive amount of some of the elements will prove even more disastrous than a deficiency. For instance, an excessive amount of the sodas will cause alkali poison.

The productiveness of soil depends upon its physical condition, its humus content, the amount and availability of water and the amount of available plant food it contains. Soils differ in their adaptability to certain crops, a matter which should be thoroughly studied by the farmer. In this particular, soils are not unlike live-stock. We know that some cows are milk producers, other varieties are useful for beef only. Likewise, we have draft horses and roadsters. So it is with the soil—some fields are adapted to potato raising, others to sugar beets, while others will excel in grain or corn; hence, no fast rules can be laid down governing the adaptability of crops to certain lands. If the farmer will make some careful experiments, he will be able to plant crops which are best adapted to his soil.

HOW TO IMPROVE THE PHYSICAL CONDITION OF SOIL

AN ideal soil is a loam containing about equal amounts of sand and clay. Such a soil readily absorbs moisture, capillary attraction is perfected, and it permits of free circulation of air.

Sandy Soil

can be improved, first, by the addition of clay, the amount depending upon the fineness of the sand; second, by the addition of peat or muck, and, third, by mixing with it barnyard manures. When barnyard manure is mixed with sandy soil, it should be well rotted and thoroughly worked into the soil with the disc.

It has been demonstrated that a sandy soil which is absolutely unproductive for agricultural purposes, will produce very abundantly by the addition of manures. The amount of plant food required to make the crop being greatly in excess of the available plant food in the manure, indicating that the sand contained fertility, but valueless because of the absence of organic matter. By adding peat or manure, sandy soils absorb moisture readily, and it is retained much longer than if the organic substances were not added. The organic matter also tends to regulate the temperature of the soil. Where the subsoil is clay, sandy soils are greatly improved by plowing deep enough to bring some of the clay into the seed-bed and subsequently applying manure or plowing under green crops.

Clay Soil

if tilled when wet, puddles, and when the moisture evaporates, it contracts, cracks and becomes so hard that it is not tillable. By the addition of coarse sand, it becomes mellow and more permeable to moisture. By the further addition of peat or organic matter in the form of barnyard manures, it is made mellow, permeable, does not puddle, crack or become hard. The amount of peat or manures to add depends entirely upon the fineness of the soil particles composing the clay. Plowing under green crops is very beneficial to both clay and sandy soils.

Calcareous Soil

or soil in which lime exists in great quantities, is apt to be coarse, thereby hindering capillary attraction. Such a soil is made tillable and productive by the addition of organic matter, either in the form of peat, muck or well-rotted manures.

Peaty Soil

is improved by the addition of clay or sand. Because this soil contains an excessive amount of nitrogen and organic matter, it is benefited by the application of caustic lime.

ALKALI

ALKALI is a salt or a combination of salts, which, if existing in the soil in excessive quantities, destroys it for agricultural purposes. A very small per cent of alkali is very essential to plant life; in fact, soil devoid of this salt is not productive. It is estimated that nearly a million acres of the irrigated lands in the west contain enough alkali to render them very unproductive or absolutely worthless for farming purposes.

Alkali salts are divided into two classes, namely, white alkali and black alkali.

The white alkali is less harmful than the black. The principal white alkalis are Glaubers salts (sodium sulphate), common table salt (sodium chloride), Epsom salts (magnesium sulphate) and common baking soda (sodium bicarbonate).

The black alkali is salsoda (sodium carbonate).

White alkalis either existed in the soil before it was cultivated, or were carried there by irrigating waters. If these salts exist in quantities as great as one per cent, they exert a deleterious effect upon the plants; however, some very resistant plants thrive where as much as two per cent of alkali exists in the soil. The ability of a plant to thrive in an alkali soil depends upon the amount of water holding the salt in solution and the location of the salt. Alkalis are carried to the surface by water through the process of evaporation, and they are driven down by the water into the deeper subsoils when it is applied in excessive quantities. They are destructive to plants when on or near the surface, but when in the deeper soil in solution, they are less harmful.

Black alkali is a very corroding destructive salt, and if it exists in the soil to the extent of one-tenth of one per cent or more, it is destructive to plant life.

White alkali appears in a thin film or crust on the surface.

Soil containing black alkali has black spots or black rings on the surface, the soil is black and puddled, and water standing on the surface is black.

How to Remedy Alkali Soils

White alkali can be removed from the soil by washing it out with water either by irrigation or by heavy rains, provided underground drainage is supplied to carry it off.

Black alkali can be remedied by the application of gypsum (land plaster). If several applications are made, the black alkali is neutralized and transformed into a white salt which can easily be washed out.

Black alkali without the use of gypsum, however, cannot be washed out to any extent.

Crops

Certain crops are adapted to soils containing different amounts of alkali.

Excessive

Soils which contain as much as 2.5 per cent of alkali are regarded as excessive, and will produce only a few useful plants. Chief among these are native and foreign salt bushes, certain native grasses, notably salt grass which offers a very inferior pasture. While sugar beets can be grown in the presence of as much as 2.5 per cent of alkali, they are very small, and the sugar content is low.

Very Strong

Soils which contain from 1 to 1.5 per cent are regarded fairly favorable for sugar beets, provided an abundance of organic matter is used and a sufficient amount of water to keep the alkali in the deeper soils. The date palm is the only fruit tree which is profitable on such a soil.

Strong Alkali

Such a soil contains about 1 per cent of salts. A fair crop of sugar beets, western wheat grass, brome grass and tall meadow oat grass can be grown.

A Medium Strong Alkali

containing not more than .8 per cent, will grow meadow and pasture grasses, wheat grass, brome grass, rye grass, meadow fesene, sugar beets and common fox-tail millet. It will also produce fair crops of rape, kale and barley hay.

A Medium Alkali

which contains .6 per cent or less of salts, will grow millet, rape, redtop, timothy, orchard grass, barley, rye and asparagus and fair crops of milo, kaffir corn, wheat, oats, emmer, alfalfa, field peas, vetch and flax. It is also very desirable for sugar beets.

Weak Alkali

containing .4 per cent or less of salts, will grow all kinds of truck, rapes, sugar beets, alfalfa, etc.

Seeding

In view of the fact that water carries alkali down, seed should be planted just after rains or after irrigating. If the farmer can secure a quick tap root before the alkali reaches the surface, he is reasonably sure of a good crop. The reason that alfalfa does so well in alkali soil is because of its deep tap root which penetrates far below the alkali. In irrigated sections, if the water contains a per cent of alkali, the farmer should place underground tile for the purpose of carrying off the salts in solution; otherwise, the accumulation will increase from year to year, and, finally, the soil will be absolutely worthless.

MODERN FARM METHODS

Essential Features to Be Observed

A FARMER should have two important objects in view, namely: 1. To produce wealth from his land sufficient to compensate himself and family for their labor and give him a reasonable interest on the value of his investment.

2. To till the land and manage his operations so that the fertility of the soil will not become exhausted.

Haphazard methods and careless work will not accomplish those results, but systematic management, modern methods and a scientific knowledge of plant and animal requirements, will surely bring success in a high degree.

Farming is a profession no less important nor less difficult to master than many of the so-called learned professions, and the man who believes that farming is a fool-proof occupation will usually make an abject failure of the business.

Two Features

must be observed, namely, stock-raising and crop-raising. They are inter-dependent; they lean on each other, and neither one will long endure alone. The crop consumes plant food from the soil, but the supply is no more inexhaustible than the farmer's bank account. The soil fertility must be replenished from time to time, and it must be stimulated to activity; otherwise, the soil becomes sick, anaemic and unproductive. Live-stock should consume the major portion of the product of the soil in order that many of the organic substances essential to make inorganic elements (which exist in most soils in abundance) available, may be returned to the soil in the form of manures. Also, eighty per cent of the fertility removed by the crop is restored to the land, if the manure is properly preserved and applied.

Stock-Raising

Stock-raising involves features requiring knowledge of breeds, means of caring for animals, and the science of feeding them. A high-bred animal, whether a beast of burden or for meat or dairy products, is manifestly far superior to a scrub. A well-bred animal requires no more feed than one with an inferior or inbred record, and the production is usually more profitable.

The difference in the amount of feed consumed by a well-bred dairy cow and a poorly-bred one is insignificant, but the production in milk makes one very profitable, while the other may not pay for the feed consumed.

The science of feeding is of even more importance. To obtain the best results, the ration must be balanced; that is, nature's requirements should be provided. Food elements that make fat, heat and energy are called carbohydrates, but they do not promote growth. Growth is made by feeding nitrogenous substances, but to secure a perfect and rapid development, the right proportions of both must be given.

Animals are no exception to the rules governing construction in other things. If one is building a house, the quantities of the various parts must be in proportion, if the structure is made complete and durable. Even the laws of chemistry are no less exacting than the laws governing growth. In chemistry we find that the law of combination will permit of no radical interference. To illustrate, two volumes of hydrogen and one part of oxygen will make pure water, but equal parts will not, nor will any other proportions of those two elements make that very necessary essential to life. Oxygen is absolutely necessary to sustain life, and will, if rightly provided, but if we combine three volumes of oxygen with one each of hydrogen and nitrogen, we form nitric acid, and no other combination will make that fluid. I mention these facts to impress upon the farmer's mind the necessity of knowing the requirements of his stock in order that he may secure the best possible results in his feeding operations, for nature's laws of exactness are very strict.

Crop-Raising

The other feature of modern farming, namely, growing crops, involves four distinct steps or operations and several sub-divisions which will be briefly referred to hereafter.

I want to impress upon the minds of my readers the absolute necessity of faithfully observing each one of the operations which are:

1. The seed-bed.
2. Fertility, or the operations necessary to prevent exhaustion of the fertility of the soil and methods to make it available.
3. Selection and breeding of seed.
4. Cultivation of the growing plant.

These operations are of equal importance, and a neglect of any one of them will invariably be the cause of a deficient harvest.

The Seed-Bed

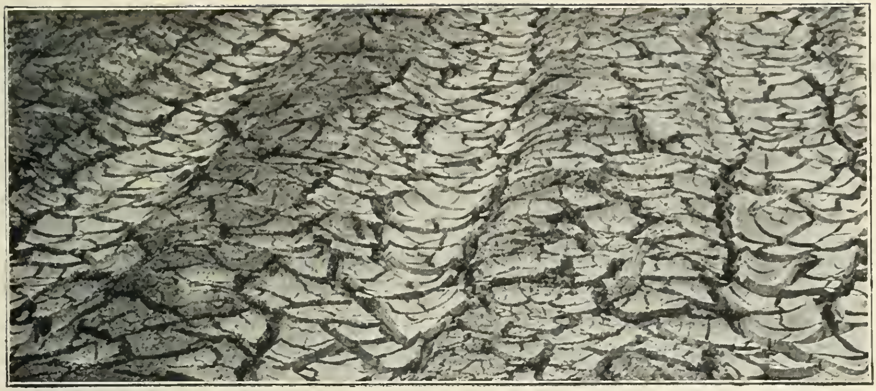
The seed-bed must be so made that it provides for each and all of the requirements of the growing plant. The requirements are:

1. An abundance of room.
2. Atmospheric oxygen.
3. Water.
4. Humus.
5. Food.

A Roomy Seed-Bed

The abundance, energy and ability of plant roots depends largely on the room and freedom they have to develop. Roots seek the course of

The Results of a Well-Made Seed-Bed .. Disced Before Plowing, Plowed 9½ Inches Deep, Five Loads of Manure Applied to Each Acre and Thoroughly Disced in After Plowing .. Forty-one Days Without Rain During the Growing Season .. Moisture Conserved by Surface Cultivation



Sun-Baked After a Heavy Rain. An Excellent Condition to Lose Moisture. Should Be Thoroughly Disced Before Being Plowed

least resistance, especially during the tender age, and at a time the plant requires the most assistance. If the seed-bed is shallow, the feeding area is restricted in both food and moisture. Such a seed-bed usually has a hard-pan preventing, not only the penetration of tender roots, but stops the downward passage of water and encourages the washing away of surface soils and fertility during heavy showers. A roomy seed-bed serves as a reservoir to catch and retain water until it percolates into the deeper subsoil. Hence, for many reasons the seed-bed should be deep, a condition which can be accomplished by plowing and tilling deep.

Caution

The process of deepening the seed-bed should be gradual, for the reason that subsoils or soils not rich in humus are not productive, but can be made rich by adding manure with each plowing or by turning under a green crop of some kind, preferably clover, cow-pea vines or soy beans.

Atmospheric Oxygen

This gas is as necessary to plant roots as it is to man or animals, and if it does not exist in the soil, the plant will perish. Soil particles have irregular surfaces, preventing a close contact. This condition is not accidental, but a wise provision for the express purpose of permitting the circulation of air and the passage of water and minute hair-like roots. The spaces, also, permit the escape of noxious gases, the result of plant root excretions and organic decomposition. If from any cause the air spaces become clogged, the phenomena of plant life is stopped. If the soil becomes surcharged with water to such an extent that the seed-bed is saturated with water, the air spaces are filled and the air is driven out.

Tile drainage or ditches will remedy the condition. If the excessive amount of water in the surface layer of soil is due to a hard-pan, which prevents it from moving downward, deep plowing or a subsoiler will relieve the condition. If the ground is naturally low and soggy, drain tile is the surest and best means to adopt, for the reason that the tile not only carry off water, but through them air is admitted. Drain tile always improve the physical condition of the seed-bed and usually the increase of production in one or two crops will pay the cost of the tile.

Water

Water is indispensable to growing crops, and how to control the supply is certainly a serious question with the farmer. Too much or too little is disastrous to the growing crop. Proper methods, however, will reduce the danger of damage to a minimum. An over-abundance can be taken care of by ditches, tile and deep tillage, but in sections where the annual rainfall is abnormally low, the problem of storing a sufficient amount to provide for the crop during protracted drouths is a serious question. To make the operation of storing, preventing the waste and nature's process of consuming water plain to the farmer, we will offer the following explanation:

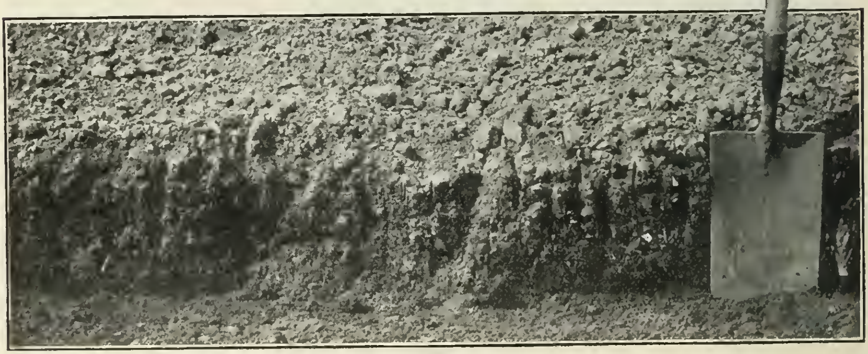
Soil water exists in three forms—

1. Hydrostatic or gravitational water.
2. Capillary water.
3. Hygroscopic water.

Hydrostatic Water

Hydrostatic water is the water that falls on the surface from rains or by irrigation. It gravitates into the deeper subsoils through cracks, worm holes and through air spaces between the particles of soil. If the soil is compact and the movement slow, the air spaces will become filled, and if the congestion remains too long, the plants will die, as is often seen in fields of grain, or any crop where water has stood for a few days in a low place.

Illustration Below Represents an Ideal Seed-Bed. It is Loose to Depth of Planting. Lower Portion is Compact and Makes Good Contact with Subsoil



Capillary Water

Capillary water is the moisture that sustains the plant. The water is first stored in the deeper subsoils and by nature's process, called capillary attraction, it moves upward, passing from soil particle to soil particle, until it reaches the surface, where it is taken up by plant roots to sustain the plant, or it is lost by evaporation. This process is perfect if the seed-bed is so made that the particles of soil are in close proximity and at the same time minute air spaces exist. If, however, the air spaces are so large that the particles of soil are not in close contact, the movement of water stops.

Two things will stop the movement of capillary water, and it is up to the farmer to so till his soil that such conditions do not exist. They are:

1. Surface trash, such as weeds, stubble, corn-stalks or coarse manure turned under.

2. Lumps in the body or on the bottom of the seed-bed.

Trash turned under is responsible for more crop failures or short crops, especially dry years, than all other causes together. The trash turned under prevents a compact soil contact between the furrow slice and the bottom of the furrow. The result is, large air spaces, and when the capillary water reaches the break, it stops, and the seed-bed dries out.

Lumps in the seed-bed produce practically the same condition. There is but one good sure remedy, and that is, disc all the trash well into the ground before it is plowed, and disc the ground thoroughly after it is plowed and in semi-arid regions, make the seed-bed more compact by using a sub-surface packer.

Mr. Farmer! The disc harrow is always a safe insurance policy against loss, and whether you farm in a humid section or in the semi-arid regions, you cannot afford to ignore discing before and after plowing. By doing so you make available soil water regardless of drouths, and you increase the feeding area of plant roots by pulverizing the lumps.

Hygroscopic Water

Hygroscopic water, or vapor water, is the moisture that exists in the air. When air enters the soil, the moisture adheres to the soil particles. This moisture is of little value in dissolving plant food elements, but does in a measure stimulate plants in dry regions.

Preventing Loss

Moisture is conserved or prevented from escaping through surface cracks and insect holes by maintaining a soil mulch blanket on the surface. This can be done in corn by running a mulch harrow between the rows or by using a surface cultivator. The mulch should be formed as soon as the ground begins to dry or bake after rains. Unless the farmer is watchful, one or more inches of water will escape during a single hot, windy day.

In grain fields the mulch can be formed either with a harrow or corrugated roller. The harrow gives the best results in hard ground where the roots are deep, but if the soil is loose, the corrugated roller forms a retaining mulch and at the same time packs the soil about the grain roots. Either implement can be used to good profit even when the grain is beginning to joint.

Humus

When organic matter becomes thoroughly rotted and combines with chemical elements in the soil, it is called humus. Indirectly, it is an important factor in fertility; in fact, soil devoid of humus is practically barren. Humus increases the moisture-absorbing ability of soil to a very marked degree and exerts a decided influence on the temperature of the ground. Barnyard manure is the best source of humus, although green crops plowed under are excellent.

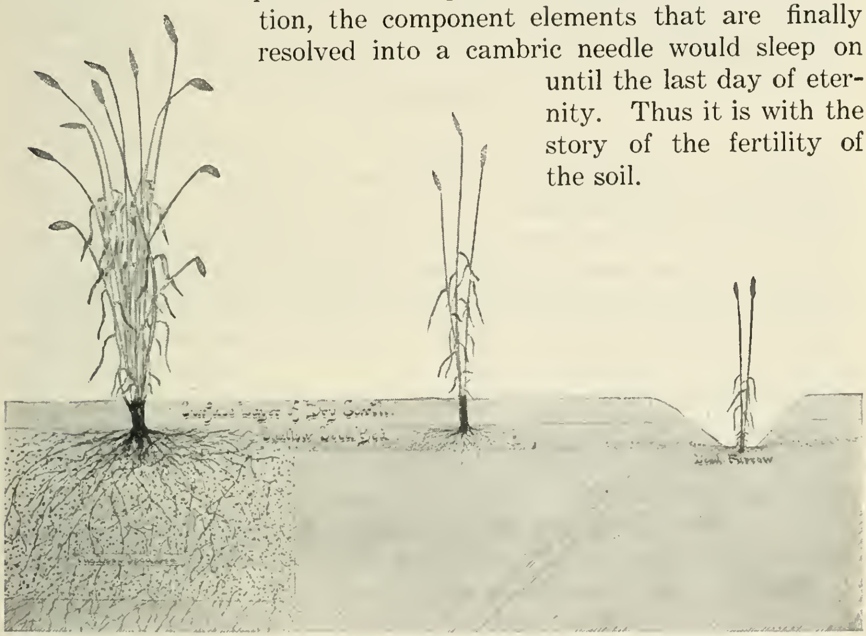
Fertility or Plant Food

Plants require certain specific ingredients in the right quantities if a rapid growth and an abundant production is secured. An unbalanced plant food ration proves as disastrous to the growing plant as an unbalanced food ration does to the animal. Hence, the farmer should know three things pertaining to feeding plants, and he can secure that information by studying and experimenting.

1. He should know the requirements of plants.
2. He should know the quantity of each element or substance necessary to secure the best results.
3. He should know how to till his land and manage the operations of the farm so as to utilize and make available what nature has provided in a crude form.

Soil is composed of disintegrated rocks. Rocks are composed of silica, alumina, lime, iron, magnesia, soda, potash, phosphorus and sulphur. In those substances we have the basic elements of fertility. To make them available plant food compounds, we must have nitrogen, oxygen, hydrogen and carbon-dioxide. Oxygen exists in the air in abundance. Hydrogen composes two-thirds of the volume of water. Three-fourths of the atmosphere is composed of nitrogen, and carbon-dioxide is the result of decomposition of vegetable and animal matter. The whole layout is fine, and it is up to the farmer to convert them into useful plant food.

Can it be done? Certainly it can, and that too by any intelligent farmer if he will use his good judgment and apply means and methods that are at his disposal. Nature's generosity is of little use, however, if man neglects his part. The factory needs steel. How is it secured? Iron ore is buried deep in the mountain, coal is hidden below the surface, lime-rock forms a portion of the crust of the globe, but when brought together in the right proportion in the blast furnace, iron is reduced to an available form for another process, and so on until the product is completed. Without man's intervention, the component elements that are finally resolved into a cambric needle would sleep on until the last day of eternity. Thus it is with the story of the fertility of the soil.



A Deep Seed-Bed [Well Ventilated] | **Medium Seed-Bed [Partly Ventilated]** | **Shallow Seed-Bed [Not Ventilated]**

The Above Illustrates the Great Value of a Thoroughly-Made Deep Seed-Bed

The story of the many complex changes and combinations that take place between the elements and substances is too confusing for the busy farmer to master. He is interested only in what to do to bring about the best results.

Most soil contains an abundance of potassium, but it may be locked up in particles of granite, feldspar, alumina or clay, but it is made available by applying powdered lime-rock to the soil.

Phosphorus may exist in abundance, but is not in the right form to use until it has been transformed into phosphoric acid by the action of acids resulting from the decaying of manures or organic materials of some kind or by the action of other acids.

Elements may exist in abundance, but are not made into compounds to be used by plants until the various elements are brought together by stirring and tilling the soil, thereby changing the position of the soil particles containing the chemicals.

Converting and rectifying bacteria may be absent or dormant for lack of oxygen or because of an acid soil. Lime neutralizes acid soil, and tile and tillage ventilate it. If nitrogen is lacking, it can be supplied by planting clover, alfalfa, cow peas or soy beans.

Water is an essential factor in forming plant food compounds, and its presence in sufficient quantities depends upon the methods used by the farmer. In short, a sweet soil well stocked with air, water and manure, and thoroughly tilled, will rarely fail to produce abundant crops.

Rotation

A well-arranged system of rotation of crops is a splendid means of assistance in keeping the soil rich in some plant food and in a most excellent physical condition.

We know that if land is cropped year after year with the same kind of crop that each succeeding year the crop is less. We also know that if crops are rotated, that a greater yield is made. The farmer naturally inquires why there is such a variation between continuous cropping and the results of a system of rotation.

While the same chemical elements enter into all farm crops, they differ greatly in the quantities the various ones require. For instance, a grain crop requires less potash than clover, potatoes or root crops; oats take more potash from the soil than wheat or corn; likewise, clover requires more phosphorus than grain crops. The requirements of wheat, for instance are the same each year. Each crop calls for just so much nitrogen, phosphorus and potash. The roots of each crop penetrate the earth to a certain depth, taking plant food in the same ratio and from the same strata of soil each year.

Clover has different habits than corn, grain or roots. The roots penetrate deep and their requirements are different. Clover, like other legumes, consumes nitrogen, but gathers it from the air and deposits it in the soil, leaving the soil richer in that plant food element than it was before the crop was planted. The deep roots decay, forming humus several feet deep and make available plant food beyond the reach of many grain plants. The decaying roots place the soil in excellent physical condition and hidden plant food thus formed is brought to the seed-bed by capillary water and is consumed by succeeding crops.

It is erroneous to believe that all the plant food exists in what we term the "seed-bed"—that is, the first six or eight inches of soil. Fertility extends many feet down and it can be utilized by resorting to a common sense rotation and thorough tillage.

How Plants Feed

Plant food in a soluble state forms an envelope around each particle of soil, and is taken up by root hairs and carried into the plant. Carbon dioxide from the air is breathed into the plant through air valves in the leaves. The oxygen is separated from the carbon and passes out as free oxygen and the carbon unites with elements that have come from the soil to form starch, sugar, etc.; therefore, it is very apparent in view of the phenomena of plant life, that the seed must throw out holding roots and a stem above ground far enough to secure carbon-dioxide from the air before plant food in the soil can be utilized; hence, the great necessity of planting seed that possesses strong vitality. If seed has been heated in the stack or bin, cut green or has been subjected to inclement conditions, it will be weak and anaemic and the stunted early growth will be reflected through the entire life of the plant.

Seed

It has been repeatedly demonstrated that plump, healthy grain will yield from twenty-five to thirty per cent more than seed ungraded. Corn intended for seed should be picked when ripe, thoroughly dried and stored in a well-ventilated seed house. If corn absorbs moisture or freezes and thaws, its germinating strength is greatly weakened.

It is practically useless to place seed in the ground when the temperature of the ground is below forty-five degrees, although it will germinate very feebly at forty-one degrees.

Again, seed is influenced by heredity. Breed and strains are as marked in seed as in animals; hence, the advantage of securing well-bred seed of a good strain. Corn is especially susceptible to hereditary influence. Inbred seed, or seed fertilized by pollen from barren stalks or sucker stalks, will in a great measure produce its kind.

Cultivation of Plants

Plants are cultivated for three purposes, namely:

1. To remove weeds.
2. To keep the surface in good tilth.
3. To maintain a surface mulch for the purpose of conserving moisture.

Conditions should govern the farmer as to the nature, frequency and depth of cultivation. Growing grains may be harrowed or rolled. If the soil is baked and weedy, harrowing is beneficial. If the soil is loose, a roller, either corrugated or smooth, closes cracks, thereby preventing the escape of moisture and at the same time packs the loose soil around the roots of the plants.

Hoed crops of all kinds should be lightly harrowed before and after the plant is up. Deep cultivation of corn is permitted until the roots are in danger of being pruned. After corn or potatoes are eight or ten inches high, every deep cultivation lessens the crop. I will venture the assertion that the corn crop of the United States is lessened each year fifteen per cent because of the almost universal practice of deep cultivation after the plant is ten or twelve inches high or after the roots have spread to the point where they can be cut by a cultivator.

PLOWING

"WHY We Plow," "When to Plow," "How to Plow," and "The Kind of Plow to Use," are questions which deserve more than a passing notice. Beyond question, haphazard plowing is responsible for more poor crops than any other operation in farming. Hence, we feel that the subject should receive very careful consideration.

Why We Plow

Primarily, we plow for the purpose of making a seed-bed and turning under trash. Plowing should also thoroughly pulverize and aerate the soil. We pulverize in order to make available plant food which envelopes each soil particle. We aerate it in order that the soil may be thoroughly oxidized, a condition necessary to the healthy maintenance of soil bacteria. We plow for the purpose of increasing the ability of soil to absorb moisture.

When to Plow

depends entirely upon the kind, character and condition of the soil and subsoil. No fixed rules can be laid down to govern all cases. The farmer should know his soil and study results. If clay soils are plowed when wet and stirred or cultivated while in that condition, they become puddled and no amount of cultivation will pulverize the lumps. If clay is plowed while wet and exposed to freezing and not stirred until it is dried out, it is mellow and of good tilth. Clay soils or soils where the subsoil is clay and a portion of it is brought to the surface, should be plowed in the fall and left in a roughened state until the lumps have crumbled in the spring after the frost has gone out; in fact, all heavy soils are in a better physical and chemical condition if plowed in the fall and left unmolested until spring and not tilled until the danger of puddling is past.

If thin clay soils are plowed in the spring they should not be tilled until they have dried. If after clay soils are plowed while in a wet condition, a quantity of gypsum or lime is spread over the plowed surface, a part of the danger of puddling is obviated. Light, sandy soils and light loams can be plowed at any time with safety.

How to Plow

is another important question. As a general rule, unless the ground is very sandy, it is advisable to turn the ridge furrow. A ridge furrow is better aerated; that is, the oxidization is more complete. It is also in condition to absorb water more readily, and by using a disc harrow or cultivator, it is easily pulverized.

The Depth to Plow

is a question which deserves very careful consideration. Too often the farmer is guided by the recommendation of an enthusiast who does not appreciate the fact that universal deep plowing is not only apt to diminish the crop, but in some instances may make the soil sterile for a number of years.

In discussing this matter, we will answer the all-important question, "Is deep plowing advisable?" by saying "Yes" and "No."

The depth to till, or, rather, to plow or use the subsoiler, depends entirely upon the character of the soil and subsoil, the length of time the land has been cultivated, and the depth of the soil. To recklessly advocate deep tillage is nothing less than criminal. The farmer should understand the value of humus, the phenomena of plant life and nature's process of supplying plant roots with water, before he ventures too far. To universally advocate deep plowing would be as inconsistent as advocating the growing of cotton or rice in the northern states.

In order to make this proposition plain, we will first note the chemical requirements of the plant; second, the kind of soil which will permit of deep tillage; third, the benefits of deep tillage in soils where conditions are admissible, and the type of implements adapted to successful deep tillage.

New Deere Light-Draft Gang .. Stubble and Breaker Bottoms

Humus or organic matter is absolutely essential to plant life. Humus is decayed vegetable and animal matter. It is found in the top layer of soil and varies in depth from an inch to several feet. Humus in virgin soil is formed from the natural growth and decay of vegetation during the past ages. In cultivated soils it is maintained and can be increased by the application of barnyard manures and by plowing under green crops or any vegetable growth.

It must also be remembered that cropping lessens the amount of humus in soil, and by continued use, that which is not consumed by being made into plant food compounds, in a measure, becomes inactive.

The following table given by Snyder shows the influence of different systems of farming upon the humus content and other properties of the soil:

	Cultivated 35 years. Rotation of crops and manure; high state of productiveness	Originally same as No. 1. Continuous grain cropping for 35 years; low state of productiveness
Weight per cu. foot, pounds	70.	72.
Humus, per cent	3.32	1.80
Nitrogen, per cent	0.30	0.16
Phosphoric acid combined with humus, per cent	0.04	0.01
Water-holding capacity, per cent	48.	39.

It will be seen from the foregoing table that, as the humus content decreased, the weight of the soil increased, and that with the decrease in humus, there was a corresponding decrease in nitrogen and phosphoric acid. The decrease in the water-holding capacity of the soil is also marked, indicating the necessity of maintaining an abundance of live humus in the seed-bed.

Humus or organic matter is the main immediate source of nitrogen in the soil. Nitrogen-fixing bacteria, which have the power to gather nitrogen from the air, require organic matter in some form. Productive soil contains countless millions of living forms which may be properly called soil laboratory workers. These living organisms flourish on the organic matter forming and transforming both organic and inorganic elements into plant food compounds. Upon the number and activity of these organisms depend the amount of available fertility. If humus or organic matter is absent or deficient, a corresponding deficiency is reflected in the crop. The availability of other elements, such as potash and phosphorus, also depends upon the nature and amount of the humus in the soil. Again, humus increases the absorbing and retaining qualities of moisture in the soil. Humus, also, in a measure, regulates the temperature of the soil; besides, it improves the physical condition to a marked degree.

Recognizing the fact that the seed-bed is the home of the plant and that from the seed-bed the plant receives its food, it stands to reason that it must contain humus in abundance, if the plant is supplied with food; hence, in plowing, great care should be exercised in gauging the depth, for we know that the subsoil is deficient in humus and that if it is brought to the surface in great quantities, the fertility of the seed-bed is materially diluted or weakened; therefore, in our efforts to secure a greater feeding area for the plant roots by plowing deep, we are sure to do harm unless the depth is increased gradually and as each slice of new soil is brought to the surface, organic matter, preferably barnyard manure, is thoroughly mixed with it. This, however, can be prevented by using the right type of plow which will be referred to later. By gradually increasing the seed-bed one-half inch each year and keeping in mind the absolute necessity of supplying humus in sufficient quantities for the new soil and to maintain the required content of the old soil, the farmer can, with no danger of impairing his crop, in a few years attain a depth of ten, twelve or even fourteen inches.

Do Not Till Deep

If the subsoil is sand or gravel, it is not advisable to bring it to the surface nor plow too near that formation. Sand or gravel will not retain water in suspension; hence, in such soils it is better to form, as far as possible, a compact plow sole which will, in a measure, prevent the percolation of rainfall.

Sandy Soils

In sandy soils, deep plowing is admissible if an abundance of humus or organic matter is provided; otherwise, the water will percolate below the reach of the roots, carrying with it fertility.

The deeper a sandy soil can be cultivated, providing an abundance of organic matter is furnished, the more certain is the soil to maintain a sufficient amount of water to mature the plant.

Virgin Soils

Virgin soils should not be plowed below the line of humus. However, subsequent plowing can be increased in depth the same as in older cultivated lands provided organic matter is supplied.

Benefits of Deep Tillage

The benefits of deep tillage are many, provided all of the requirements heretofore mentioned have been complied with.

It is obvious that the plant roots require room. Soil bacteria, which perform the function of converting elements into compounds, require air.

Plants require food and most of it is secured from the seed-bed, and plants require water; hence, to meet all of these requirements, the seed-bed should be deep, of good tilth and in a good sanitary condition.

Roots Require Room

Plant roots require room. The initial roots of the plant being fragile, they naturally seek the course of least resistance. If the seed-bed is shallow, they remain near the surface where they are apt to suffer for moisture in case of drouth, but if the seed-bed is deep and mellow, they take their natural course which is downward, and when they reach the bottom of the furrow, they have strength and stability to penetrate the more compact subsoils where they secure moisture, and, in some instances, plant food.

Air

Soil bacteria being aerobic, or, in other words, oxygen-consuming organisms, the seed-bed should be well aerated, a condition which can be attained by deep and thorough tillage. In some instances drain tile are necessary to facilitate the circulation of atmospheric oxygen through the soil, but if the water line is not too near the surface, deep plowing serves the purpose.

Plant Food

A deep seed-bed well stocked with organic matter, necessarily will maintain more of the soil organisms than a shallow one. The greater the number of bacteria and the more active they are, the more nitrogen will exist and the more inorganic plant food elements will be made soluble.

Water

The amount of available moisture depends, to a great extent, upon the depth and tilth of the seed-bed. If the seed-bed is shallow, primarily it does not absorb great quantities of water, and in case of drouth, it dries out readily. If it is deep, mellow and spongy, it acts as a surface reservoir to absorb and retain heavy downpours of rain until the surplus can percolate into the storehouse below. If the seed-bed is shallow, the soil is liable to wash away during heavy rains.

Soil Which Admits of Deep Plowing

In some sections of our country where the soil is rich in humus, which is indicated by the black color, it is safe, after the first plowing, to till deep, and, as a rule, the production will be in keeping with the depth the ground is tilled. Rough, heavy clay soils should not only be plowed deep, but plowed often. If such soils can be plowed twice or three times for one crop, the physical condition is greatly improved, oxidization is more perfect, and the permeability is increased; the farmer keeping in mind, of course, the necessity of furnishing organic matter. The arguments, based upon experience in favor of deep tillage when the laws governing plant growth and plant food chemistry are not violated, are so apparent the farmer cannot afford to ignore the benefits to be derived from making a thorough investigation of all conditions heretofore mentioned and govern himself accordingly.

Deep Plowing Without Bringing Subsoil to the Surface

The danger of bringing subsoil to the surface can be prevented and many of the benefits of deep plowing gained, by using a plow which thoroughly pulverizes the bottom half of the furrow slice, but does not place the subsoil on top of the surface soil which contains humus. This plow has a broad share and the moldboard is very narrow at the point where it joins the share, but widens gradually at the upper end. The share loosens and pulverizes the bottom slice which immediately falls to the bottom of the furrow through the space between the outer edge of the moldboard and the wing of the share, and the broad part of the moldboard turns the top soil in the ordinary way.

John Deere Deep-Tilling Stag Turning a Furrow 16 Inches Deep

While this plow penetrates to a depth of fourteen to sixteen inches, the furrow is left half-full of pulverized soil. A seed-bed so made is necessarily thoroughly ventilated, an abundance of room is provided for plant roots, and owing to the loose condition of the soil, water is rapidly absorbed.

This plow is certainly an ideal implement to use; in fact, it is the only one which has ever been devised that eliminates dangers previously mentioned and at the same time provides a deep seed-bed.

The Jointer

When trash exists on the surface in such quantities that it is not thoroughly covered, the jointer should be used. This attachment can be gauged to any required depth necessary to turn surface trash. As it is turned, it strikes the previous furrow a few inches below the top and is caught and covered by the moldboard slice, leaving the surface free of the accumulation and at the same time not placing it below the reach of the disc or other tillage implements.

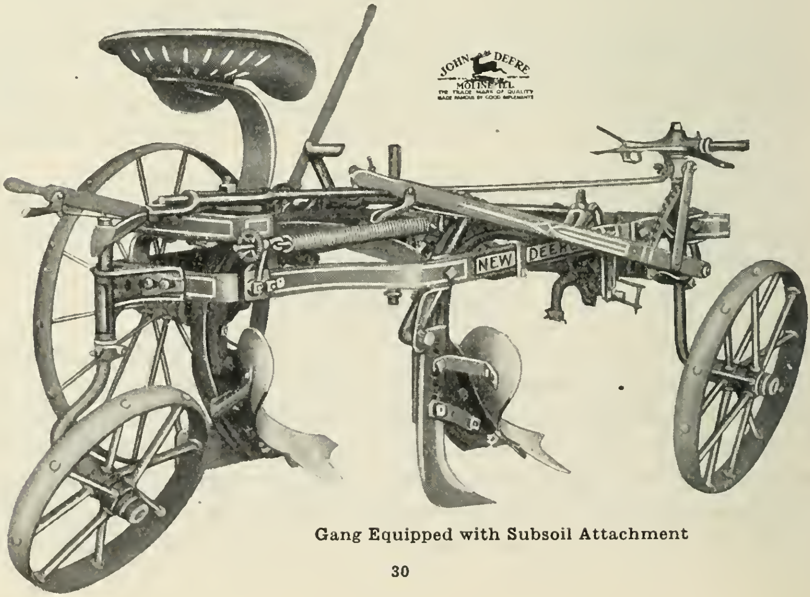
Sod can be plowed deep with perfect safety if the jointer is used. It should be run to a depth of two or three inches, depending upon the nature of the sod. The sod-ribbon is so placed when it is turned that it is slightly covered by the dirt from the moldboard and can be easily pulverized by using a disc. Without the jointer attachment, the sod strip might be covered too deep or project above the surface, depending entirely upon the texture of the soil.

The advantage in plowing sod deep, if this plow with the jointer attachment is used, is plain. Water is secured and stored more readily and roots can penetrate very deep, a condition which cannot be attained where the ordinary plow is used. It must be remembered, however, that to plow sod deep with the ordinary plow turning the sod, as is necessarily the case, to the bottom of the furrow and bringing to the surface raw, unventilated soil devoid of humus, is disastrous.

Subsoil

Unfortunately, conditions exist where deep plowing cannot be accomplished until the physical condition of the soil has been changed. Some soils below the depth of the ordinary plow are so dense and sticky, that penetration is difficult and scouring impossible. In other soils a hardpan may exist which is not only difficult to penetrate but if turned or materially loosened, large air spaces are formed which hinder the upward movement of capillary water. Either condition can be overcome by using the right type of subsoil plow.

The benefits of subsoiling are often misunderstood, and, in many instances, the farmer has been misled to the extent of making his land unproductive for a number of years.



Gang Equipped with Subsoil Attachment

The First Type of Subsoil Plow

invented had a narrow share and a long moldboard, which would bring subsoil to the surface. Theorists at that time believed that subsoil, being new, was rich in plant food elements, and that it would make their land productive. The absence, however, of humus in the subsoil resulted in disappointments. If the subsoil was clay or sand, there would be no production until organic matter was thoroughly mixed with the soil and reduced to humus.

The Next Type of Subsoil Plow

devised was one with a duck-bill-shaped point, intended to break up the soil below the bottom of the furrow. This implement was condemned,

Proper Method of Subsoiling Is to Cut a Thin, Deep Gash in Bottoms of Alternating Furrows .. In Dry Sections It Should Be Used in Every Furrow

especially where the subsoil was hard and composed largely of clay, for the reason that the breaking up process caused large air spaces which practically stopped capillary water from rising to the seed-bed.

The Modern Type of Subsoil Plow

possesses none of the objectionable features of the other two mentioned, but it does solve the difficulties which were first mentioned, namely, dense, sticky subsoils and hard-pans.

This plow is built on the principle of a colter. It cuts a gash from three-eighths to one-half inch in width and to any required depth, but it does not break up the subsoil or hard-pan to any great extent. In this gash water and air are freely admitted. They naturally spread out when the bottom of the gash is reached and obeying nature's laws, they reach the surface by capillary attraction. To illustrate, if a wooden floor is laid upon another floor which is tight and water is poured into a crack in the top layer, it naturally spreads out and in time comes to the surface by the process of capillary attraction, causing a rotting of the boards. Likewise, water which enters this gash in the soil followed by air, works on the same principle, coming to the surface, as it must, it causes a mellowing or rotting of the compact soils.

Two important things can be secured by using this type of plow, namely:

1. Water is stored to be utilized by the plant, and the dense soil is mellowed, permitting the penetration of roots.

2. After this plow has been used and the water and air have done their work, the deep plow will then not only penetrate but will usually scour. Where this plow has been used, especially in dry sections, the results have been remarkable. The implement can be attached to a gang plow, penetrating every alternate furrow, or it can be easily drawn by two horses running to a depth of from ten to eighteen inches.

Storer gives the following:

"Mr. Wilson, near Edinburgh, operating on land that had been tile-drained, plowed a field eight inches deep and subsoiled a part of it to a depth of eighteen inches. The differences in the crops grown the first year after these operations are given in the table:

	Turnips		Barley		Potatoes	
	Tons	Cwt.	Grain, bu.	Straw, cwt.	Tons	Cwt.
Plowed to 8 inches	20	7	60	28	6	14¼
Subsoiled to 18 inches	26	17	70	36½	7	9½
Gain made by subsoiling	6	10	10	8½		14¼

Mr. MacLean, in the same vicinity, made a similar experiment with the following result:

	Turnips		Barley	
	Tons	Cwt.	Grain, Bu.	Straw, Cwt.
Plowed to 8 inches	19	15	54	168½
Subsoiled 15 inches	23	17	62	206½
Gain made by subsoiling	4	2	8	38

In another case, where accurate accounts of the products were kept, the good effects of subsoiling were seen for five successive years after the operation.

In this country, Sanborn plowed two plots of land, each of $\frac{1}{10}$ acre, seven inches deep, and then subsoiled one of them to a depth of nine inches more, so that this plot was stirred to a depth of sixteen inches in all. After a severe drouth, he drove gas-pipes into the earth so that samples of the soil could be taken up from both plots to a depth of fifteen inches. In the earth from the subsoiled plot he found 10.1 per cent of moisture, while in that from the other plot there was only 8.3 per cent. The subsoiled plot yielded corn at the rate of seventy bushels to the acre, and the other plot yielded only forty-nine bushels to the acre."

Caution

Do not use the subsoil plow in clay saturated with water; or when the subsoil is sand or gravel.

In thin soil, when a hard-pan lies immediately on top of the loose sand or gravel, the subsoil plow should not be used, for the reason that it would permit water to percolate beyond the reach of the plant roots.

SEED-BED

OF the four essential steps in the production of farm crops mentioned in a previous chapter, namely—the seed-bed, fertility, selection of seed and cultivation—the seed-bed deserves special consideration, for if it is not properly made, the defects will be reflected in the final production, regardless of how carefully the three remaining features are observed.

We realize that the seeding season is short, and that to comply with all of the requirements, the average farmer is unable to plant a great acreage, but we contend and we know that if the seed-bed of one acre is made right, it will produce as much as two acres improperly prepared.

The seed-bed is a laboratory containing chemical elements which are used in making plant food compounds. Soil bacteria are the chemists and the plants are the consumers. Plants are exacting in their requirements, and if denied any of the essentials, in whole or part, the farmer suffers the penalty when the harvest is gathered.

Requirements

The chemists or soil bacteria and the plants enjoy a roomy, sanitary home; they require a sufficient amount of all of the inorganic elements necessary to plant growth and a good supply of organic substances. They perish if atmospheric oxygen is denied them, and water is just as necessary to them as it is to animate creatures. Micro-organisms are assisted in their work by the chemical action of elements forming and transforming new compounds, by gases and water and organic substances.

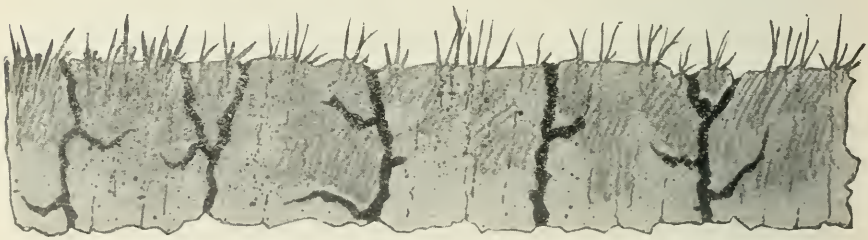
The seed-bed is made deep by deep plowing; it is made sanitary by tiling, trenching and tillage. Its physical and mechanical condition is always in keeping with the amount of tillage it receives.

Why a Roomy Seed-Bed

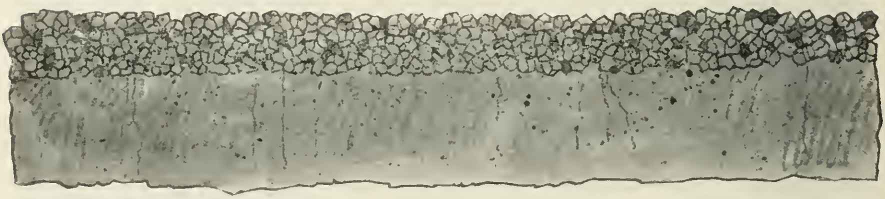
1. Some water and the available plant food is stored in the seed-bed; hence, it is very plain that a deep seed-bed would contain more than a shallow one just as we would expect to find more nourishment in a thick slice of bread than in a thin one.

2. A deep, roomy seed-bed affords freedom to plant roots. Roots are not unlike leaves and branches. They require room and freedom if the development is rapid and perfect. Roots seek the course of least resistance, and their natural course is downward, just as the natural course of branches is upward. If the seed-bed is shallow, when the first delicate roots reach the bottom of the furrow, which is usually compact and sometimes very hard, they spread out, not being able to penetrate the hard substance, and in the event of a drouth, the shallow bed dries out and the plant suffers. If, however, it is deep, the roots will have strength and stability to penetrate the more compact subsoils where they can secure water and some plant food.

3. A deep seed-bed, if properly pulverized, acts as a reservoir to hold water until it can percolate into the deeper soils and necessarily a

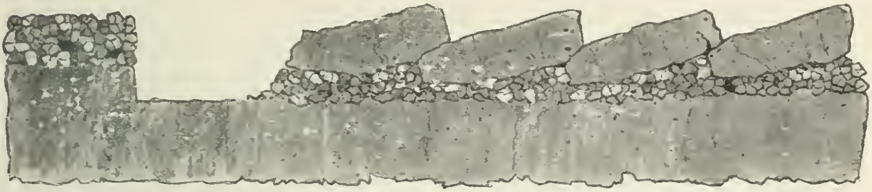


Showing Cracks in the Land Through Which Moisture Escapes

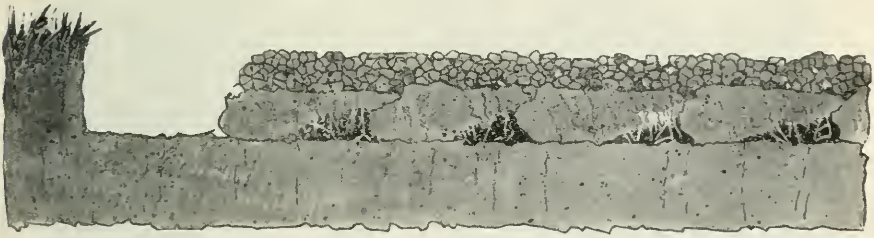


Showing How Effectively a Surface Mulch Prevents the Escape of Moisture

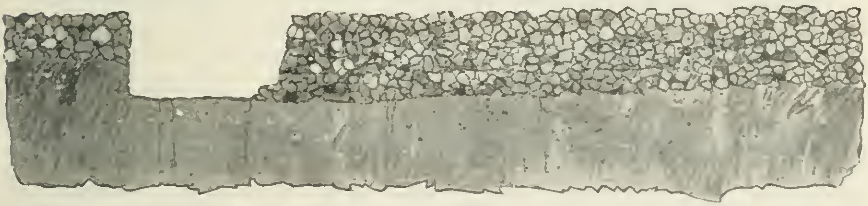
Was Not Disced Before or After Plowing



Disced Before Plowing, Making the Contact Compact Between the Bottom of the Furrow and the Furrow Slice



A Poorly-Made Seed-Bed .. Disced After Plowing, But Not Before .. The Large Air Spaces Prevent Capillary Action



A Perfect Seed-Bed .. Disced Before and After Plowing .. Seed-Bed to the Left Is Too Shallow. Note .. Soil Particles Magnified 1,000 Diameters

greater volume of water will adhere to the particles of soil as it passes down and be available to the plant roots in a deep seed-bed than a shallow one. Air being necessary to both micro-organisms and plant roots, it is reasonable to expect more to be available in a roomy seed-bed than in a shallow one.

Storing and Utilizing Water

Water is stored just in proportion to the permeability of the seed-bed and the texture of the subsoil. After the plants have utilized the water which adheres to the particles of soil in its passage downward, they then begin to draw by the process of capillary attraction, upon the water which has been stored in the subsoil. In order to insure perfect capillarity, there must be no large air spaces either at the bottom of the furrow or in the body of the seed-bed. In other words, there should be a medium compact condition of the soil particles. Before the plow turns surface trash and surface lumps under, the disc harrow should be used. Trash on the bottom of the seed-bed acts as an insulation, on account of the large air spaces, which effectually stop the upward movement of water. The disc harrow not only pulverizes lumps which

Disc Harrow .. This Implement Is an Insurance Against Loss from Drouth if Used Before and After Deep Plowing

may be on or within three or four inches of the surface, but it chops up and works into the soil stubble and all trash on the surface so that when the plow turns the slice of earth, the contact is compact between the plowed ground and the bottom of the furrow. After the ground is plowed, it should be again disced in order to insure pulverization and compactness of the portion of the soil which has been turned up by the plow. Again, the seed-bed should be disced and harrowed so as to alter the position and condition of the soil particles in order that changes in their chemical composition may be brought about by contact with each other, by the action of air and water and by micro-organisms.

Furthermore, the seed-bed should be mellow and at the same time firm enough to afford proper support to the plant. It should be loose enough to permit water to percolate and admit without hindrance the free growth of delicate root fibers. The soft points of roots will not penetrate hard lumps, but will pass around and adhere to them in their effort to secure food and water.

We know that plant food in solution forms a film around each particle of soil, and that the very minute roots throw their tentacles around it and secure nourishment by osmosis. Therefore, the advantage of a thoroughly pulverized seed-bed is very apparent when we realize that the available feeding area contained in a lump of soil is increased one thousand-fold when it is broken up and all of the particles are separated. While tillage does not increase the amount of plant food elements in the soil, it does make available those which are there. We know that millions of acres, rich in plant food, are producing less than one-half of their capacity, simply because the fertility is not available or within reach of plant roots, and because stored water cannot move upwards on account of obstructions which could be avoided. In the judgment of the writer, a farmer takes out an insurance policy against crop failure when he uses the disc harrow before and after plowing.

DRAINAGE

WE will not attempt to enter into a lengthy discussion of this subject, believing that every observing farmer is convinced of the benefits to be gained by thoroughly draining his land. We will, however, mention a few of the reasons why lands are made more productive and the possibility of failures eliminated by thorough drainage.

1. Farm crops are not aquatic; that is, the roots will not perform their function of gathering plant food and water if they are submerged in water.

2. Plant roots and soil bacteria require free atmospheric oxygen. If for any reason air does not circulate through the soil, the plant will be smothered and bacteria will not transform elements into compounds.

We have stated in a previous chapter that because of the irregular shape and variety of sizes of soil particles, air spaces exist when any number of particles are brought together. These air spaces constitute from twenty-five to fifty per cent of the volume of soil. If air spaces did not exist, the soil would be a solid stone. Again, many soil particles are not solid, but perforated, thereby further increasing the volume of air spaces. Air spaces between and through the particles of soil are:

1. To permit a free circulation of atmospheric oxygen through the soil.
2. To permit water to pass downward.
3. To promote capillary attraction.

4. To permit the minute food and water-gathering roots to pass between and to particles of soil.

5. To provide a storehouse for plant food and moisture.

Benefits of Drainage

All plants require water and will perish without it. Excepting water plants, it must be supplied in the form of a film adhering to the free surface of soil particles. Plant roots, unless they be of the aquatic variety, will soon die if submerged in water; hence, it is necessary to keep the water table or standing water at a distance far enough from the surface to permit the roots to freely develop. Underlain drain tile tend to carry off surplus water after the soil below the tile is filled. The tile in no way interfere with water stored below them, but simply carry away the superfluous amount above it, leaving all that will adhere to the particles of soil to be used by plants, and as it is consumed, more is furnished from below by capillary attraction.

During the early spring, at a time when seeds are planted and rapid germination is very necessary, the soil is usually surcharged with snow and ice water. Evaporation is necessarily very slow, and, as a consequence, the soil is cold, soggy and lifeless at a time when the plant should be making its most rapid growth. If the land is drained, the cold water is removed from below, the upper stratum of soil is warmed by spring rains and air thereby causes a rapid germination and root development.

Plant Roots Require Air

If the spaces between the soil particles are filled with water, air cannot circulate, a condition which causes the roots to rot or cease to develop.

Drain Tile Warm the Seed-Bed

During the spring, air is warmer than the soil and spring rains warmer than snow water. If both ends of the drain are open, or manholes are placed along the line of tile, warm air enters and finds its way through the soil, and warm rains are freely absorbed, thereby materially affecting the temperature of the soil.

If the farmer will test a drained and an undrained soil at early seeding time, he will find the drained land from six to twelve degrees warmer than that which is not drained. In view of the fact that seed will not germinate in soil below 42 degrees Fahrenheit, it is very evident that if the temperature can be raised from six to twelve degrees, by placing drain tile, the early growth gained on account of the warmth of the seed-bed would be worth considering.

Drainage Prevents Loss from Drouths

This statement may seem strange, but it nevertheless is true. If in the spring when seeds are planted the soil is surcharged with water, nearly to the surface, the roots will develop above the water line, keeping near the surface. If, after the roots have attained their growth, a drouth sets in, the water line is lowered several feet, but the roots having ceased to grow, they are left in the surface soils in a helpless condition. If, however, during the first few weeks, the water line is at or below the tile, the roots will strike downward very rapidly, and when the drouth does come, they will be in a territory containing moisture. It is recorded that during the terrible drouth of 1854 wheat, corn, oats and other plants flourished and made a fair crop on tile-drained land, but perished on land not drained.

Drain Tile Improve the Soil Physically

Drain tile naturally give life and vigor to the soil and such soils are mellow and friable, water is absorbed more freely and capillary attraction is perfect.

Low Ground

If low ground is drained, it can be worked much earlier in the spring or after heavy rains than undrained ground, and the danger of puddling is greatly lessened.

Drainage Prevents Surface Washing

If sloping land is saturated with water, the soil is apt to wash in the event of more rain. Drained soil will readily absorb the water as fast as it falls, thereby preventing the loose soil from washing away and forming gulleys. By running a few lines of tile at a gentle slope on a steep hillside, gulley-forming will be prevented.

Water-Holding Capacity of Soil

Plants are benefited only by the water that adheres to the surface of the soil particles, and any additional water is a detriment. Prof. Schubler states that one hundred pounds of the following types of soil will hold by attraction to the surface of the soil particles as follows:

Sand	25 pounds of water
Loam Soils	40 pounds of water
Clay Loam	50 pounds of water
Pure Clay	70 pounds of water

Mr. Sheld states that the soil of ordinary density to a depth of three feet will hold by attraction before any will drain away, $17\frac{3}{4}$ inches of rainfall. If drains are placed three feet deep, a square foot of surface will receive 10.6 gallons of water before one particle would enter the drain. Hence, it can be seen that drain tile do not rob the ground of water that can be utilized, nor does it in any way exhaust that which may be stored below the growing line.

Power of Soil to Absorb Moisture from the Air

Dry soil will absorb moisture from air in varying quantities, the amount depending upon the character of the soil. This moisture, known as hygroscopic water, enters the seed-bed and is beneficial to plants if the ground is so thoroughly drained that air can freely circulate through it. As the air passes through the soil, the moisture adheres to the particles and in a limited way is beneficial.

Schubler states that different soils possess this power in unequal degrees. During a night of twelve hours and when the air is moist one thousand pounds of perfectly dry

Quarts Sand will gain	0 pounds
Calcaria Sand will gain	2 pounds
Loam Soil will gain	21 pounds
Clay Loam will gain	25 pounds
Pure Agricultural Clay	27 pounds

If the soil is of good tilth, thoroughly drained and contains an abundance of humus, the amount of hygroscopic moisture absorbed is increased.

Size of Drain Tile to Use

The size to use depends upon the length of the line, the fall, amount of water to be carried away and the character of the soil. A one-inch pipe carries one inch (circular measure) of water. A two-inch pipe will carry four inches of water. A three-inch pipe will carry nine inches and a four-inch pipe will carry sixteen inches of water. Thus it will be seen that under the same conditions a four-inch pipe will carry sixteen times as much water as a one-inch pipe, in fact it carries more than that for the reason that friction is much less in a larger pipe than in a small one. A drain tile eight inches in diameter with a fall of three-tenths of a foot in one hundred feet will discharge 277,487 gallons of water in 24 hours. If a foot fall it will discharge 525,647 gallons during the same time. A four-inch drain pipe having three-tenths of a foot fall in one hundred feet will discharge 43,697 gallons in twenty-four hours and with a one-foot fall it will discharge 86,181 gallons. Therefore it can be seen from the above that the amount of water a pipe will carry in a given time not only depends upon the size of the pipe, but the fall which is a very important thing to consider.

Care should be taken to have the main tile large enough to carry off the maximum flow without exhausting the capacity of the drain. If the tile is not large enough it is apt to be undermined and disarranged. The main can be made large at the outlet and gradually diminished to the highest point using a reducer from time to time. At the junction where laterals join the drain tile, both main and laterals should have a firm foundation and be well tamped on the sides and top.

While no fast rules can be laid down governing the size of tile, a main eight or ten inches in diameter and laterals four inches in diameter will usually meet ordinary conditions unless the area drained is exceedingly large.

Number of Rods of Drain Tile Required per Acre at Different Distances

The following table will serve as a guide in ordering tile for a single acre.

Intervals Between the Drains in Feet	Rods per Acre
15	176
18	146 2-3
21	125 5-7
24	110
27	97 7-9
30	88
33	80
36	73 1-3
39	67 9-13
42	62 5-7

Depth of Drains

It is entirely useless to lay drain tile one or two feet below the surface. In order to secure the many benefits which may be gained, the ditch should be not less than four feet deep. In some instances it may be necessary, on account of the lay of the land, to place them at less depth, but an effort should be made to secure an outlet which will permit a depth of not less than four feet at the shallowest point.

Drain tile should be below frost. If a drain tile freezes while filled with water it will burst.

How to Lay Pipe

After the engineer has determined the route for each line, the operation of digging the ditch and laying the tile should begin at the outlet. If a middlebuster or heavy broad gauge plow is used, the first foot of soil can be thrown out at little cost. If quick sand is encountered, a solid foundation should be secured in some way before the tile are laid.

IRRIGATION

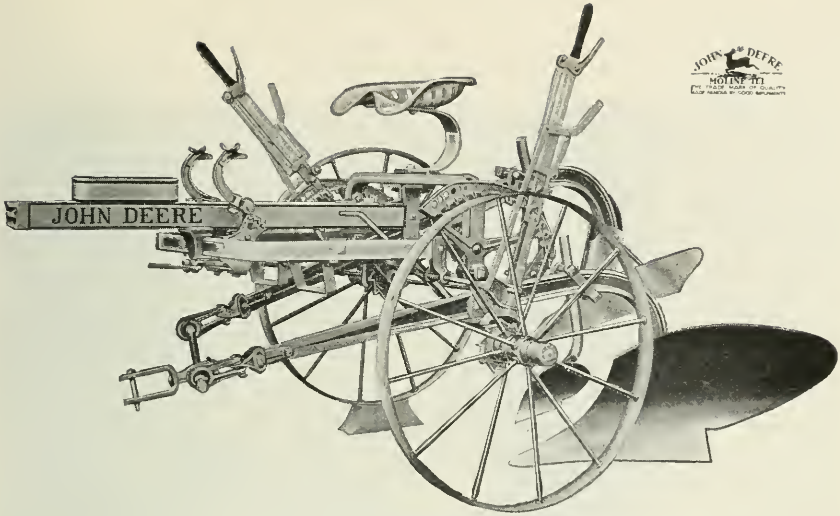
TO successfully irrigate land, several very important things must be observed, otherwise the results sooner or later will be disappointing.

1. The field should be leveled or at least the surface made even. All dead furrows and depressions must be remedied.

2. The ground should be underlain with drain tile. We fully appreciate the fact that the farmer who is just beginning in a new country will hesitate on account of the expense, still tile are so important that he cannot afford to ignore them if he expects his soil to continue to produce as it should. Drain tile not only carry away surplus water, but they furnish an escape for water holding in solution alkali salts. In most of our irrigated sections the water contains more or less of some of the alkalis. It is estimated that fully a million acres of irrigated lands which at one time were productive, are worthless today because of the presence of these deleterious salts. Again, drain tile admit atmospheric oxygen. Free atmospheric oxygen is just as essential to irrigated soils as it is to other soils, in fact, where alfalfa is raised it is even more necessary. Oxygen supports soil bacteria of various kinds which are necessary to absorb nitrogen from the atmosphere, to nitrify organic nitrogen and to make plant food compounds.

3. Water should be supplied in such a way that it will not interfere with the growth of the plant, but be utilized by the plant roots according to nature's process. The air spaces between the particles of soil are for the purpose of permitting water to percolate into the deeper soils to permit plant roots to pass down and to the particles of soil in their efforts to secure plant food and for the purpose of permitting the circulation of atmospheric oxygen. When the water is turned on the land and it is percolating to the deeper soils, the air spaces are necessarily filled, the oxygen is driven out and the plant for the time does not grow. If this condition continues for a protracted period, the plant necessarily smothers; therefore, before the crop is planted, water should be turned on in sufficient quantities to make the crop if possible. If the ground is tiled, the water percolates very freely into the deeper subsoils and is brought to the surface seed-bed by capillary attraction, just as hydrostatic water or rain water is utilized. In extremely dry sections, it may be necessary to irrigate more than once, but, as a rule, frequent irrigations hinder rather than benefit the crop. The irrigating farmer should use the same methods adopted by the dry-land farmer. He should store his water and then practice intensive cultivation methods, pulverizing, packing and maintaining a mulch to prevent the escape of moisture. The writer has seen many splendid prospects practically ruined by using too much water and not adopting dry-land methods for the purpose of conserving moisture.

After the farmer has prepared his land so that no ridges or depressions exist, all subsequent plowing should be done with a two-way plow. By using this implement, there will be no dead furrows or back furrows or depressions. Farmers who have used this implement unhesitatingly testify that it makes a saving of from five to ten dollars an acre each year by leaving the land as level and regular as it was before it was plowed.



A Two-Way Plow .. Indispensable on Steep Hillsides and Irrigated Ground

ROTATION

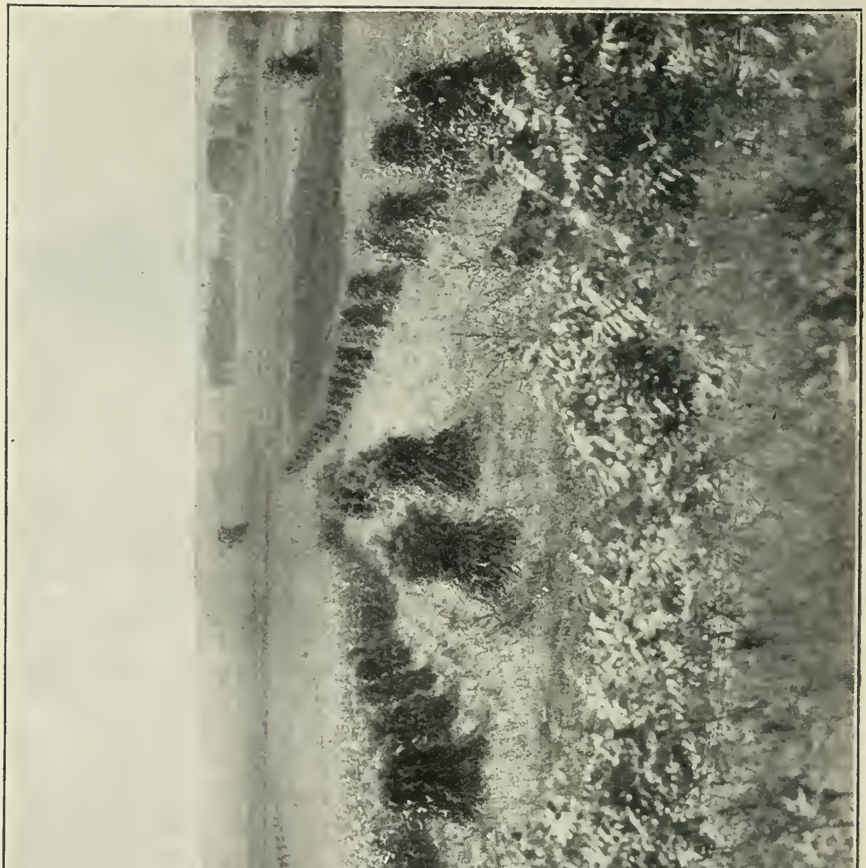
THE value of a systematic rotation of crops is so well known to every observing farmer, that it seems unnecessary to enter into a lengthy discussion of the subject. Farmers have practiced rotation and appreciated the benefits since early Roman times, still many farmers of our country have neglected and are neglecting the art, not because of ignorance, but because rich lands have been plentiful and cheap in price, and they could, without great effort, produce enough to supply the demand; hence, a system which guarantees a greater production has, in a measure, been neglected.

We will offer, however, a few common-sense suggestions, hoping that the farmer will, in view of the fact that the demand for farm products is increasing much faster than our production, accept and enforce them, for he is the custodian of the nation's larder, and we, judging from the high cost of living, are liable to face actual want unless the volume of food is increased.

Plant Roots

Scientific investigation has proven that the plant root excretes or forms deleterious substances which are a poison, in a degree, to its own kind, but a stimulant to another plant. We know that if a piece of ground is cropped year after year with the same crop, that each year the production is a little less, until, finally, it will not pay for the seed and labor expended for cultivation, when, at the same time, plant food elements may exist in the same soil in abundance.

In one demonstration where corn was grown on the same piece of land for twenty-eight years, the last ten years averaged twenty-two bushels



Corn in Rotation with Oats and Clover

per acre, and an adjoining field, where rotation was practiced, made a yield of over seventy bushels per acre. Another demonstration extended over a period of seventeen years gave a yield of eleven bushels of corn the last five years, but where rotation was adopted on an adjoining field, the yield was seventy-five bushels per acre. Scores of like instances can be mentioned.

We know that flax cannot be profitably grown on the same land two or more years in succession because of a root wilt, and potatoes rarely do well when they succeed themselves on account of scab, fungi, rot, etc.

We know that land becomes wheat, oats, barley and clover-sick to the extent of being discarded as "worn out," when in reality the land simply refuses to produce because of mismanagement.

Deep-rooting plants should be followed by those which have shallow roots; for instance, alfalfa and clover roots grow many feet into the subsoils; they secure water and food far below the reach of other plants. We know that legumes have the power to take nitrogen out of the air, not only to provide for their own wants, but leave a surplus in the soil. Such crops should be followed by one which requires an abundance of nitrogen and does not send roots as deep. Corn always produces more abundantly when it follows a legume, because it requires a large quantity of nitrogen and secures most of its food from the seed-bed. Wheat and other grain crops obtain their food nearer the surface, and their plant food requirements are somewhat different from corn and clover; hence, wheat yield is increased when it follows corn.

Crops which encourage the growth of weeds, such as grains, should not succeed each other, but follow a hoed crop. Crops which are liable to be infested with insects should not succeed each other; likewise crops which develop fungi, scab and rot, such as potatoes and other root crops, should not be repeated on the same land each year. Grain crops are apt to lodge if not planted on compact soils, and root crops do well only when planted in loose ground. Again, root crops such as turnips and beets should follow crops which have been heavily manured and the soil is of such texture that they can easily penetrate it.

In every rotation, some one of the legumes, preferably the lucerne or clover, should be grown.

Lucerne or Alfalfa

The roots of the lucerne penetrate very deep. It is not uncommon for them to attain a length of from twelve to eighteen feet, and one fifty feet long, in a preserved state, is in the museum at Berne.

Clover

Clover roots do not penetrate so deep as the lucerne, rarely going more than three and one-half to four and one-half feet, but they are very abundant.

The advantages of these deep-rooting plants are hardly appreciated by the farmer who has not made a test of their worth. They improve the texture of the soil, permitting water to be more freely absorbed; they, in a measure, admit air, and when they decay, the organic matter is resolved into humus which, acting with the air and water, combines with inorganic plant food elements, making them available. Plant food thus formed is brought to the seed-bed or the upper subsoils by capillary attraction and utilized by other plants. This process accounts, to a great extent, for the increase in any crop that follows clover or alfalfa.

The legumes are further beneficial in this, that they have the power through a bacteria which forms on the roots to take nitrogen from the air, not only in sufficient quantities to provide for their own wants, but to deposit a considerable amount in the stubble and roots, which becomes a part of the soil.

Storer says that for every ton of clover hay harvested, 1600 pounds of roots and stubble are left upon the land.

Heiden states that of the total nitrogen produced by a clover crop (roots included), 58 per cent are contained in the stalks and leaves above the ground and 42 per cent in the roots. In proof of the fertilizing power of clover-refuse, Boussingault states that wheat taken before clover in the rotation studied by him habitually gave 16 or 17 hectolitres of grain to the hectare, while wheat taken after clover, gave 20 to 21 hectolitres. It also appears from results obtained by Voelcker that clover roots and stubble after the second cutting for hay contained less nitrogen than the stubble and roots after the first cutting for hay and the second cutting for seed, as is shown in the following table:

Residues left in the soil by a crop of	Clover mown twice. Total yield, four long tons to the acre	Clover mown once, then left for seed. Yield, 2.5 tons hay and 3 cwt. seed
Pounds of dry roots to the acre	1,493.5	3,622.0
Pounds of Nitrogen in these roots	24.5	51.5
Pounds of Nitrogen in upper six inches of soil of an acre	3,350.0	4,725.0
Pounds of Nitrogen in 2d six inches	1,875.0	3,350.0
Pounds of Nitrogen in 3d six inches	1,325.0	2,225.0
Pounds of Nitrogen in upper 12 inches of soil and in the roots	5,249.5	8,126.5

The difficulty in securing a stand of clover and the possibility of winter-killing prevents many farmers from growing it. Failures, however, to secure a stand is due very often to a poorly-made seed-bed.

First, the clover seed-bed should be of good tilth, all of the surface lumps thoroughly pulverized, and the seed sown at a time when germination will be rapid. If clover is sown on fall grain in the spring, the farmer should not mud it in nor sow it when the ground is extremely cold. He should wait until the surface is beginning to dry and is reasonably warm. A light harrow should be run over the surface before the seed is sown; after the seed is on the ground, a corrugated roller should be used.

Lime Needed

I think I am safe in saying that a large per cent of the failures to secure a good, healthy stand and a continued, rapid growth through the season, is due to the lack of lime in the soil. Sour soil causes the plant to be weak and anaemic. It turns yellow and most of it will die in the event of drouth.

Winter-Killing

Winter-killing can, in a great measure, be prevented by spreading a thin coat of manure over the surface just as the ground is freezing. Early in the spring a peg-tooth harrow or a rake should be used for the purpose of loosening compact pieces of manure which, if permitted to remain on the plant, would cause smothering. If clover winter-kills, cow peas, soy beans or vetch should be sown. If the ground is rich, cut for hay, leaving a high stubble, fall plow and top dress with barnyard manure, and disc in before planting corn. Clover, like alfalfa, should not be pastured too close after the last cutting.

No fixed rotation will apply to all climates and soils. The farmer should plan to suit the crops best adapted to his climate and to the general character of the soil.

In the corn belt, a good rotation is corn, wheat (oats or barley) and clover. Where clover cannot be grown, another legume should be substituted. Where wheat and corn do not thrive well, Kaffir corn, milo maize or millet may be substituted. When alfalfa is used in a rotation, it should not be plowed under more often than every five years. Barley and rye follow wheat very nicely, but wheat should never follow those crops. Potatoes, beets and turnips require a deep, loose seed-bed, rich in organic matter. It is not advisable, however, to apply manure the year the crops are planted. Sugar beets require an alkali soil and the ground should be of loose texture and the seed-bed not less than twelve inches deep. Root crops do well after clover or any of the legumes provided the land is plowed deep and thoroughly disced the previous fall. A good plan is to plant cow peas as a catch crop after the grain has been harvested. The ground should be thoroughly manured, and after the pea crop has attained a good growth, plowed under deep. It should be again plowed the next spring before the crop is planted. It is not advisable to plant oats and rye on loose ground or soil that is too rich, for the reason that they lodge easily.

A Drove of Pure-Bred Guernsey Cows on the Deere Dairy Farm
Barnyard Cemented .. Under-Ground Tank to the Right
into which Liquid Manure Flows

MANURES

"But sweet vicissitudes of rest and toil
Make easy labor, and renew the soil.
Yet sprinkle sordid ashes all around,
And load with fatt'ning dung thy fallow ground."
—Virgil.

MANURE is any substance added to the soil with a view of rendering it more fertile. Vegetable growths, all kinds of animal matter and many inorganic substances contain plant food, either in the form of elements or compounds.

To simplify the study of this very important subject, we will classify manures as follows:

Barnyard or farm manures.

Green manures.

Commercial fertilizers.

In order that we may have a comprehensive knowledge of farm manures from a plant food standpoint, several things should be considered.

The various feeds contain different amounts of the principal elements of fertility. Likewise the amount of plant food contained in excrements from live-stock varies greatly for different animals. The age and habits of animals affect the different amounts of the essential elements to be found in manure of the same class. For instance, a young growing animal will consume and retain more of the nitrogen and phosphorous in feed eaten than one which has attained its growth and a working animal requires more than an idle one. Hence, it is impossible to give the exact amount of nitrogen, phosphorous and potash in a ton of mixed barnyard manures without making a specific analysis.

The figures given, however, are based upon chemical analyses made by many of our most learned chemists and represent very closely the plant food value of mixed barnyard manures and the excreta from different animals. All manures contain a percentage of all plant food elements, but we will deal only with the important ones—nitrogen, phosphorous and potash. Such elements as iron, alumina, silica, magnesia, sulphur, lime and soda exist in most soils so abundantly that it is not necessary to consider any of them excepting lime which will be discussed later.

We will first give the number of pounds of nitrogen, phosphoric acid and potash in a ton of the most commonly used stock feed; and, subsequently, the pounds of the same elements in dung and urine from various farm animals, also the pounds contained in mixed yard manures and in litter or bedding.

If the reader will keep in mind the amount of plant food contained in a ton of manure and will note the requirements of crops which will appear in a subsequent table, he will have a guide to direct him in his efforts to supply his soil with the necessary elements.

TABLE NO. 1 .. PLANT FOOD IN STOCK FEEDS

Kind of Feed	One Ton Contains Pounds Nitrogen	One Ton Contains Pounds Phos. Acid	One Ton Contains Pounds Potash
Clover Hay	39.4	11.	37.4
Alfalfa	50.	8.	24.
Timothy Hay	18.8	6.6	28.4
Cow Pea Hay	43.	10.	33.
Corn Stover	16.	4.	17.
Oat Straw	12.	4.2	21.
Wheat Straw	10.	4.4	12.6
Corn	33.	14.2	11.4
Wheat Bran	49.2	53.8	30.4
Oil Meal	108.4	33.2	27.4
Oats	33.	16.	11.
Barley	40	18.	11.
Rye	42.	20.	13
Wheat Shorts	48	31.	20.

From the above table, the farmer can easily determine the manurial value of the feeds given to his stock, knowing that eighty per cent of the elements contained in the feed is found in the manure.

To illustrate, a ton of corn contains 33 pounds of nitrogen, 14.2 pounds of phosphoric acid and 11.4 pounds of potash. The market value of the elements is eighteen to twenty cents per pound for nitrogen, six cents for phosphoric acid and five cents for potash. Therefore—

The nitrogen would be worth	$5.94
The phosphoric acid would be worth	.85
The potash would be worth	.57
Making the total value	$7.36

If the corn is fed to live-stock and the manure placed in the soil, eighty percent of the fertility removed is returned. In other words, the farmer has had the full feeding value of the corn and $5.89 worth of fertilizer to place on his land.

It will be seen that the value of all of the fertility permanently removed by the corn is only $1.47 and .81 percent of that is nitrogen, an element easily replaced by planting legumes. The above figures show that only 28 cents' worth of the reserve stock of potash and phosphorous is permanently taken from the soil in one ton of corn.

TABLE NO. 2 .. PLANT FOOD CONTAINED IN A TON OF FRESH DUNG

Source of Manure	Pounds Nitrogen	Pounds Phos. Acid	Pounds Potash
Horse	10	7	9
Cow	6 to 9	5 to 6	9 to 10
Swine	12 to 15	9	6.4
Sheep	15	10 to 15	11.8
Poultry	32	30	16 to 20

TABLE NO. 3 .. PLANT FOOD CONTAINED IN A TON OF FRESH URINE

Source of Manure	Pounds Nitrogen	Pounds Phos. Acid	Pounds Potash
Horse	24.	---	30.
Cow	16.	---	28.
Swine	6.	2.5	4.
Sheep	28.	1.	40.

A ton of drainage from gutter behind milk cows contains—

20 pounds of nitrogen
5 pounds of phosphoric acid
17 pounds of potash

Drainage from a manure heap per ton contains—

30 pounds of nitrogen
2 pounds of phosphoric acid
98 pounds of potash

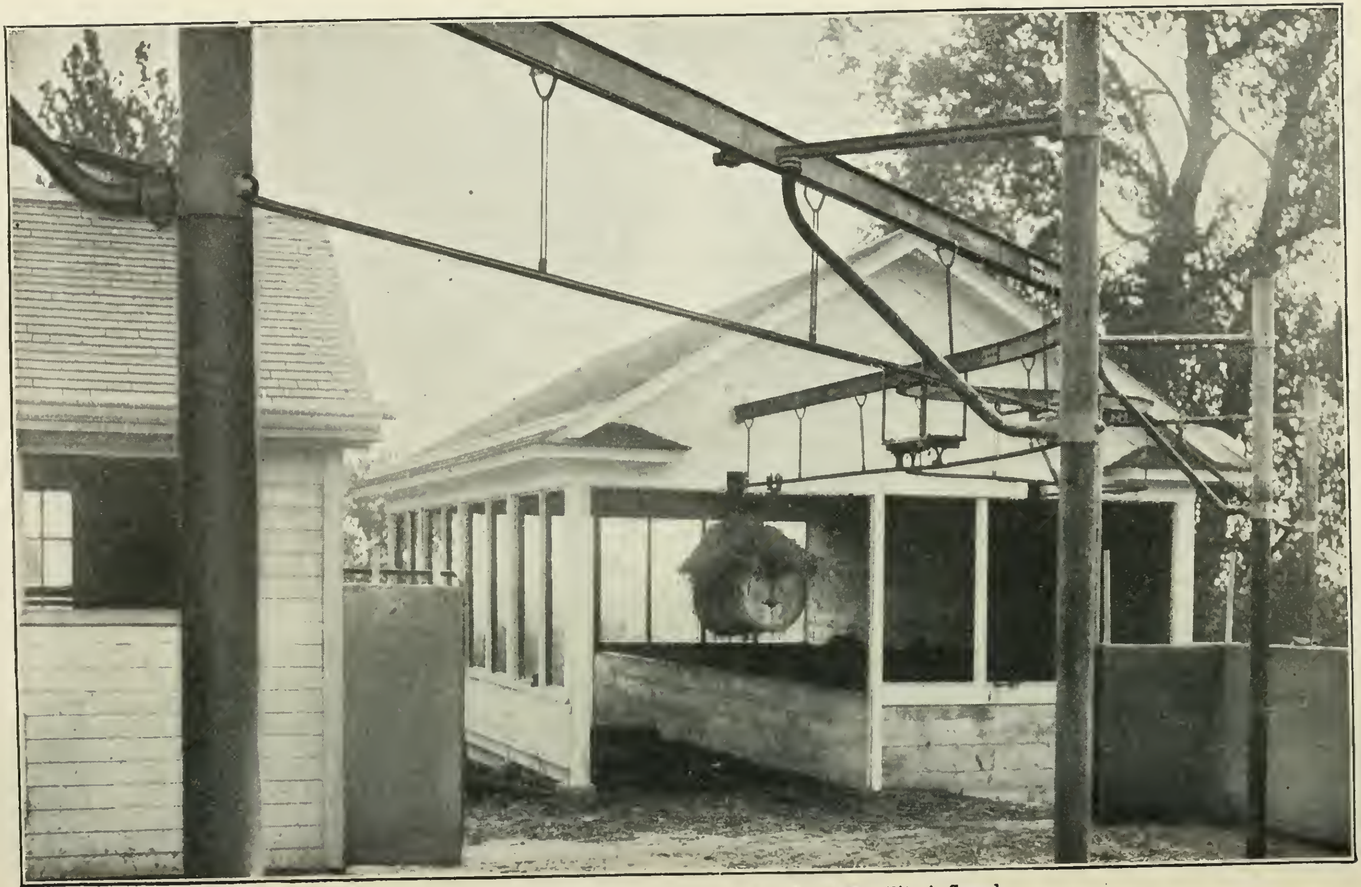
Composition of Farm Manure

Barnyard manure is composed of excrements, urine and litter. The amount of plant food in a ton depends upon the amount of water it contains, the kind of litter used, the feed given the animal and the kind of animal. Average barnyard manure contains per ton—

10 pounds of nitrogen
From 6 to 7 pounds of phosphoric acid
From 12 to 16 pounds of potash

TABLE NO. 4 .. COMPOSITION OF LITTER PER TON

	Pounds Nitrogen	Pounds Phos. Acid	Pounds Potash
Wheat, Oat & Rye Straw	9.6 to 12	4.4 to 5	16.4 to 23
Barley Straw	11.4	5.	23.5
Buckwheat Straw	13.	7.1	24.2
Millet Straw	14.	3.6	34.
Marsh Hay	17.2	10.6	54.
Leaves	15	3.2	6.



A Manure Pit on the Deere Dairy Farm .. All of the Fertility is Saved

The following table compiled from Hopkins' "Soil Fertility," gives the approximate maximum amount of plant food removed from the soil:

TABLE NO. 5

Product	Quantity	Pounds Nitrogen	Pounds Phos. Acid.	Pounds Potash	Tot.No.Lbs. Plant Food
Corn Grain	50 bu.	50	8.5	9.5	68.
Corn Stover	3000 lbs.	24	3.	26.	53.
Total Crop		74	11.5	35.5	121.
Oats Grain	50 bu.	33.	5.5	8.	46.5
Oat Straw	2500 lbs.	15.5	2.5	26.	44.
Total Crop		48.5	8.	34.	90.5
Wheat Grain	25 bu.	35.5	6.	6.5	48.
Wheat Straw	2500 lbs.	12.5	2.	22.5	37.
Total Crop		48.	8.	29.	85.
Cotton Lint	500 lbs.	1.5	0.2	2.	3.7
Cotton Seed	1000 lbs.	31.5	5.5	9.5	46.5
Cotton Stalks	2000 lbs.	51.	9.	29.5	89.5
Total Crop		84.	14.7	41.	139.7
Potatoes	150 bu.	31.5	6.5	45.	83.
Sugar Beets	10 tons	50.	9.	78.5	137.5
Apples	300 bu.	23.5	2.5	28.5	54.5

The above table gives the amount of each of the three essential elements removed from an acre of soil by some of the principal farm crops.

To return to the soil all of the plant food removed and some additional, the farmer should apply five good loads or tons of manure to each acre. By applying more than five tons, the fertility will be increased proportionately. It will be remembered that a ton of average barnyard manure contains—

10 pounds of nitrogen
From 6 to 7 pounds of phosphoric acid
From 12 to 16 pounds of potash

Therefore, five tons would contain—

50 pounds of nitrogen
30 to 35 pounds of phosphoric acid
60 pounds of potash

making a total of 142.5 pounds which is more than any of the crops mentioned in the foregoing table require. While the corn and cotton crops consume more nitrogen than is returned in the manure, the stalks of both plants are usually left on the ground and finally worked into the seed-bed.

The Right Way to Spread Manure Evenly and Quickly .. Time Occupied in Spreading One Ton, Two Minutes

HUMUS

THUS far, we have considered only the plant food elements contained in manure. Manure has another value of greater importance which, if thoroughly appreciated by the farmer, would prompt him to make stock-raising a prominent feature and cause him to preserve and utilize every atom of everything which can be construed as manure, for it is the foundation of the yeast of the soil. It is the organic substance which is finally resolved into humus.

Value of Humus

Humus is just as necessary to make soil fertile as water is to make lime and sand into plaster. Soil which is barren of live humus is as unproductive as pure sand. The value of humus is apparent, but the chemistry of its component parts is not thoroughly understood.

We know, however, that it is the portion of organic matter found in the soil which is in a partly-rotted conditon.

We know that it supplies nitrogenous plant food and combines with phosphorous, potash and other fertilizing elements, making them available and effective.

We know that it furnishes the food for niter-forming bacteria which convert it into nitrates, an available form of organic nitrogen.

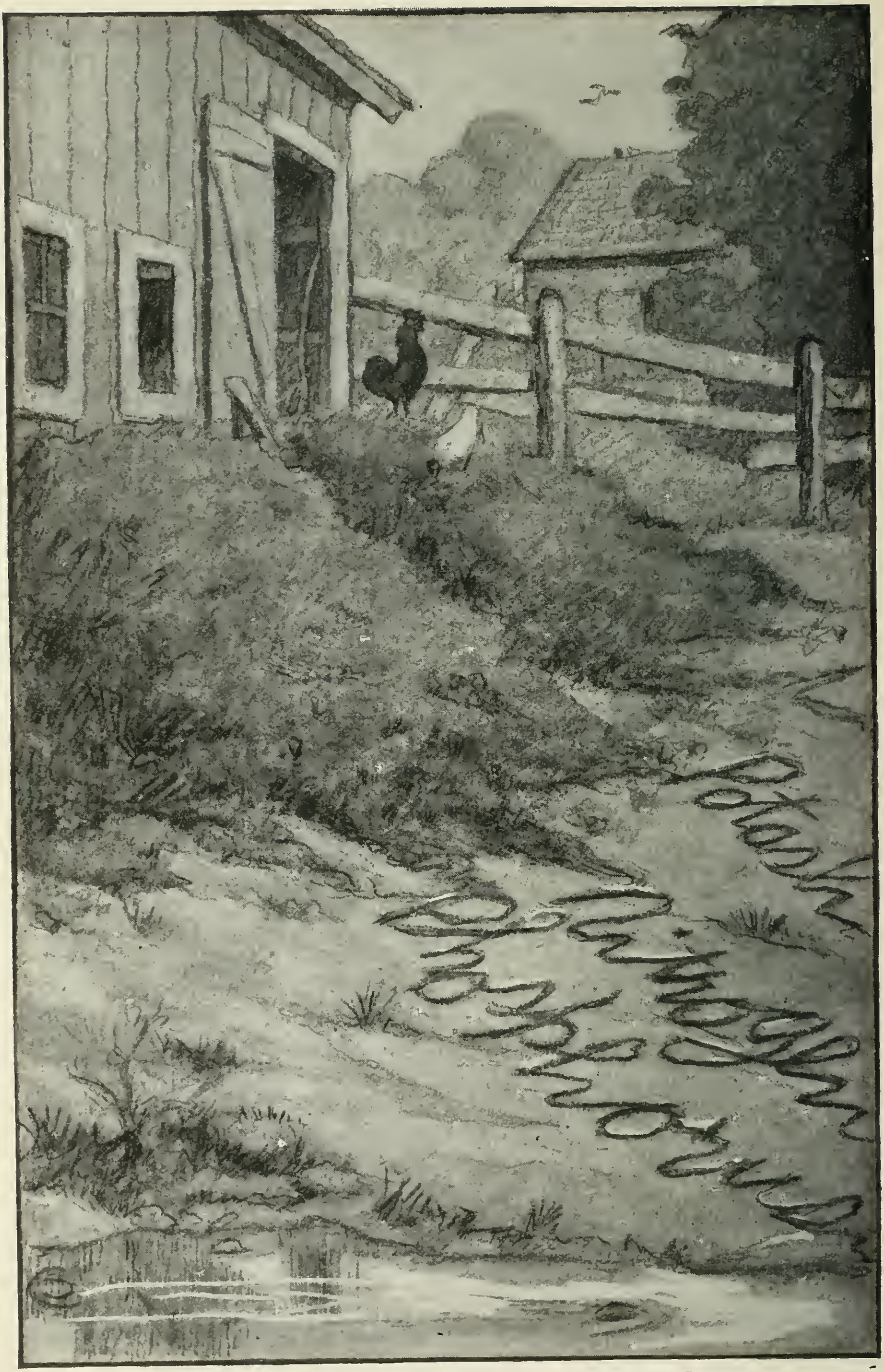
We know that it improves the phyiscal condition of the soil by making it mellow and friable and gives it permeability and substance. It also assists in the absorption and retention of moisture, prevents puddling, baking and cracking and renders light sandy soils productive and clay soils tillable.

It influences the temperature of the soil to a marked degree. In fact, it is the one great substance which cannot be dispensed with in our efforts to maintain the fertility of the soil.

Humus must be renewed from time to time, for it becomes worthless in soil which has been repeatedly cropped with the same crop or like crops. It can be supplied, renewed and kept active by the application of barnyard manure, green crops plowed under and rotation of crops. Intensive methods of tillage are also factors in keeping humus active. Soils may be rich in potash, phosphorous and other inorganic elements and be abandoned as "worn out" when, in fact, they need only humus to make them very productive. It must be remembered, however, that HUMUS is practically worthless in unventilated, water-logged and sour soils. Such soils need lime and drainage.

Benefits of Manure and Crop Rotation

Manure is the foundation of successful agriculture and will be until the laws governing plant life and the formation of plant food compounds are changed.



Fertility from the Manure Pile Filtering Into an Adjacent Stream

History tells us that Memphis, the first great city of ancient times, a city which controlled the civilized world, was built up and made powerful because of the fertility of the farms, made so by the judicious use of manures. Nineveh, Babylon, Venice and other ancient cities grew to greatness from the same source and then fell to the pit of destruction when the farmers ceased to observe stock-raising as a feature of farming.

America today is the foremost commercial nation of the world, but to maintain that supremacy we must produce from the soil food to feed our people and, if we produce a surplus for other nations, our power will be universal. On the other hand, if we disregard nature's exacting laws which govern soil maintenance, history will repeat itself and our great commercial institutions will be crumbling monuments to the American farmer's carelessness.

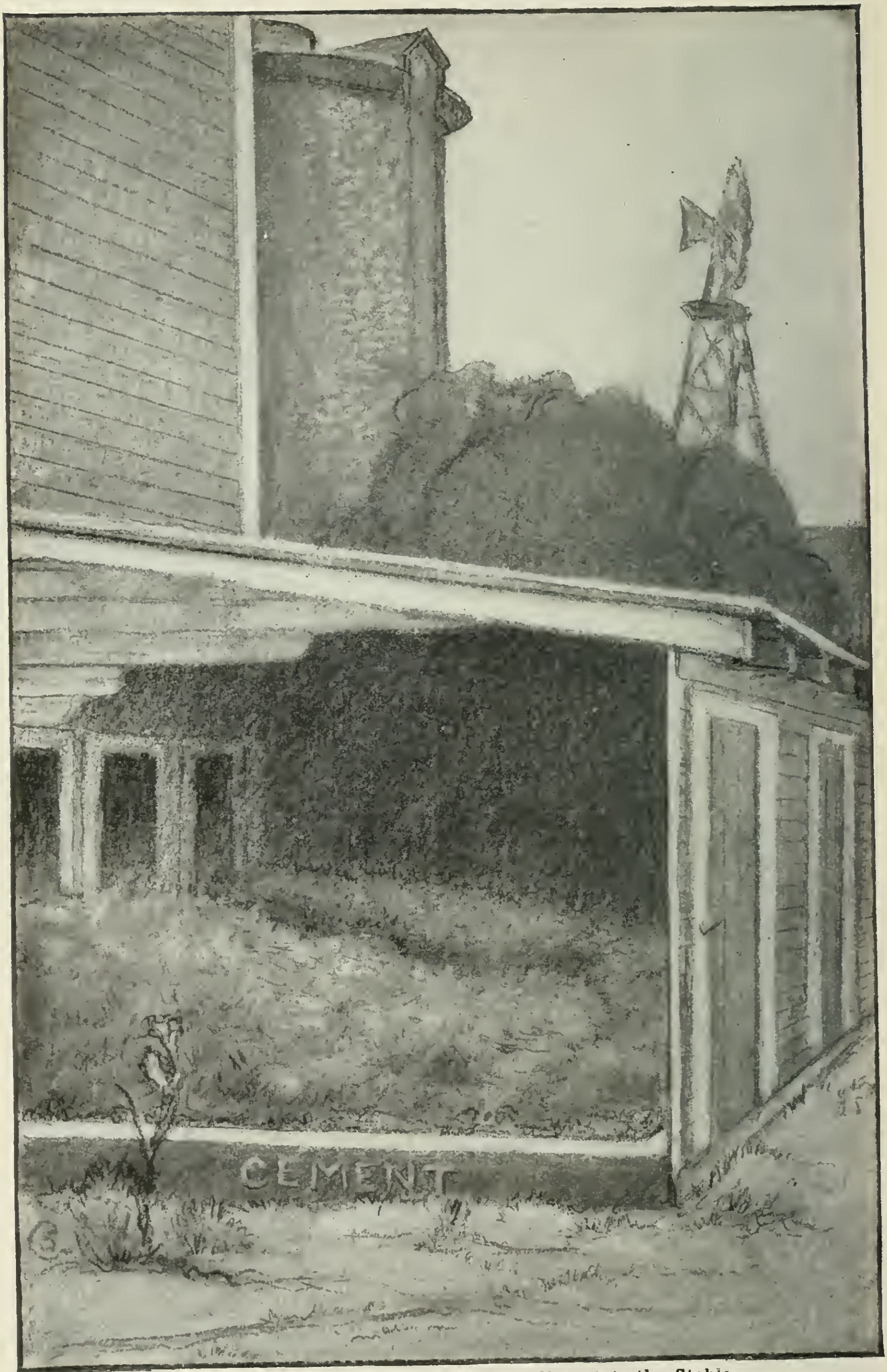
The history of "Farmers of Forty Centuries," in the Orient gives us a vivid picture of the successful application of manures, good tillage and rotation. For 4200 years the fertility of those lands has not waned, but increased and today are producing four and five times as much as the soils of our own country.

If every farmer could read "Farmers of Forty Centuries," written by Prof. King, he would be so impressed with the results of the systems described that he would not ignore a single feature which has wrought such remarkable results.

The advent of the dairy cow in Wisconsin was the beginning of a new era of progress in the Badger State. Her soil, because of continuous cropping, the neglect of systematic rotation and the application of organic matters had become emaciated and her vegetation withered. Today Wisconsin stands first in number of dairy cows; 1,504,000 on the farms and a goodly number in the towns and cities produced last year 150,000,000 pounds of cheese, about one-half of all the cheese manufactured in the United States, and 131,049,000 pounds of butter, the two products having a market value of $60,000,000. The increase in their superior breeds brought the total products close to $100,000,000.

While the Wisconsin farmer has secured millions of dollars from his dairy products, he has reduced plant food exhaustion to a minimum and, by applying manure from purchased feeds, planting legumes and rotating crops, has increased the fertility of his lands to a remarkable degree.

From eighty to eighty-two percent of all the plant food removed from the soil by the feeds eaten by the live-stock is returned to the soil in manures and, if legumes (especially clover and alfalfa) are grown in rotations with grains and corn, the loss is very small. Legumes not only secure their own supply of nitrogen from the atmosphere, but a considerable amount is deposited in the soil through roots and stubble, leaving the soil richer in that valuable element than it was before the crop was planted.



A Cheaply Constructed Manure Shed Adjacent to the Stable
Prevents the Loss of Fertility

Further, the deep penetrating roots decay and thereby act upon dormant potash and phosphorous forming plant-food compounds, which would otherwise remain inactive till the end of time.

Wisconsin has in a few years become the Holland of America, and is a splendid example for farmers to follow.

From a mathematical standpoint, it is very clear that the dairy cow cannot alone maintain the fertility of the soil. If butter only is sold, the loss of fertility is exceedingly small, but when the milk, cream and cheese is sold, from fifteen to twenty per cent of the plant food which goes to make the feed for the cow is carried away from the farm. The losses can be overcome, and manifestly they are, in countries where intensive methods are pursued. While it may be said we are robbing Peter to pay Paul, it is nevertheless customary for dairymen to buy feeds, especially some of the concentrates, from sections where stock raising is not profitable, either on account of climatic conditions or because of diseases. Many cotton growers, for instance, do not raise stock, but depend entirely on commercial fertilizers for their plant foods. Also a small per cent of farmers will never raise stock, even though conditions are favorable, but will farm on and on, selling their grain and hay, returning nothing to the soil until their farms become derelicts and are consigned to the scrap pile. The plant food in those purchased feeds goes to make up the deficit.

Again, many dairy farmers appreciate the fact that leaves, moss and peat, all rich in plant food, make splendid bedding and subsequently good manure.

We know that legumes more than keep up their end in furnishing nitrogen from the air and we also know that such inorganic elements as phosphorous, potash, sulphur, etc., are not confined to the surface seed-bed, but are found in abundance in the deeper subsoil, far below the reach of the plow and are made available through the action of humus resulting from the decayed roots. Plant food compounds thus formed in the deep subsoils are brought to the seed-bed by capillary attraction, as every farmer knows who has grown clover and other deep-rooting plants in rotation with corn and small grain.

A Reasonable Conclusion

In view of our resources and the potential inventiveness of man, is it not reasonable to suppose that when the Creator planned this planet, He, in some way, made provision to sustain the living world until the end of time and that in the evolution of events, as necessity demands, the man will be found to unfold the means and methods?

We know oxygen has existed for an indefinite period, but it is only recently that we have fully appreciated the fact that it was vital to the plant roots and devised means of placing it in the seed-bed.

It has been only a few years since man discovered that clover and

Spreading Manure from Piles .. The Distribution is Uneven .. Time Required to Unload and Spread, Thirty-two Minutes
Fifty Percent of Fertility Lost by Evaporation and Percolation

other legumes possessed the power to take nitrogen from the air and fix it in the soil.

We have just learned that rains, after a dry spell, wash from the atmosphere with every gallon of water more than one-half grain of ammonia containing one-half grain of nitrogen, and deposit it in the soil, provided the soil is in a good physical condition and contains humus.

Other powerful forces exist in nature of which we know little. The ingenuity of man will, however, when necessity demands, devise means and methods to utilize them which are as simple as the clover, alfalfa, cow peas, etc., are means to secure nitrogen from the atmosphere.

Knowing, as we do, that life has been sustained for millions of years from the soil and other forces in nature, we are just optimistic enough to believe that if we will utilize scientifically such means and methods as have been unfolded to us and will do our part to solve new problems, we will not want.

Preserving Manure

Does it pay to preserve manure? Does it pay to harvest your grain, husk your corn and store your hay? The first question is no less important than the second.

Manure has a commercial value based upon the amount of nitrogen, phosphorous and potash it contains.

It has an auxiliary value in the organic substance which is equal to the plant food elements.

According to our best authorities, the value of manure is as follows:

Cattle	$2.02 per ton
Horse	2.21 per ton
Hog	3.29 per ton
Sheep	3.30 per ton
Chicken	7.07 per ton
Liquid	7.00 per ton

The above values do not include the value of the organic substance.

The United States Department of Agriculture in Farmer's Bulletin No. 21 estimates that, if the manure from live-stock is preserved, its value each year is as follows:

Horse Manure	$27.00
Cattle Manure	19.00
Hog Manure	12.00
Sheep Manure	2.00

The ideal way to preserve manure in order to prevent waste is to spread while in a fresh state directly on the land. When that is done, there is no loss from leaching or evaporation and very little from washing.

When conditions prevent the farmer from hauling it direct to the fields, he should use care to prevent losses.

Manure wastes in two ways—leaching and evaporation.

A Poor Way to Spread Manure .. Time Required, Twenty-Eight Minutes

If carelessly left in the yard or in piles unprotected, a large per cent is lost by leaching and washing away. That liquid is just as precious as the golden grain in the bin and, if it is lost, the land is deprived of its just portion of food.

If manure is piled and not protected, it loses much of its nitrogen through fermentation. Fermentation is carried on by two kinds of organisms—aerobic and anaerobic. The first variety is active only where free oxygen exists, as in the loose part of manure. The other variety is the opposite, working only where no oxygen exists. The anaerobic bacteria are less harmful than the aerobic. When aerobic fermentation is completed, gases such as ammonia, carbon-dioxide and allied gases are lost. The loss in nitrogen is the most important, as seven-eighths of the ammonia gas is nitrogen.

Composting

If the heap is kept compact and thoroughly wet, oxygen is excluded and the loss is not great, providing there is no leaching. If the manure is stored in a tight-bottom pit or cement bin, kept moist and a quantity of gypsum, kainit or raw rock phosphate is sprinkled on from time to time as the pit is filled, the loss will be very slight. A layer of earth placed over the pile will also prevent the escape of gases.

Extensive experiments made by Roberts show that the loss from exposure and leaching amounts from one-third to one-half of the value of fresh manure, or manure that has been protected. Horse manure placed in a pile and subjected to the weather and leaching, depreciates as follows:

TABLE NO. 6

	April 25th Pounds	Sept. 25th Pounds	Loss Percent
Gross Weight	4,000	1,730	57
Nitrogen	19.60	7.79	60
Phosphoric Acid	14.80	7.79	47
Potash	36.00	8.65	76
Value per ton	$2.80	$1.06	--

A similar experiment with cow manure conducted at the same time showed the following losses:

TABLE NO. 7

	April 25th Pounds	Sept. 25th Pounds	Loss Percent
Gross Weight	10,000	5,125	49
Nitrogen	47	28	41
Phosphoric Acid	32	26	19
Potash	48	44	8
Value per ton	$2.29	$1.60	--

Unloading Manure in Piles .. Fifty Percent of the Fertility is Lost .. Time Required to Unload and Spread, Thirty-two Minutes

The foregoing table is a fair example of the losses sustained by most of our farmers by not properly handling and protecting manure. It is estimated by the Agricultural Department of the United States Government that $2,000,000,000.00 worth of fertility is lost annually through carelessness.

How to Spread Manure on the Land

In spreading manure, the farmer is naturally anxious to accomplish two things—

First, to secure the full benefit of the plant food and humus.

Second, to do the work as cheaply as possible.

Suppose we just analyze the various methods resorted to and see what the net results are.

Farmer A hauls the manure to the field and dumps it in piles containing from one to two hundred pounds each and later spreads it, usually just ahead of the plow.

Farmer B hauls his to the field and spreads it with a hand fork from the wagon.

Farmer C uses a manure spreader.

Farmer A has made piles about two rods apart. The top of the pile is loose, permitting the free circulation of air and at the same time compact enough to cause fermentation. The aerobic bacteria convert the organic matter into ammonia, carbon dioxide and other gases which readily pass into the air. The result is a great loss of the nitrogen in the upper two-thirds of the pile. In case of rains, much of the plant food in the bottom of the pile percolates into the soil which is evidenced in the rank growth of vegetation where the pile laid, a condition we have all seen a thousand times. Under such conditions, the stand is uneven and the crop ripens unevenly. The practice of placing manure in piles is absolutely wrong if profitable results are expected. The cost of spreading a ton will be found in Table No. 9.

Farmer B does a little better. He hauls his load to the field and spreads it the best he can with a hand fork from the wagon. He saves most of the fertility and makes an effort to thoroughly distribute the coarse substance of the mass. After he has done the best he can, the distribution is uneven. If the manure is left in bunches and subsequently plowed under, the capillary movement of water in the soil is materially affected on account of the large air spaces made by the bunches. Such a condition proves disastrous to the crop in case of drought. If the distribution of organic matter is uneven, the inorganic elements will not be uniformly treated and the plant food will be unevenly placed throughout the seed-bed.

Farmer C uses a spreader. When asked, "Why?" he replied: "A ton of average manure contains from twenty-seven to thirty pounds of plant food, and I want an even distribution of that precious material in

It Required Twenty-one Minutes to Load an Ordinary Wagon .. Sixteen Minutes to Load the Low-Down Spreader order to secure a uniform growth. I know the value of humus. It warms the soil, it causes soil to absorb and hold moisture, it is necessary to have humus if I have nitrogen, it makes my soil mellow and of good tilth, and I believe it assists in making phosphorous and potash useful. In order to accomplish those things, I want the manure evenly spread so that I can work it thoroughly into the body of the seed-bed. Those are some of my reasons for using a spreader. Another reason is that the spreader saves money."

Farmer C is a good farmer. He increases his crop, as has been repeatedly demonstrated, and he saves money by doing his work much faster than either Farmer A or Farmer B.

The following test was made under the writer's supervision and is certified to by a committee of honest disinterested farmers.

It required Farmer A twenty-one minutes to load one ton of manure. He spent eleven and one-half minutes going to the field and returning and he spent thirty-two minutes in unloading the manure in piles and spreading it on the land.

Farmer B loaded his wagon in twenty-one minutes, drove to the field and returned in eleven and one-half minutes, and spent twenty-eight minutes in spreading the manure from the wagon.

Farmer C loaded his spreader in sixteen minutes, drove to the field and returned in eleven and one-half minutes, and spread the manure on the land evenly and thoroughly pulverized in two minutes.

The net comparative results were as follows:

TABLE NO. 8

	Farmer "A"	Farmer "B"	Farmer "C"
Time loading	21	21	16
Time going to field and returning	11½	11½	11½
Time unloading in piles and spreading	32	---	---
Time spreading from wagon	---	28	---
Time spreading with spreader	---	---	2
Total time required	64½	60½	29½

Cost of Handling One Load

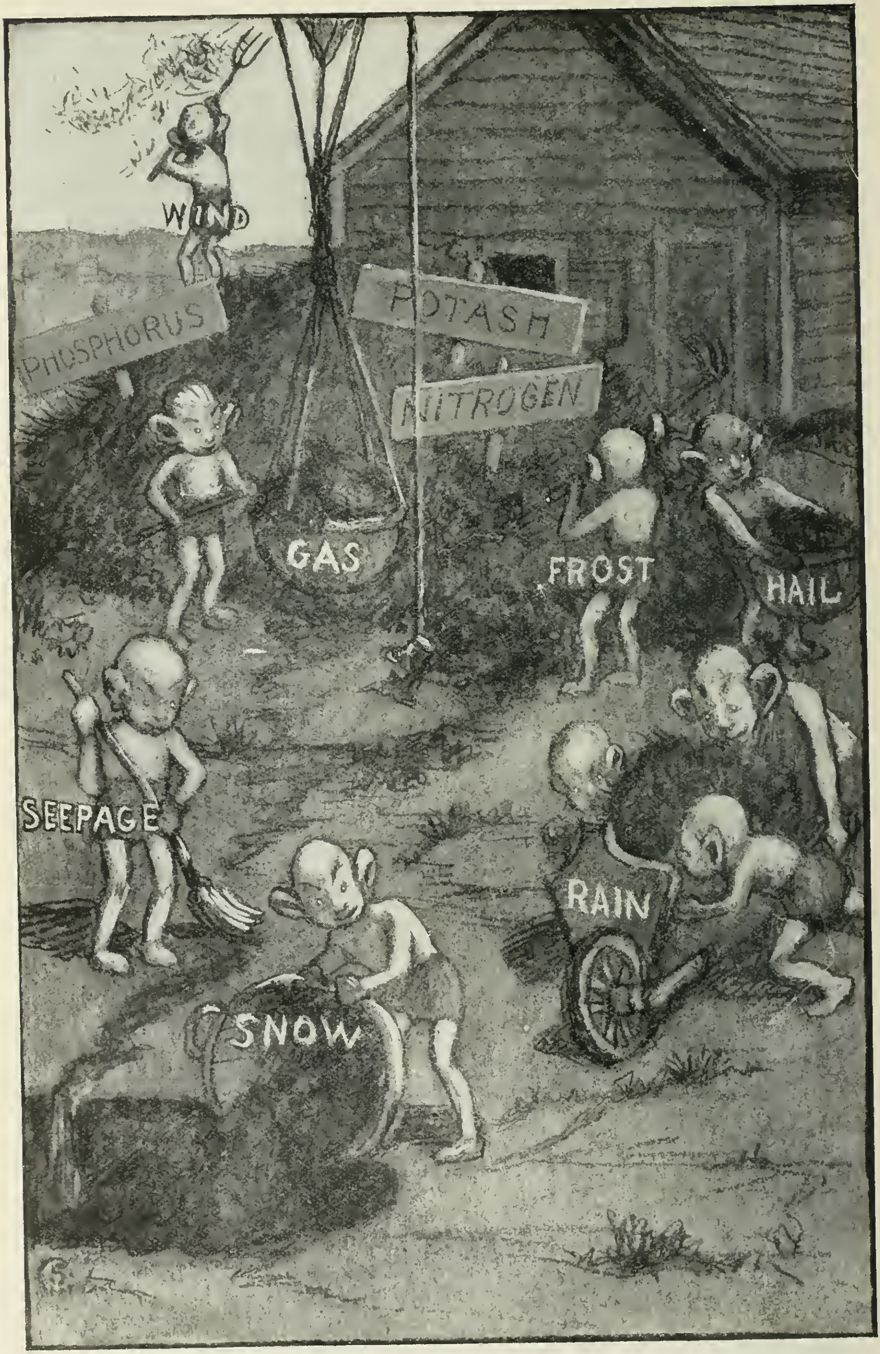
TABLE NO. 9 .. VALUE OF TIME OF MAN AND TEAM VALUED AT 40 CENTS PER HOUR

Farmer A, 44 cents Farmer B, 40 cents Farmer C, 20 cents

Farmer A would haul 9.3 loads in one day, working 10 hours a day
Farmer B would haul 9.9 loads in one day, working 10 hours a day
Farmer C would haul 20.3 loads in one day, working 10 hours a day

It costs Farmer A $88.00 to haul and spread 200 loads of manure
It costs Farmer B $80.00 to haul and spread 200 loads of manure
It costs Farmer C $40.00 to haul and spread 200 loads of manure

It costs Farmer A $48.00 more to dispose of 200 loads than it does Farmer C, and it costs Farmer B $40.00 more than it does Farmer C.



Millions of Dollars Worth of Fertility is Wasted Annually by These Brownies

Increasing the Yield

While the saving to the farmer by using the manure spreader is material, it is insignificant as compared to the increased yield in crops, which is shown in the following table. The table showing the increase in production where manure is applied over that where no manure is applied, is also worthy of the farmer's attention.

Repeated trials extending over a number of years have demonstrated the fact that a manure spreader used on forty acres of land will more than pay the cost of the machine in one season by increasing the crop, to say nothing of the great saving in labor.

The experiments of Mr. Chesney Hatch, of Newton County, Ind., are strictly in keeping with hundreds of other like trials. Mr. Hatch experimented by spreading manure on twenty acres and at the same time compared the results with crops raised on similar land without manure.

The results of his experiments given in the following table should cause the farmer to seriously consider the great value of a spreader.

TABLE NO. 10 .. MANURE SPREAD WITH A SPREADER

Kind of Grain	Number of Acres	Time Planted	Amount Harv'st'd	Loads of Manure Per Acre	Value of Crop	Value of Crop per Acre
Corn	10	May 5th	620 bu.	5	$248.00	$24.80
Oats	10	April 6th	560 bu.	5	156.80	15.68
Clover	10	April 6th	30 tons	4	150.00	15.00

TABLE NO. 11 .. MANURE SPREAD BY HAND

Kind of Grain	Number of Acres	Time Planted	Amount Harv'st'd	Loads of Manure Per Acre	Value of Crop	Value of Crop per Acre
Corn	10	May 4th	500 bu.	5	$200.00	$20.00
Oats	10	April 6th	420 bu.	5	117.60	11.76
Clover	10	April 6th	21 tons	4	105.00	10.50

TABLE NO. 12 .. CROP RAISED WITHOUT MANURE

Kind of Grain	Number of Acres	Time Planted	Amount Harv'st'd	Loads of Manure Per Acre	Value of Crop	Value of Crop per Acre
Corn	5	May 6th	200 bu.	None	$ 80.00	$16.00
Oats	5	April 6th	190 bu.	None	53.20	10.64
Clover	5	April 9th	7½ tons	None	37.50	7.50

Forming a Mulch on the Surface of a Corn Field .. This Prevents the Escape of Moisture, Prevents the Growth of Weeds and Enriches the Soil .. A Splendid Treatment for Potatoes

The manure spreader secured a gain over hand spreading in the corn crop of $4.80 per acre, or $192.00 on forty acres. In oats, the spreader has a credit of $3.92 per acre over hand spreading, or $156.80 for forty acres. In clover, the gain was $2.00 per acre. Manured land made a gain over unmanured land of $8.80 per acre on corn, $5.04 on oats and $7.50 on clover.

Note—(Corn was valued at 40 cents per bushel, oats at 28 cents and clover at $5.00 per ton.)

Mr. Lawrence Enzminger of Platte Center, Nebraska, made the following report:

"We manured forty acres with a spreader and an adjoining thirty acres received no manure. The forty acres averaged forty-eight bushels of corn per acre, and the thirty acres averaged thirty-nine bushels per acre. The gain in favor of the manured field was nine bushels per acre, or three hundred and sixty bushels on the forty acres. The corn sold for fifty cents per bushel, or $180.00, much more than the cost of the spreader."

The following is the average results of other experiments carried on for a period of three years to determine the advantage of a machine spreader over the hand fork:

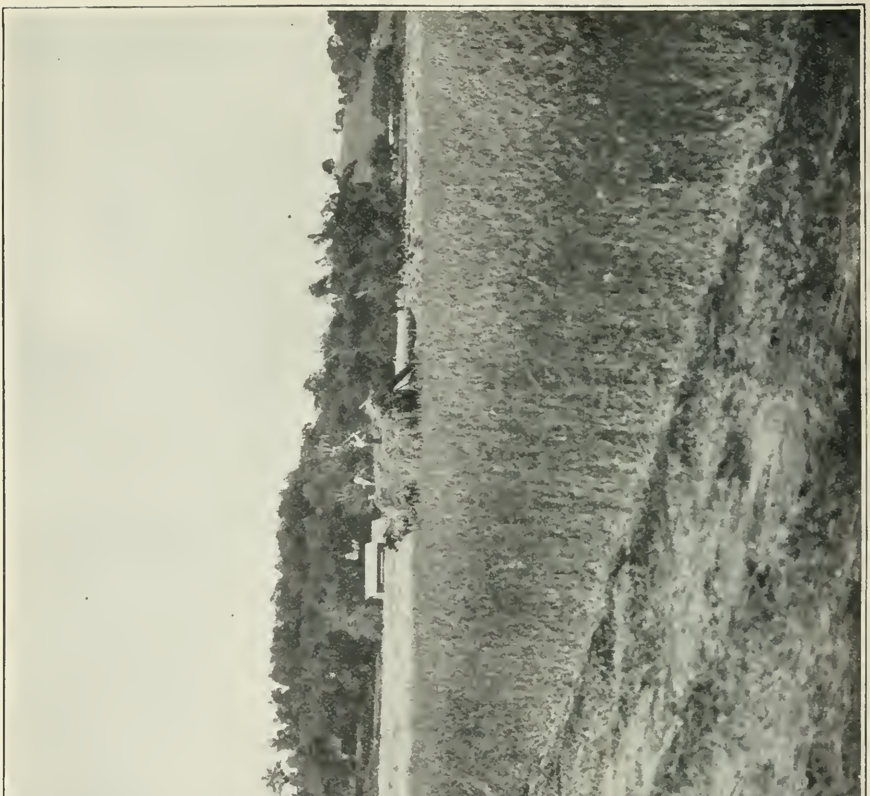
TABLE NO. 13

	Acres	Amount Raised	Crop	Price	Value	Total Gain
Spreader	6	420 bu.	Corn	$ .50	$210.00	$42.00
Hand Spreading	6	336 bu.	Corn	.50	168.00	------
Spreader	10	35 tons	Meadow	10.00	350.00	80.00
Hand Spreading	10	27 tons	Meadow	10.00	270.00	------

Total gain for manure spreader over hand work on six acres of corn and ten of meadow in one year was $122.00.

The gain made in all the crops where the spreader was used over land where no manure was applied is so marked that a farmer cannot afford to ignore the value of this fertilizer or the most profitable way to apply it.

The farmer should also keep in mind the fact that manure is lasting, if properly distributed and thoroughly worked into the soil. At the Rothamsted Experiment Station, records have been kept for over fifty years as to the effects of manures upon soils. In one experiment, farm manure was used for twenty years and then discontinued for the same period. It was observed that when its use was discontinued, there was a gradual decline in crop-producing power, but not so rapid as of plots where no manure had been used. The manure applied during the twenty-year period made itself felt for an ensuing twenty years.



Timothy .. Three Tons Per Acre .. Manure Used as Top Dressing

Top Dressing

Without question, the best results are obtained from manure when it is used as a top dressing after the ground has been plowed. The reasons are very plain.

Plant roots necessarily make their initial growth in the upper portion of the seed-bed. A rapid and strong early growth is usually reflected throughout the entire life of the plant. If the plant food is accessible to the young roots, the growth will be very rapid. If, on the contrary, the fertilizing elements are near the bottom of the seed-bed, the early benefits are not so marked. If the ground is plowed early in the fall, it usually becomes compact after the first rain so that it is not difficult to haul the spreader over the plowed ground. Even if the ground is frozen, there is nothing lost by spreading the manure and discing it in after the frost is out.

If coarse manure is plowed under, it is apt to create large air spaces at the bottom of the furrow, thereby causing an insulation which retards the upward movement of capillary water. Even though manure is spread before the ground is plowed, it is always advisable to disc it in before plowing. By that process lumps of dirt are pulverized and the substance of the manure is worked into the soil. When the furrow slice is turned, the contact is compact between the bottom of the furrow and the furrow slice, making capillary attraction perfect.

It is hardly feasible, especially if the ground is very soft, to top-dress spring plowing, but it is very essential if the ground is to be planted to corn to disc it thoroughly after the manure is applied and before plowing in order to insure equal distribution and quick fermentation.

Manuring Growing Crops

In some sections of the country, especially where spring wheat is the principal crop, farmers do not have time to haul manure until after the grain is in the ground. Again, yard manure, especially that which is in large piles, remains frozen until after the wheat is planted; hence, in order to secure the full benefits, the manure should be distributed on the ground after the grain is sown. It is perfectly feasible to spread it either before the blade has shown above the ground or after it has attained a growth of one or two inches. By distributing it thinly and evenly, the young roots, which are necessarily close to the surface, receive the essence of fertility contained in the manure, at a time when they need it most.

Winter wheat and rye can be top-dressed either during the fall, winter or early spring. If manure is applied late in the fall, it is of material assistance in preventing the grain from winter-killing. The coarser substance of the manure serves two purposes, namely, to prevent the surface from cracking, thereby preventing the escape of moisture, and to assist in absorbing rain. It also in a great measure, prevents the soil from blowing, thereby uncovering the grain roots. The plant food contained in the coarser substance is not lost, but when plowed under, is beneficial to the following crop, not only because of the plant food it contains, but for the humus which it forms after it has become thoroughly rotted.

Farmers who have top-dressed growing grain are very enthusiastic in their praise of the system, many claiming that they obtained far better results than when applied in any other way.

Top-dressing growing corn and potatoes is also very beneficial. If, however, the crops are to be cultivated after the application has been made, the manure should be well rotted. It is especially beneficial to potatoes after they have been cultivated once or twice, by preventing the growth of weeds and the escape of moisture. Top-dressing pastures and meadows always stimulates the growth. In a number of instances the writer has seen the yield of hay doubled by the application of five tons of manure to an acre.

Green Manures

Green manuring is growing on the land a crop and plowing it under. This form of manuring adds no new inorganic plant food elements to the soil, but when a crop is turned under all of the elements or compounds consumed in the growth of the plant are returned to the soil. When legumes (alfalfa, cow peas, clover, soy beans, vetch, etc.), are plowed under, the nitrogen gathered from the air by the legumes is added to the soil. After the crop is removed, the soil is much richer in nitrogen than before the crop was planted, due to nitrogen in the roots and stubble.

Vaelcker in England found that one acre of clover roots and stubble contained one hundred pounds of nitrogen which had been gathered from the atmosphere in excess of the amount removed in the crop and the amount in the soil before the clover was planted.

Weiske in Germany found one hundred and eighty pounds of nitrogen in an acre of roots and stubble.

Any green crop which is not taken off the land is beneficial to the soil, both from a physical and chemical standpoint. Physically, the improvement is due to the roots and stems which decay and become a part of the soil. When the roots die and the plant decays, the entire substance is finally resolved into humus, an essential factor in maintaining soil bacteria and nitrogen. Humus thus formed assists in absorbing and retaining moisture, and tends to make the soil mellow and friable.

The necessity of renewing humus may be due to continued cropping, hot winds and protracted droughts which deplete the soil of that essential substance very rapidly.

Again, humus in time becomes dead, especially if thorough tillage is not practiced; hence, the supply should be renewed as often as conditions demand it, either by plowing under green crops or by applying manure.

Chemically, green manuring is beneficial for the following very good reasons.

Through the process of fermentation and decomposition of green manure, humates are formed which in combination with other elements in the soil form plant food compounds.

The deep-rooting legumes are especially beneficial, for the reason that they decay, admitting moisture and air far below the reach of the plow, forming as they do plant food by combining with the inorganic elements that exist in the subsoils. Plant food thus formed in the deeper strata is brought to the seed-bed through the action of capillary water. This process is responsible for the great increase in crops following clover and other deep-rooting plants.

Green manuring is resorted to profitably in sections where stock-raising is not practiced to an extent sufficient to secure an abundance of barnyard manure. Dead vegetation plowed under is also beneficial, but owing to the fact that most of the moisture contained in the plant has evaporated, decomposition is slow.

Next to legumes, rye is regarded as the best green crop to plow under. The following table, the result of experiments on light soil in Germany, is very interesting:

TABLE NO. 14 .. INCREASE IN THE YIELD OF RYE PER ACRE ON GREEN MANURED PLOTS OVER THOSE NOT GREEN MANURED

Kind of Green Manure	Date When Plowed Under	Increase in Grain, Pounds	Increase in Straw, Pounds
Yellow Lupine	Sept. 28th	1,101	1,261
Blue Lupine	Sept. 28th	1,343	1,963
White Lupine	Sept. 28th	1,352	2,137
Crimson Clover	Sept. 28th	903	1,620
Vetch	Sept. 28th	1,077	2,122

Prof. Neale of the Delaware Experimental Station presents the following:

"8.3 tons of crimson clover, grown from seed which cost $1.00 per acre, added 24 bushels to the corn crop; $1.00 invested in nitrate of soda and used as a top-dressing, added 6 bushels to the corn crop. Hence, in this case, $1.00 invested in clover seed returned four times as much as $1.00 invested in nitrate of soda. As to the relative amount of labor involved, the sowing of the seed and the broadcasting of the nitrate of soda possibly balance each other."

The following favorable results are reported from a heavy soil in Germany:

TABLE NO. 15 .. YIELD OF OATS AND STRAW PER ACRE WITH DIFFERENT MANURING

Treatment	Grain, Pounds	Straw, Pounds
Without Green Manuring, no Fertilizer	1,099	1,748
Green Manuring, no Fertilizer	1,645	3,381

The following table, given by the Massachusetts Experiment Station, is very interesting:

TABLE NO. 16 .. COW PEAS AND SOY BEANS FOR GREEN MANURING

Variety	Pounds Per Acre		
	Green Weight	Dry Matter	Nitrogen
Wonderful Cow Pea	19,600	3,622	80.4
Black Cow Pea	20,035	3,389	62.1
Medium Green Soy Bean	19,685	5,386	167.3

COMMERCIAL FERTILIZERS

COMMERCIAL fertilizers are used very extensively by truck gardeners, fruit growers and farmers in the sections of the country where manure cannot be secured in sufficient quantities.

Commercial fertilizers are classed as complete fertilizers and amendments. A complete commercial fertilizer contains the three essential plant food elements in a concentrated form, namely, nitrogen, phosphoric acid and potassium. An amendment may be any one of those elements.

In order to secure the best results and to minimize losses, the farmer should know the needs of his soil. He should not only know the plant food requirements, but have a thorough knowledge of the physical condition of his land. Otherwise, he is apt to apply some of the elements which already exist in abundance, or the fault may be in poor tillage, need of drainage or lack of humus.

Commercial fertilizers are manufactured from various substances, both organic and inorganic.

Nitrogen is secured from sulphate of ammonia, nitrate of soda, nitrate of potash, dried blood, tankage, hoof and horn meal, ground fish, guanos, cotton-seed meal and a few other minor substances.

The sources of phosphoric acid are phosphate rock, phosphate slag, raw bone, bone ash, steamed bone, bone black and guano. These substances are treated chemically, rendering them soluble.

Potash is secured from kainit, muriate of potash, sulphate of potash and other potash salts and wood ashes.

The percentage of amounts of available plant food elements in a complete commercial fertilizer is usually marked on the package. In most states the inspection is quite rigid.

To the credit of the standard commercial fertilizer firms, it has been found, upon analysis, that the amount specified in the formula is found in the fertilizer. To illustrate, a package weighing one hundred pounds containing—

5 per cent of nitrogen
7 per cent of phosphoric acid
6 per cent of potash

would contain respectively—

5 pounds of nitrogen
7 pounds of phosphoric acid
6 pounds of potash

The market price of nitrogen ranges from 17 cents to 20 cents per pound, phosphoric acid is worth about 6 cents per pound, and potash is worth 5 cents per pound.

The balance of the mass, amounting to 82 pounds, is called filler, having no fertilizing value.

It is not policy to apply, at one time, more available plant food in a commercial fertilizer than the plant requires for the one crop.

It is not profitable to use commercial fertilizers on land which is barren of humus.

Barnyard manures make commercial fertilizers more effective and more lasting.

Attachments are made for agricultural implements for distributing fertilizers. The material can be deposited in the hill, along the side of the row or broadcast. The writer is of the opinion that it is advisable to sow the fertilizer broadcast and work it into the seed-bed with the disc.

Distributing Lime with a Manure Spreader .. Note the Special Attachment to Prevent Lime from Blowing

LIME

LIME is classed as an indirect fertilizer. While it is not regarded as a plant food, it is just as essential to plant life and growth as nitrogen, phosphoric acid or potash.

A very small per cent of lime is found in grains, but a considerable amount is found in the substance of the plant.

If a seed is planted in soil absolutely devoid of lime, the growth is checked as soon as the lime is exhausted from the seed. If a soil is deficient in lime, the plant is correspondingly deficient. There are a few plants, however, which do not require lime.

Soil may be rich in all of the essential elements, namely, nitrogen, phosphorous and potash and still be worthless for agricultural purposes if it does not contain a sufficient amount of lime.

Clovers and other legumes grown in such soil are stunted and the leaves are yellow and sickly.

Alfalfa without lime will hardly survive after the first year and cow peas, soy beans and vetch are a failure where lime is absent.

Corn grown on land which does not contain a reasonable amount of lime will have small, long-jointed stalks, small, delicate leaves and a deficient ear.

It is safe to say that the productiveness of many of our fertile farms is reduced fifty per cent simply because they do not contain the required amount of lime.

Originally, most of our soils contained a sufficient quantity of lime, but on account of continued cropping, it has, to a great degree in many soils, been reduced to such an extent that the soil is unhealthy.

Unless the natural supply of lime in the soil is abnormally large, the drain incident to cultivation and fertilization exhausts it to a point where not enough remains to keep the soil in a healthy condition; or, in other words, free from harmful acid.

Every farmer knows that a sour soil is sickly and he should know that, unless the condition is remedied, it will not produce even fair crops.

Lime acts both chemically and physically.

Chemically, it is the most powerful agent known to sweeten sour soil. Soil becomes sour; or, in other words, harmful acid is formed, it being the result of decaying vegetable matter.

Lime unites with the organic matter forming humate of lime, thus preventing the formation of any harmful acid.

Nitrifying bacteria which form nitrates, an available form of organic nitrogen, will not live in acid or sour soil.

Nitrogen does not combine with phosphorous, potash and other inorganic base elements without the assistance of lime.

Lime renders potash in the soil more available. The soil may be rich in insoluble silicates containing potash and still be starving for soluble potash. Lime decomposes the soil silicates, thus setting the potash free.

"The presence of sufficient lime in the soil prevents the soluble phosphoric acid applied in fertilizers from satisfying its hunger for a base by combining with iron or alumina, which is undesirable because phosphates of iron and alumina are very insoluble. When lime is present, the phoshporic acid will take this by preference and the reverted phosphate thus formed is much more valuable than would be the phosphates above mentioned." (W. P. Brooks.)

Lime hastens the decay of all organic substances which may be in the soil. Green manures and barnyard manures are of little use the first year or two if a sufficient amount of lime does not exist in the soil to promote decomposition.

Injurious iron compounds in the soil are rendered harmless by the free use of lime.

Lime stimulates to activity plant food in peaty soils, drained lands and swampy lands which have been under water for a long time.

The physical effect of lime on soil is also very marked.

All soils, except those of a light, sandy nature are made mellow and friable by the use of lime.

Dense clay soils are especially improved by being treated with lime. Often clay soils are so compact that they are impervious to both air and water. Prof. Brooks has the following to say regarding clay soils.

"As the result of an experiment, it is reported that a layer of water about two inches thick required 26 days and 19 hours to pass through a clayey soil. After the soil was mixed with 2.5 per cent of lime, the same quantity of water passed through it in 17 hours. The explanation of this remarkable effect of mixing lime with clayey soils is that it causes the exceedingly fine particles of clay to gather in little balls. Between these little balls of clay, air and water circulate as between grains of sand and it is to this particular effect chiefly that the great improvement in the heavy soils resulting from liming is due.

The fact that certain fertilizers, among which kainit, muriate of potash and nitrate of soda may be named, when freely used make the soils compact, has been pointed out. The use of these fertilizers also increases the tendency to formation of a crust at the surface. If such a crust be broken up by cultivation or hoeing, it forms again after the next rain. It is practically impossible under these circumstances to keep the soil in suitable tilth. The use of lime in connection with such fertilizers will prove an effectual preventive of crust formation. In European agriculture, air-slaked lime is generally employed in connection with nitrate of soda or potash salts."

Sandy soils become more compact and hold humus better, thereby absorbing and retaining moisture longer if they are well limed.

Crops Most Benefited by Lime

Alfalfa, clover, soy beans, cow peas, vetch, all root crops and tubers, grasses, garden truck, barley, oats, buckwheat, corn, wheat and sorghums require lime in substantial quantities.

Wheeler states that lupines, millet, red top and blackberries are injured by lime.

How to Test for Lime

Make a small ball of dirt with a depression on one side. Pour in the depression a few drops of hydrochloric acid. If lime is present, bubbles will appear.

How to Test for Acid

If the soil is acid, it indicates that lime is absent. Place a strip of blue litmus paper in some moist soil. If the paper turns pink or red, it indicates that the soil is acid. Pinkish tint would indicate only slightly acid and bright red is an indication that the soil is decidedly acid.

Neither of the above tests are very reliable if the soil is nearly neutral. Excepting a chemical analysis, an actual demonstration is the most reliable. The farmer should lime a strip two, three or four rods wide through the center of the field and note the difference between the limed and unlimed portion in the crops.

Land on which sorrel thrives is usually sour.

Amount of Lime Land Should Contain

Land should contain from 0.4 to 0.5 per cent of lime. Soil containing less than 0.3 per cent is apt to be very unproductive.

How Much Lime to Apply

The amount to apply depends entirely upon the condition of the soil, both chemically and physically, and the kind of crops to be grown. The reserve supply below the average depth of the furrow should also be taken into consideration. Lime may be exhausted in the first five or six inches, but an abundance may exist below. When that condition is found, if the ground is plowed a little deeper and manure is added, it may not be necessary to add commercial lime.

It is better toapply a smallamount of lime often than a large quantity at one time. For instance, it is better to apply 500 pounds every year for four years than to apply a ton at one time. If the soil is sour, heavy and lifeless, it may be necessary to apply from one to two tons to the acre. If it is only slightly acid, 500 pounds may be sufficient to neutral ize the acidity and rectify abnormal physical conditions.

The following table gives the amount of lime, according to Snyder, removed in crops:

20-bushel crop of wheat	8 pounds
65-bushel crop of corn	12 pounds
30-bushel crop of peas	75 pounds
15-bushel crop of flax	16 pounds
2 tons of clover hay	75 pounds

Kind of Lime to Apply

The principal sources of lime are raw limestone rock, air-slaked lime hydrated lime, land plaster, oyster shells, wood ashes, natural phosphates, gas and dye-house lime, basic slag and marl.

The writer favors raw limestone rock, finely ground, which contains a high per cent of calcium oxide (Ca O).

Burned or caustic lime is best for heavy, peaty soils which contain an excessive amount of nitrogen.

Hydrated and air-slaked lime are favored on account of their light weight, especially in sections where freight rates are excessive.

Phosphate rock contains lime as well as phosphoric acid. The cost, however, is too high to make it economical to use for liming purposes.

Wood ashes contain from 35 to 50 per cent of lime, besides considerable magnesia and potash. The farmer should save all the wood ashes and place them on the ground as a top dressing. Ashes are especially fine for fruit trees.

Land plaster contains lime, and is manufactured from gypsum. It is not as beneficial as lime rock to sweeten soil. When land plaster is sprinkled throughout manure piles or gutters or in stalls, it prevents the waste of ammonia. When so mixed and applied to the land, the effect is fine.

Marl compares favorably with air-slaked lime. It is especially beneficial to light, sandy soils on account of the clay it contains.

When to Apply Lime

The chemical and physical action of lime being slow, it should be applied several weeks before the crop is planted. If the land is intended for potatoes, the lime should be applied the previous year. It is a good plan to apply lime after the ground is plowed in the fall and immediately disc or harrow in. It can be applied safely any season of the year on clover or pasture. If the pasture or meadow is disced after the application is made, it prevents in a great measure, washing away by rains.

Commercial fertilizers and yard manures should not be mixed with lime. It is best to apply the manure several weeks before the lime is put on the ground. If alfalfa, peas or beans are to be planted, no serious harm will result if lime is applied within a few days before sowing.

How to Apply Lime

Lime in any form should be distributed with a machine spreader in order to insure an even distribution.

An excessive amount in one place is harmful and none in another place causes an uneven stand. Hence, it is not advisable to spread with a shovel.

Several types of lime sowers are on the market and most of them do good work if the lime is ground to an even fineness and is perfectly dry. If it contains large pieces, it clogs, and if damp, it cakes. In either case, the distribution is uneven. After experimenting with a number of lime sowers and various types of manure spreaders, the writer has found the Success Spreader to be an ideal machine for the work. This machine has three factors, two of which are special attachments, in its make-up which are absolutely necessary to insure perfect distribution and at the same time not damage the machine.

1st. A return apron. This so that any lime that falls through the bottom will fall directly upon the ground and not be carried back into the spider wheels, as would be true were an endless apron machine used.

2d. A worm and gear drive. This to give a positive movement of the bottom, which is not possible with a ratchet feed.

3d. A cylinder set inside the box above the apron and in front of its rear end. In machines where the cylinder is back of the box, set below the apron back of its rear end, the lime falls onto the ground without passing over the cylinder. It is not evenly distributed.

The Success Manure Spreader has all of these qualities, and, in fact, is the only machine on the market which will satisfactorily spread lime. For the distribution of lime, however, it is necessary to protect the material from being blown by the wind, and to reduce the feed of the bottom to smaller amounts than are used in the distribution of manure. To accomplish this purpose on the Success Spreader, a hood is provided which goes entirely over the cylinder and extends down near enough to the ground so that the wind cannot blow the material. There is also provided a slow-feed worm and gear which are used in place of the regular worm and gear on the apron feed of the machine and reduces the quantity of material spread to the acre to one-half the amount indicated on the feed gauge at the various speeds of the machine. In other words, in a seventy-bushel spreader, it reduces the range of feed to $1\frac{1}{2}$ to 6 loads per acre.

In distributing lime with any manure spreader, it is wise to fill the bottom of the box with a little loose straw and throw a forkful over the end of the cylinder. This is to prevent the material rattling out in going to the field. On account of the weight of the material, it is also wise to load the box only from one-half to two-thirds full. You then have all that the machine should handle.

Common Salt

Salt (Chloride of Sodium) was used at one time quite extensively as a fertilizer, but during recent years it has not been regarded with favor. Some years ago the writer observed the effect of salt on a piece of land which for some reason failed to produce normal crops. The effect the first year was splendid, but the crop grown the second year was much inferior to that grown on an adjoining plot which had not been salted.

It seemed to act as a quick stimulant, but its effect was not lasting. Prof. Brooks says:

"1st. It helps to absorb and retain moisture and may be useful on light soils.

"2d. According to Lloyd, it may liberate ammonia from inert compounds.

"3d. According to Storer, it makes lime and potash, which are a part of the compound silicates of the soil, more available. The potash will doubtless be more effectively made available by the use of lime.

"4th. In large quantities, salt hinders decomposition and has been used with apparent benefit in soils containing very large amounts of humus on which the growth was naturally so rank that grains tended to lodge.

"5th. If used in very large quantities, salt may injure or prevent plant growth. It is sometimes so used on walks to keep down weeds.

"6th. Salt lessens the percentage of starch in potatoes, of sugar in beets or in fruits. This effect is due to the chlorin and is similar to that of muriate of potash.

"Salt is more likely to prove beneficial on the lighter soils, and among the crops benefited by it most are asparagus, mangolds, cabbages and grains. It can seldom prove beneficial to use salt in quantities exceeding 200 or 300 pounds to the acre. It should be spread broadcast and worked in with a harrow."

Peat, Muck and Leaf Mould

Peat, muck and leaf mould are valuable substances to apply to certain types of soil. They are composed largely of humus having been formed from vegetable matter. They contain from one-half to four per cent of nitrogen and a small quantity of phosphoric acid and potash. The two latter elements exist in greater quantities in leaf mould than in peat or muck. Nitrogen is found in greater quantities in peat than in muck and mould.

If any of these substances are easily accessible and the haul is short, it pays to put it on land deficient in nitrogen and humus. They improve clay soils both chemically and physically.

Chemically, they are improved by adding humus, nitrogen and some carbonic acid. The acids act upon some of the inorganic elements, rendering them soluble.

Physically, clay soils are benefited as follows:

1st. They are made porous, mellow and friable, a condition which facilitates the absorption of water.

2d. Capillary attraction is stimulated.

3d. Atmospheric oxygen is admitted.

4th. Increases the warmth in the early spring.

5th. Soil is easier to cultivate and less liable to puddle and crack.

Sandy soils are improved by the addition of humus and nitrogen. The humus or organic material is of great value in holding moisture and giving the soil permeability.

The value of all these substances is greatly enhanced when made in a compost with unburned lime, phosphate rock, gypsum, kainit or wood ashes.

In some countries, farmers not only maintain, but increase, the fertility of their soil and produce remarkable yields by using muck, peat, leaf mould and sediments from ponds and streams made in a compost. Fish and meat scraps also improve the mixture.

Poultry Manure

Too often the farmer does not sufficiently appreciate the value of poultry manure to give it the proper care and utilize it to the best advantage.

Poultry manure is richer in plant food elements than any of the other farm manures. It is especially rich in nitrogen and phosphoric acid.

On account of rapid fermentation, unless properly cared for, much of the nitrogen is lost by evaporation.

The droppings should be gathered from the floor of the poultry house every few days and stored in a dry place. If stored damp and allowed to remain so, much is lost by fermentation.

It is a good plan to sprinkle dry muck, peat, dirt or mould on the floor of the house. By so doing, the liquid is absorbed and the drying process is hastened. Gypsum, kainit or ground phosphate rock are splendid absorbents, besides they add to the richness of the compost.

Caution

Ashes should not be mixed with poultry manure for the reason that they contain alkalies which increase fermentation, causing a loss of nitrogen.

Before using, poultry manure should be mixed with dry earth and spread thin and evenly.

If placed in the hill, care must be taken not to use too much. An excessive amount will burn the plant, but a very small amount will cause a remarkable growth. The writer knows of nothing in fertilizers as valuable as poultry manure to use in the truck garden, flower garden and in young orchards.

Conclusion

In concluding our appeal to farmers, we earnestly urge those who are at all skeptical or in doubt regarding the value of barnyard and other manures mentioned in this book, to make a thorough test of their worth.

From the earliest civilization down through all the ages, manures have been the source of successful agriculture and the chief staff in maintaining the fertility of the soil.

Cato, the renowned agriculturist of Roman times, said: "To maintain the fertility of the soil, plow deep, plow again and mix with the soil well-rotted manure."

Tull, several centuries later, said: "The fertility of our soil will not wane if we plow deep, rotate crops and mix with the soil animal dung."

The history of "Farmers of Forty Centuries" presents a vivid description of what is being accomplished by a people who know the art, but not the science, of farming.

King tells us that five hundred million people, more than five times our entire population, are being maintained from the cultivated fields of Japan, Korea and China, an area much smaller than the tilled lands of our own country. Manure, he states, is as precious to those people as their harvest. Their ways of farming are not based upon scientific knowledge, but they do things as their forefathers did. They do not know the plant food elements contained in manure, but they do know that when evenly spread and worked into a deep, well-made seed-bed, an abundant crop is assured. They cannot tell why leaf-moulds, peat, muck and sediments from rivers and ponds enrich the soil, but they do know that when these substances are not used, the soil produces grudgingly. Without being able to give a scientific reason, they have plowed deep, packed and pulverized, utilized organic matters of all kinds and irrigated, producing year after year from five to seven times more than our farmers.

We, with our fertile soil, have heard the alarm of depletion which is being sounded through our land. Do you not think it time for us to imitate the methods of those farmers who are producing enough on a plot of ground no larger than the area contained within a boundary line extending from Chicago south to the gulf; thence westward to and along the western line of Kansas, and back to the place of beginning, to feed five hundred million of people? Do you not feel that all farmers should adapt methods which many of our advanced agriculturists have demonstrated will bring rich results?

Why should we be alarmed? Why should we fear want? Why should we not produce enough to keep pace with the increase in our population and for centuries have a surplus?

We know the art and we possess knowledge which makes plain the reasons why scientific methods are successful. We should not wait until grim necessity compels us to adopt nature's ways, nor neglect to conserve fertility which was manifestly intended to perpetuate the producing ability of our soil.

Farmers! To rob the soil of its fertility by growing crops and not observe stock-raising as a feature of equal importance, is larceny upon posterity. Not to protect from waste, manures, organic matters and other substances containing plant food elements, is certainly a crime.

CORN

CORN is the American farmer's most valuable crop. According to the government estimate issued Nov. 8, 1912, the corn crop of the United States amounts to 3,169,170,000 bushels, having a market value of approximately $1,584,580,000.00. Practically the entire amount was produced in twenty-eight states. Iowa stands first; the crop amounting to 432,025,000 bushels, an average of forty-three bushels per acre as compared with thirty-one bushels in 1911, and Illinois comes second with 428,450,000 bushels, the average per acre being 40.2 bushels, an increase of 7.2 bushels per acre over the previous year. The enormous crop is attributed to a fairly favorable season and better farming methods. The results show very plainly that the fertility of the soil is not waning, and that all it needs in order to produce abundantly is the right treatment.

Farmers do you know where the fertility came from that made such a wilderness of corn? It is thought by some that all of it comes from the soil, when in reality, only a very small per cent of soil plant food proper is used in making the crop. Ninety-seven and one-half (97.5) per cent of the dry substances of the crop is composed of carbon, oxygen, nitrogen and hydrogen. The balance, being only two and one-half (2.5) per cent, is ash salts which includes potash, phosphorus and sulphur, were taken directly from the soil. About sixty-one (61) pounds of every hundred pounds of dry corn is carbon alone. Carbon comes from the atmosphere; it enters the plant through the leaf, in the form of carbonic acid gas.

Oxygen and hydrogen are secured from air and water, and nitrogen, indirectly, comes from the air. Water is also an important feature in making a crop of corn. From seventy-five to eighty per cent of the green plant is composed of water and in the process of growth three hundred pounds are used to mature each pound of dry material.

To utilize these valuable elements which exist in inexhaustible quantities, requires knowledge and scientific management. The requirements of other farm crops are not materially different from corn; for instance, one hundred pounds of wheat grain contain forty-six and one tenth (46.1) pounds of carbon, five and eight tenths (5.8) pounds of hydrogen, forty-three and four tenths (43.4) pounds of oxygen, two and three tenths (2.3) pounds of nitrogen and two and four tenths (2.4) pounds of ash elements. The ash includes all the phosphorus, potash, silica, lime, magnesia, iron, sulphur and soda used in making plant food compounds. One hundred pounds of wheat straw contains ninety-three pounds of carbon, nitrogen, hydrogen and oxygen, and the roots and stubble contain some of the same elements. The one hundred pounds of grain and one hundred pounds of straw combined rob the soil of but one and one tenth (1.1) pounds of phosphorus.

Pure-Bred Boone County White Corn Raised on a Deere Modern Method Farm, Moline, Illinois
Yield 119½ Bushels Per Acre .. Barnyard Manure the Only Fertilizer Used

While the per cent of ash salts required is very small, we do not wish to be understood as intimating that they are any less necessary to make a crop than the other elements mentioned.

To successfully raise corn, plant food elements must co-operate with each other and the farmer must co-operate with the elements. Potash, phosphorus, etc., are worthless without water and air, and nitrogen needs humus. The plant must have a good home and the right care if it thrives.

The soil is a great complex factory and the farmer is manager. He should know his factory, know what each crop requires and just how to furnish it, if he is to turn out a first-class product at a profit.

How to store and make available soil water, how to admit oxygen, how to select and preserve seed, how to make a suitable home for the plant, how to care for the plant, how to get a supply of nitrogen free of cost, how to make available plant food elements which exist in the soil, and how to restore elements which have been used, are all features of equal importance and should be thoroughly understood by the farmer.

The market price of corn does not represent its real value to the farmer. If the corn is fed to live-stock and the manure from the stock is placed on the land, the farmer receives the full feeding value of his corn, which is greater than the market value, and in addition returns to the soil eighty per cent of the fertility removed by the plant.

If the farmer burns his corn stalks, he loses all of the nitrogen and organic matter contained in them. On the contrary, if he works them into the seed bed, all of the plant food is returned and in addition the fiber, which is equally as important and valuable as the elements.

While the present acreage and the average production per acre appears to be sufficient to meet our present requirements, the natural increase in population will necessarily demand more corn each year. The high price of beef and pork should stimulate the farmer to feed more stock and ship less corn. At the present time the United States is exporting corn to a foreign country, knowing that every bushel that is shipped across the sea, carries with it fertility from our farms. The farmer simply receives, when he sells his corn, the market price; but if he will feed it to hogs and cattle, he will, if he feeds scientifically, double the value of his corn and at the same time keep the fertility where it can be used again.

In a previous article on tillage, the question of how to store and utilize water is fully discussed. Under "Rotation," "How to Secure Nitrogen from the Air, and Its Value," is gone into quite extensively; hence, it is unnecessary to consider those subjects again. Seed, cultivation and fertility, three of the important features not heretofore referred to, deserve special consideration.

Reed's Yellow Dent Corn Raised on Deere Modern Method Farm, Moline, Illinois .. Soil Disced Before and After Plowing ..Corrugated Roller Used After Planting .. Surface Cultivation to Conserve Moisture .. Yield 137½ Bushels Per Acre
The Only Fertilizer Used Was Five Loads of Manure Per Acre

Fertility

Fertility comprises all of the elements, compounds and substances which are utilized to make the plant. Carbon and nitrogen are a part of the atmosphere, and they abound in great abundance. Oxygen and hydrogen are in the air, water and soil. Potash, phosphorus, sulphur, iron, lime, magnesia, silicon, aluminum and soda are in the soil. Water is a compound composed of oxygen and hydrogen, and is utilized by the plant through its roots. Humus, another compound, is a part of the soil.

The availability and usefulness of all of the component parts of fertility depend upon the judgment and activity of the farmer. The supply may be abundant, but if the operations pertaining to production are mismanaged, the crop will be disappointing.

Carbon

is absorbed and converted into plant substances just in proportion to the size and health of the plant above ground. Good seed in a mellow soil, well watered and aerated, causes a strong, rapid growth, insuring an abundance of carbon.

Nitrogen

Three-fourths of the atmosphere is nitrogen. The medium through which it can be secured and placed in the soil is the legume. A crop of one hundred bushels including the stalks requires about 148 pounds of nitrogen. Commercial nitrogen is worth twenty cents per pound. The value of nitrogen alone in the crop of one hundred bushels is, therefore, $29.60. This can be furnished free of cost if legumes are grown on the ground the previous year. By referring to the chapter on "Rotation," it will be seen that legumes not only furnish nitrogen, but make available other elements and improve the soil in many ways.

Water

is necessary, not in minute, but very substantial quantities. It requires from five hundred to seven hundred tons to make an average acre of corn. In order that plants may use water according to nature's ways, it must be stored in the ground. This is done by plowing deep, using the subsoil plow and other tillage implements, as is fully explained in the chapter on "Dry-Land Farming."

Air

is supplied by tiling and by tillage.

Potash

is found in disintegrated particles of rock which form the body of soil. Most soil contains enough to last until the end of time. In clay soils, it is very abundant. Peaty soils are apt to be deficient. It can be supplied by adding barnyard manures, wood ashes or kainit. Quite often it will be found that the soil is rich in potash, but that it is dormant or unavailable. The condition can be remedied by sowing a few hundred pounds of lime on each acre. Weak, slender, long-jointed stalks indicate a lack of potash.

Phosphorus

like potash, is found in disintegrated particles of rock. Phosphorus is of no value as a plant food until it is made soluble; or, in other words, transformed into phosphoric acid. This is accomplished by applying barnyard manure to the land. When fermentation takes place, carbonic acid is formed, which, in conjunction with the other acids, act upon the phosphorus, rendering a small per cent soluble. Where manure cannot be obtained, green crops should be plowed under. Sometimes it is necessary to furnish phosphorus in the form of acid phosphate or superphosphate. In this form most of it is available. It should be applied at planting time in quantities ranging from fifty to one hundred and fifty pounds per acre.

Lime

While lime is not a plant food, it is necessary that it should be in the soil. It not only neutralizes acids, but it makes available other elements and improves the physical condition of the soil. Most corn lands, especially those in the Mississippi river territory, need lime.

All of the other inorganic elements mentioned as component parts of fertility exist in the soils of the United States in abundance.

Humus

is an organic substance which cannot be dispensed with. It contains nitrogen; in fact, where it does not exist, there is little or no nitrogen. It is necessary to maintain soil bacteria; it influences the temperature of the soil, assists in absorbing water, and improves the tilth of the soil.

Manure

Barnyard manure is the ideal fertilizer for corn. It is a waste of money and energy to attempt to raise corn without it, if the farmer wishes to produce and at the same time maintain the fertility of the soil. It contains all of the plant food elements, and the organic portion is finally converted into humus. It is the sheet-anchor to the corn-grower, and will be until the entire economy of plant growth is changed.

Is Fertility Waning

The writer is not entirely in sympathy with those who know that the fertility of our land is fast disappearing and that each year the soil will produce less and less. We feel that depletion is *very, very* remote; we are confident that our soils are very rich, and that they will continue for ages to produce just in proportion as they are tilled and managed.

Farmers know the art of farming, and they are fast learning the chemistry of the soil and the science of plant life and growth. They know the profits to be made by properly feeding their stock, and the value of manure when applied to land as well as other allied features of modern farming. While teachers, demonstrations and bulletins have done a great deal to assist farmers in knowing modern methods, the splendid price for farm products has also been, during the past few years, very stimulating.

As evidence that the soils of the corn belt are not losing their fertility but on the contrary are very rich and productive, we need only to examine the government report for 1912. This report shows an increase in Illinois over the previous year of seven and two-tenths (7.2) bushels per acre. Iowa made an increase of twelve bushels, Ohio four and two-tenths bushels and Missouri six bushels. The increase in corn in the United States is five and four-tenths bushels per acre. These increases indicate very conclusively that our soil will produce if properly tilled and managed.

Seed

As previously intimated, there are four essential steps to be observed in raising corn, namely; the seed bed, fertility, seed and cultivation.

Seed is no less nor is it more important than the other three features. To fulfill one requirement and neglect the other would be as inconsistent as attempting to teach long division and not know how to multiply or add.

The inherent power of corn to transmit its own kind, is more marked than in any other plant. Strong healthy, pure-bred seed produces its own kind and weak emaciated seed of poor heredity is always reflected in the harvest. Inbred corn produces deficient and deformed ears. Corn fertilized by pollen from barren stalks and sucker stalks is not apt to yield good corn if at all. The tendency is for such corn to produce like stalks. The hereditary tendency is so sensitive that the location of the ear on the stalk is transmitted, a point to be considered in sections where the growing season is short.

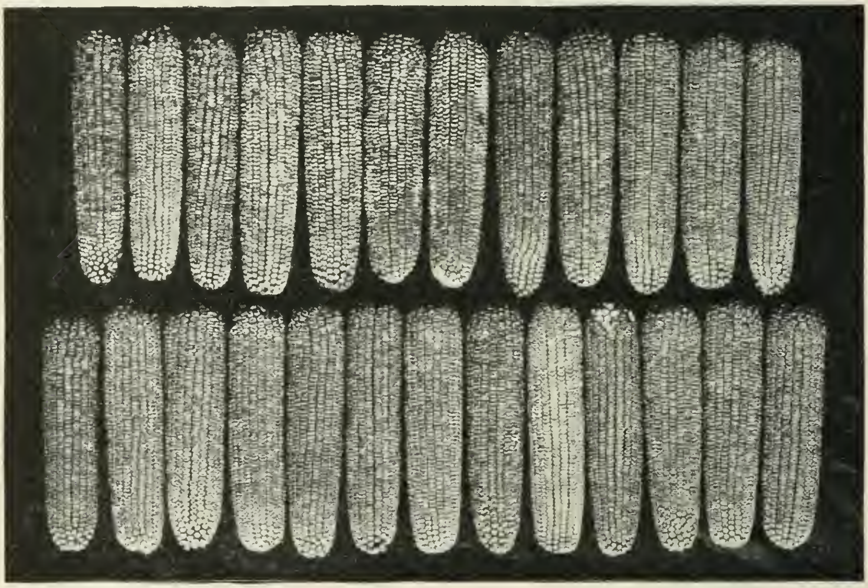
It has been demonstrated that corn planted from ears located near the ground will mature from ten to fifteen days earlier than those located very high. Seed should be of a variety and strain adapted to the locality where it is to be planted. Southern corn will not mature in a northern latitude, neither will corn grown in a humid climate do well in a semi-arid section. Corn can, however, become acclimated in two or three years if care is used.

The seed grain should possess a strong vitality, for the reason that the first stem and the holding roots secure their nourishment from the seed itself and not from the soil until the leaf is far enough above ground to breathe in carbon-dioxide.

If the seed is shriveled or has a weak vitality from any cause, the initial growth will be weak and the leaf will be pale and anaemic, but if on the contrary the seed is strong, plump and healthy, it will germinate quickly and before its vitality is exhausted the leaf will be breathing in that element which composes the major portion of the plant.

Selecting Seed

Corn for seed should be selected, (preferably from a breeding plot) in the field after it is thoroughly ripened and before the corn is cut. It is advisable to collect the earliest maturing ears which are at a uniform distance from the ground. As soon as it is gathered it should be



A Good Type of Seed Corn

placed in a seed house which is artificially heated, if possible, and thoroughly ventilated. The corn, grain and cob, when gathered, contains a large per cent of moisture, and unless evaporation is rapid and the corn kept so that there will be no re-absorption of moisture, the germ is apt to mould.

Storing Seed

The results from planting seed rightly cared for and that which was not properly taken care of, are fairly illustrated in an experiment made by the writer. Each year for three years two bushels were selected and stored in a crib. The ears were bound together in a braid and hung up. Another two bushels was selected from the same field and placed in a dry, warm, well-ventilated room. The corn was planted on adjoining plots and received the same cultivation. The average yield for the three years was eighteen bushels and two pounds per acre more annually in favor of the seed kept in the seed house. Practically all of the seed germinated, but as it came through the ground the difference between the two plots was very apparent. In the one the seed came up rapidly, throwing out a strong dark-green stem. The other was more retarded in its growth and many of the leaves were yellow and the stems slender and weak.

Wisconsin Experiments

Wisconsin farmers under the direction of the State Agricultural College, have carried on some experiments which demonstrate the value of properly preserved seed. These experiments are so convincing that I feel they should have the widest possible publicity.

Samples of farmers' seed corn as planted by them were secured from twenty-five farmers surrounding each demonstration farm. Each ear of this was tested for germination and a record kept at the Madison station. One hundred and fifty kernels of each farmer's corn was planted in duplicate rows in different parts of one of the demonstration fields. The exact stand was determined from the number of stalks appearing from the 160 kernels planted, and later, the yield of each man's corn was secured. Samples of station-bred, kiln-dried corn were planted beside the farmer's corn and were taken as standards for comparison."

Variety	Storage	Germination, Per Cent	Stand	Yield Per Acre, Bushels
Silver King	Fire-Dried	95.0	90.0	85.7
Silver King	Garret	99.	95.0	77.5
Golden Glow	Old Factory	97.	91.	71.1
Golden Glow	Garret	99.	93.	72.8
Silver King	On outside of pump house	40.	60.	41.7
Yellow Dent	House (crib)	42.	32.	33.3
Flint	House (crib)	42.	87.	27.6
Flint	Porch	77.	77.	50.6

It will be observed that the Silver King seed field cured and stored on the outside of a pump house produced a stand of 60 per cent and a yield of 41.7 bushels per acre, while the same variety of seed at the same station on the same kind of soil and properly cured produced a stand of 90 per cent and a yield of 85.7 bushels per acre or 44 bushels more, worth $22.00 per acre.

In other words, Farmer A secured one-half a crop because of poor seed, and Farmer B a full crop because of good seed.

One bushel of corn will, the report states, plant six acres; hence, for every bushel of corn that the first farmer planted, he lost on the six acres $132.00, or on 30 acres, $660.00.

The following table gives data regarding storage, germination and stand of 350 farmers' corn scattered widely over the state. It, therefore, represents fairly the condition of corn in the state during 1909-10.

Method of Storage	Germination			Number of Tests	Average Stand, 1909-1910
	Per Cent	Per Cent	Per Cent		
1. Kiln Dried	93.	90.	91.5	16.	89.
2. Furnace Room	93.	89	91.0	8.	----------
3. Room above Kitchen	92.	81.	86.5	112.	81.
Average of above	92.6	86.6	89.6	136.	----------
4. Attics	92.	77.	84.5	75.	79.
5. Under Porches	79.	62.	70.5	27.	63.
6. Granaries	65.	43.	54.0	20.	77
7. Barns, Tool-houses and other Outbuildings	86.	52.	69.0	52.	60.
8. Corn Cribs	38.	37.	37.5	26.	49.
9. In Shocks during Winter	81.	1.5	41.2	4.	41.
10. Wind-mills and Outside of Walls of Buildings	45.	23.	34.0	10.	56.
Average	76.4	55.5	65.9	350.	59.5

Barren Stalks

It has been demonstrated that, if pollen from barren stalks fertilize the silk of an ear on an adjoining stalk and that ear is used for seed, barren stalks will, in a measure, result. It has also been demonstrated that if barren and stunted stalks are removed from a breeding plot before the pollen falls, the percentage of barren stalks is greatly reduced. The Wisconsin report states:

"The selection of seed corn from the strains producing few barren stalks and the removal of the barren stalks present before they produce pollen, therefore, offer a means of very materially reducing the percentage of barren stalks present. The following table is very convincing, but it does not represent the percentage of barren stalks in the average corn field:

Row	Barren Stalks. Per Cent	Seed Corn, Per Cent	Seed Corn, Bushels	Feed Corn, Bushels	Total Bushels
4	3.3	30.0	12.	28.0	40.0
6	5.0	23.7	7.6	24.4	32.0
11	2.3	59.4	43.9	30.0	73.9
13	3.0	53.4	23.5	20.5	44.0
15	1.0	57.4	42.1	31.7	73.8
21	.6	58.2	46.0	33.0	79.0
Average per acre, three best strains		58.3	44.0	------	75.6
Average per acre, all strains		47.0	27.4	------	57.3
Improvement in yield		11.3	16.6 Bushels Per Acre.	----------	18.3 Bushels Per Acre.

(Difference between best and poorest strains is 47 bushels per acre.)

The results of the Wisconsin experiments are no more startling than those made by thousands of thorough farmers and practically every demonstration station in the United States where corn-raising is a feature. The lessons are so convincing that farmers cannot afford to disregard them.

Seed House

It is very evident that a warm, well-ventilated garret or a furnace room is an excellent place to store seed corn. It has also been demonstrated that a corn crib, stock barn, granary, pump house or any building where the ventilation is irregular and atmospheric changes are not under control is a very undesirable place to store seed corn. The seed ear should be picked when ripe and placed where the evaporation is rapid enough to prevent deterioration of the germ.

If corn is subjected to atmospheric changes, it will absorb moisture one day and probably freeze the next, weakening its vitality, if not entirely destroying the germ.

We fully realize that all farmers cannot have an ideal seed house, but they can utilize a garret or vacant room which may be kept warm and well ventilated for a time sufficient to take the moisture from the grain and cob. It is shown that barns, especially where stock is confined, is a poor place to store or cure seed corn, due to exhalations from the animals.

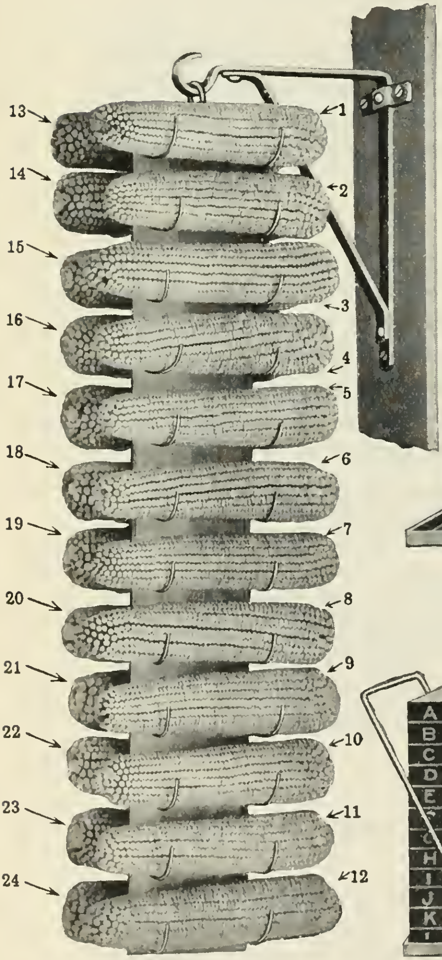
Testing Seed

In order to prevent as far as possible, the danger of having a poor stand, every ear should be tested.

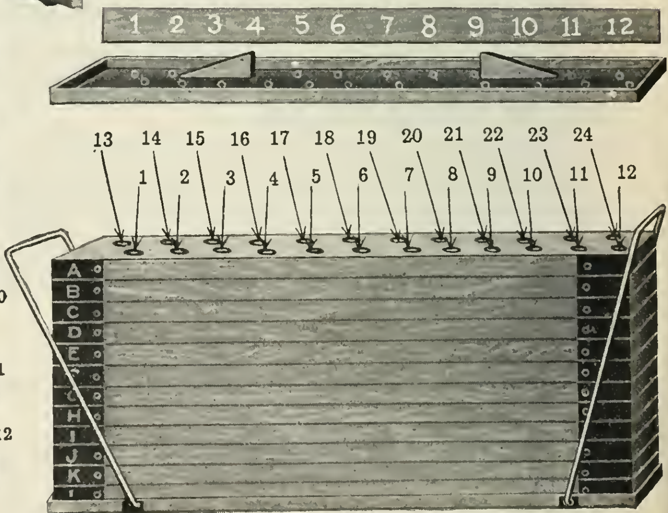
The grain of corn planted should produce at least one ear. An average ear of seed corn contains about 750 kernels which ought to produce as many ears. Five ears should produce at least forty-five bushels of corn. If any per cent of the seed corn planted fails to germinate, the loss is material, but when fifty per cent or more fails to germinate, the loss is great.

While there may be exceptions to the rule, it will be found that in most instances if two or more kernels in an ear are dead, the whole ear is dead. If a farmer plants his corn and does not discover that the seed is defective for a week or ten days after, he does not have time to make tests, but must immediately plant again with probably the same results. These delays necessarily postpone a growth which should take place early in the season.

To test enough corn to plant forty acres will require about four or five hours work, a matter of time hardly worth considering.



Rack for Brown's Seed Corn Tester



Brown's Seed Corn Tester

How to Test

A modern method. Brown's Seed Tester consists of a holding rack, Figure 1, and seed trays, Figure 2. The rack holds twenty-four ears, twelve on each side. The ears on the front side are numbered from one down to twelve. On the back side they are numbered from 13 down to 24. Each tray, as shown in the illustration, has twenty-four holes, twelve on each side. The holes are numbered from left to right running from 1 to 12, on the front side, and from 13 to 24 on the back side. The holes should be filled with sand. If sand cannot be easily secured use absorbent cotton. Commence filling by removing three or four kernels from ear No. 1 at the top of the rack, taking the kernels from different parts of the ear, and place them in hole No. 1 on the first tray and so on until kernels have been removed and planted from twenty-four ears. After all trays are filled, they should be locked. It is now ready to receive warm water (not hot), sufficient to soften the corn and fill the sand or cotton. Water is poured into the tin on top of the trays. The amount necessary can be determined by the drainage showing in the bottom tray. It is unnecessary to put on more water than just enough to keep the sand or cotton moist. The set of trays should then be kept in a room at a temperature between 70 and 80 degrees F. for a period of four days. In examining the corn if two or more seeds are found which have not germinated in a hole, say No. 7, the ear in the rack can be easily located and discarded. The racks of corn should bear a tag corresponding with the letter on each tray, for instance Rack D should correspond to Tray D. You can, with this apparatus, test 288 ears or enough to plant about twenty-five acres of corn.

Another Plan of Germinator

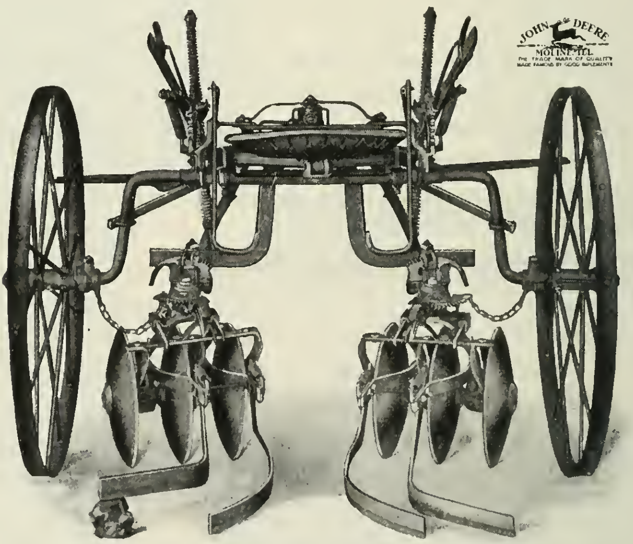
This germinator is made from any box 25 inches or more wide, from 4 to 6 inches high and about 25 inches in length for each bushel of corn to be tested. This is filled with moist sawdust to within two inches of the top. A piece of muslin is moistened and with an indelible pencil marked off in squares 2½ inches each way so that when the cloth is laid on the sawdust in the box there shall be 10 squares on the cloth across the box. In a box 25 inches square, there will be ten rows of squares and ten squares in a row.

The ears of corn are laid in rows on a table, floor or board and marked in tens. Beginning with ear No. 1 at one end of the row, take out 6 kernels from different parts of the ear. Place these in square No. 1 at the upper left hand corner of the box. Place the kernels from ear 10 in square 10 at the adjacent corner from No. 1. Place No. 11 immediately below No. 1, etc. When six kernels from each ear have thus been placed in the box, cover with a piece of wet muslin larger than the box and place moist but not saturated sawdust over all to the top of the box.

Before placing corn in the germinator, sterilize the sawdust and cloths by boiling or by the application of steam to destroy fungus spores. Leave germinator at room temperature, from 50 to 70 degrees F., for from six to eight days, until sprouts are from one to two inches long. To read the test, carefully roll back upper muslin with sawdust in such a manner as not to remove the kernels from their places. Examine roots and stems. Wherever a kernel is found having failed to germinate or having no root or no stem or a weak, thin, spindling root or stem, discard the ear from which it was taken. In this way perfect germinating corn can be secured.

Cultivation

The nature of the cultivation of corn depends, in a great measure, upon the character and depth of the seed-bed. If the seed-bed is deep and thoroughly pulverized, the cultivator shovels can be run to a greater depth without injury to the plants than if it is shallow and lumpy.



An Excellent Tool for Cultivating Corn

Any mechanical operations that tend to disturb the roots necessarily interfere with the growth of the plant. The natural growth in size and length of corn roots moves the soil sufficiently to admit air and moisture, providing the seed-bed is of good tilth.

Cultivation is intended to remove weeds, keep the surface in condition to readily absorb rain, and maintain a surface mulch or blanket to prevent the escape of soil moisture. A surface mulch is made effective by stirring the soil. After a mulch is formed and remains untouched for a protracted period, the soil particles adjust themselves in such a way that the mulch becomes ineffective; hence, the necessity, even though no rain falls, to stir the surface at least every two weeks during the growing season. Again, if a mulch is a smooth fine dust blanket, it will not promote rapid absorption of water in case of rain, but rather tends to cause it to run away. The most effective mulch is slightly coarse or granular, and left in a roughened state instead of smooth.

It must be remembered that while we are attempting with the mulch to preserve moisture, we must not have that mulch of such a nature that water cannot be absorbed in the event of rain.

Years of demonstrations on an extensive scale convinces the writer that the following plan of operations will result in less failures and more large yields than any other plan devised.

A deep seed-bed is the first thing to provide. After the corn is planted, it should be rolled, either with a smooth or corrugated roller for the purpose of packing the soil around the kernels, a condition necessary to promote rapid germination. In sections where the wind blows hard, a corrugated roller run at right angles with the wind, will, in a measure, prevent soil from blowing.

As soon as the corn begins to break through the ground, or even before, a weeder or peg-tooth harrow should be used. These imple-

The Corn Plant on the Left Is in a Deep Seed-Bed .. Deep Cultivation Did Not Destroy the Roots .. The One on the Right Is in a Shallow Seed-Bed .. Deep Cultivation Pruned the Roots

ments remove weeds and keep the surface in condition to receive moisture as well as to retain it.

After the corn is three or four inches high, one deep cultivation is admissible. As soon as the roots begin to spread between the rows, the corn should not be cultivated deep enough to cut them or in any way interfere with their growth. There is less danger of cutting and disturbing roots in a deep seed-bed than in one that is shallow.

Length and Depth of Roots

The depth to which corn roots grow depends upon the mechanical condition of the seed-bed and the subsoil; also upon the amount of moisture in the ground. It is a well-known fact that if the soil is wet in the spring when the roots are developing, the lateral roots will be found much nearer the surface than if the ground is dry. If the surface soil is not moist, roots will necessarily go downward seeking moisture.

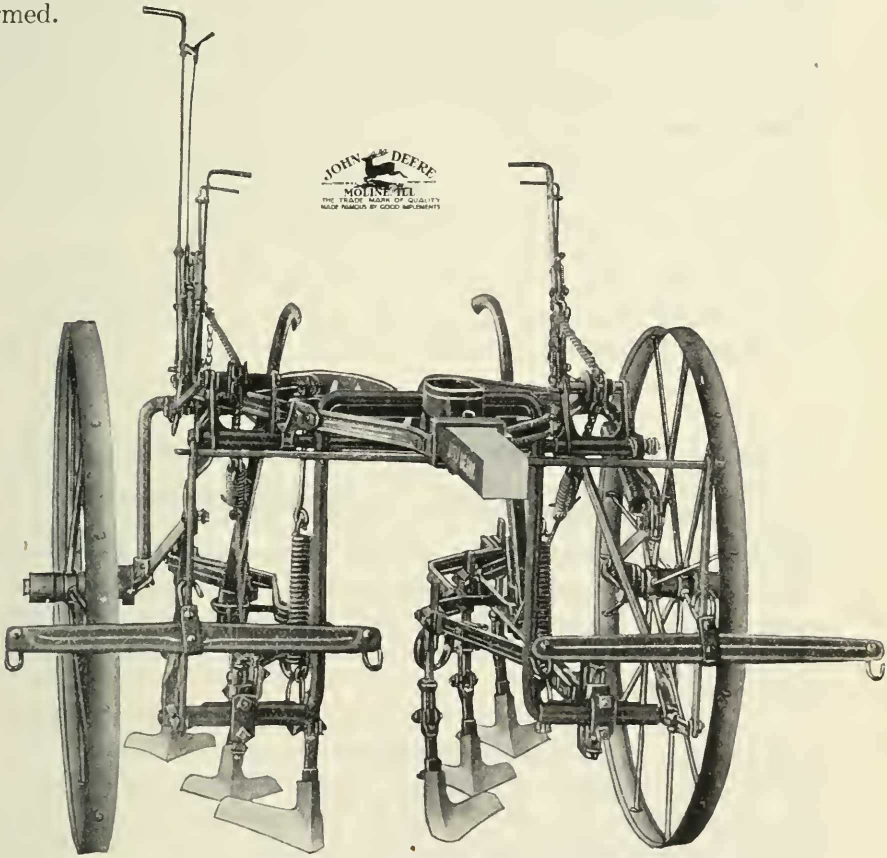
Professor King, of Wisconsin, has made elaborate experiments on the distribution of corn roots. He found "that nine days after the seed was sown, roots had grown laterally to a distance of sixteen inches and that some of them had reached a depth of eight inches. Some of the lateral roots, however, were three inches from the surface at a distance of six inches from the seed. Eighteen days after planting, the tips of the longest of the lateral roots were eighteen inches from the seed and were five inches from the surface. The greatest depth attained at this stage was twelve inches. Twenty-seven days after planting, the lateral roots were twenty-four inches and their tips four inches below the surface. The greatest depth reached was eighteen inches. In another trial it was found that forty-two days after the seed was planted, when the plant was eighteen inches high, the roots had penetrated to a depth of eighteen inches and spread laterally to a distance of three feet five inches. When corn was three feet high, the entire seed-bed to a depth of two feet was completely filled with roots, the surface leaders being six inches from the surface. When the corn was in tassel, the upper three feet of soil was full of roots and the surface leaders were scarcely five inches deep. At maturity the roots had reached a depth of four feet, and many lateral roots were within four inches of the surface."

Had the soil been extremely dry during the growing season, the roots would have been much deeper. Had it been very wet, they would have been nearer the surface.

Kind of Cultivator

The best and most economical implement for the farmer to use is a combination cultivator, using the shovels during the first cultivation and subsequently taking them off and substituting for them small surface shovels known as sweeps. Sweep shovels can be worked extremely close to the hill, and owing to the fact that their depth is easily regulated, there is no danger of cutting or disturbing the roots. Again, the sweep shovel, while it forms a splendid mulch, leaves the ground in a roughened state.

Gopher knives are often used for surface cultivation, but owing to the fact that they shave the surface, cracks are not well filled, especially if the ground is hard, and the smooth surface, after the shaving process, does not easily admit rain; or, in other words, the proper mulch is not formed.



Sweeps, Gopher Blades and Shovels Can Be Used on this Corn Cultivator
Sweeps Are Splendid for Surface Cultivation

By using the combination cultivator, the farmer can easily adapt his shovels to the condition of the soil. If the seed-bed is deep and the roots are four or five inches from the surface, he can substitute for the sweep a small shovel, which is very desirable in some soils. If the soil is extremely loose and mellow, and it is thought desirable to use the gopher blades, they can easily be placed on the shank of the same type of cultivator. I merely mention this implement for the reason that in cultivating corn, not less than two and quite often three types of shovels are necessary to meet all of the requirements, and it is more economical to have two or three sets of shovels for one cultivator than to have a separate cultivator for each type of shovel.

After the corn has attained a growth too high to straddle the row, a mulch should be maintained by running a one-horse mulch harrow between the rows, going over the ground often enough to destroy weeds and prevent the surface from baking.

When farmers realize that by adapting the right tool to different conditions as they arise, they can increase their crops from five to twenty bushels per acre, they will then appreciate the value of scientific or common-sense cultivation.

For surface cultivation, the disc cultivator also gives excellent service. The dirt can be thrown to or from the hill as may be required and the leveling irons leave the surface in splendid condition.

HOW TO RAISE 100 BUSHELS OF CORN PER ACRE

Brief Recapitulation of the Essential Features

TO raise 100 bushels of corn per acre is not a difficult task if certain specific features are carefully observed. If all of the "ifs" are overcome, and they can be, the task is made exceedingly easy. The following figures will give the farmer an idea of what must be done to secure the yield:

An acre of corn should have 3,556 hills, and each hill should contain at least 3 stalks, or 10,668 stalks on an acre. Each stalk should have 1 ear, and an acre as many ears, namely, 10,668, as there are stalks. The average ear of corn weighs 12 ounces. If, however, the ears weigh an average of $10\frac{1}{2}$ ounces, there would be 112,014 ounces. One bushel of 70 pounds weighs 1,120 ounces. Divide the total number of ounces on an acre (112,014) by the number of ounces in a bushel (1,120), and we have 100 bushels and a slight fraction.

1. In order to accomplish that result, the soil must be rich enough to grow three healthy stalks to the hill and mature at least three good ears.

2. The seed-bed must be deep, thoroughly ventilated, well pulverized and made compact.

3. A sufficient amount of water must be stored in the deeper subsoils to prevent a retarding of growth in the event of drouth.

4. Seed should be pure-bred and have strong vitality.

5. Cultivation should be thorough and repeated often enough to maintain a mulch to prevent the escape of moisture and to remove weeds.

6. Great care should be taken not to prune or even disturb roots when cultivating.

The Seed-Bed

Corn roots require room and freedom; therefore, the seed-bed should be deep and mellow. A seed-bed should be thoroughly ventilated and well drained for the reason that corn roots will not tolerate a soggy home, and soil bacteria and plant roots require free atmospheric oxygen. The seed-bed should be compact in order to give the roots a firm hold on the particles of soil and to promote perfect capillary attraction.

Fertility

The plant must be supplied with an abundance of all of the essential elements which enter into plant food compounds. The elements found in the soil are phosphorus, potash, sulphur, lime, iron, magnesia and soda. Other elements of fertility are carbon, oxygen, nitrogen and hydrogen.

Carbon

which composes the major portion of the plant is secured from the air. This, however, cannot be utilized by the plant unless the leaves of the plant are in such a healthy, vigorous condition that carbon-dioxide, of which carbon is a component part, is readily absorbed. Good seed means a quick growth and an abundance of healthy leaves.

Oxygen and Hydrogen

are furnished both from the air and water; hence, the supply of water should be adequate and available.

Nitrogen

is secured from the air through the legume, a plant which should precede corn. Of the legumes which give the best results, clover should be selected. This plant furnishes nitrogen in abundance, it grows deep, and is equipped with an abundance of roots which furnish a rich feeding area for the corn.

Barnyard Manure

should not be overlooked. This substance contains all of the plant food elements which enter into corn. It tends to assist in the absorption of moisture, and on account of fermentation, it makes the seed-bed warm, especially in the spring of the year when an early growth is very desirable.

The Value of Humus

to maintain nitrogen, also, is a feature to be considered.

Lime

may be necessary. Old land is apt to be sour, a condition disastrous to many soil bacteria, especially those that take available organic nitrogen. When soil is sour, finely-ground lime rock should be applied in amounts ranging from two hundred pounds to two tons per acre, depending upon the acidity of the soil. Lime not only neutralizes the acid in the soil, but it improves its physical condition, gives it new life and assists in making available other plant food elements, especially potash.

Rotation

Corn should always be raised in a rotation, following clover if possible. It must be remembered that clover roots not only furnish nitrogen, but when they decay in the deeper subsoils, they admit air and water which combine with plant food elements. Compounds thus formed are brought to the seed-bed by capillary attraction and are utilized by the corn roots, as is evidenced by a marked increase in the crop.

Cultivation

Cultivation should be thorough. The depth to cultivate, the character of the cultivation and the number of times to cultivate corn must be determined by conditions.

Note

The digestible nutrients in corn are:

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
	Crude Protein	Carbohydrates	Fat
89.4	7.8	66.8	4.3

The digestible nutrients in corn stover are:

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
	Crude Protein	Carbohydrates	Fat
59.5	1.4	31.2	0.7

OATS

LIKE the other cereals, there are two classes, namely, spring and winter. Winter oats are raised very generally throughout the Southern states.

Soil

Oats require a fairly rich soil. While a heavy loam is very desirable, if it contains too much organic matter, the growth of straw will be very rank and liable to lodge, and the grain is not apt to be plump and heavy.

Fertility

It is not advisable to apply manure direct to oat land. Oats should follow a crop that has been manured, unless the ground naturally contains sufficient fertility.

Rotation

The oat has very deep and vigorous roots and is regarded as a better rustler than wheat. If oats follow corn and the land was not plowed during the fall, a good crop can usually be secured by thoroughly discing the land without plowing, provided it was well cultivated and manured for corn. If the land is plowed in the spring, it is apt to be loose, causing the oats to lodge in the event of heavy storms. Oats should follow rather than precede wheat in a rotation.

Varieties

It is impossible to recommend any special variety for all sections of the country. In Minnesota and the Dakotas, where oats are grown very extensively, it was found that a variety known as the "Kherson" made an average yield of sixty-five and nine-tenths bushels. The Sixty-day and the Swedish Select made an average of sixty-one and six-tenths bushels. The Kherson variety proved to have the greatest smut-resisting qualities. In Indiana, where tests were carried on for a period of five years, there was very little difference in the yield between varieties known as Czar of Russia, Great Dakota, Swedish Select and Silver Mine. In Nebraska, experiments were carried on for a period of five years, demonstrating that the Kherson gave the highest yield.

Seed

Home-grown seed is considered equal to, if not better than, seed brought from another section. Iowa made some extensive experiments during the years 1910 and 1911. Imported seed made an average yield of forty-six bushels to the acre, and home-grown seed made an average of forty-seven and one-tenth bushels per acre. The best crops from seed raised in 1910 were as follows: Great American seed imported from Illinois made a yield of seventy-two and two-tenths bushels. Illinois Big Four made a yield of seventy-one and two-tenths bushels. Michigan Brobesteier made a yield of seventy bushels. Home-grown Silver Mine made a yield of seventy and six-tenths bushels.

The Iowa Experimental Station concludes that "Northern grown seed is not superior for corn-belt conditions. The best corn-belt seed is better than the farmer is likely to purchase elsewhere."

"Where importations have been made with successful results, the increase has been due to the securing of a better adapted variety and not to the quality of the seed purchased."

Diseases

It is estimated that from two to five per cent of the oat crop is destroyed by smut. Unless the smut is killed in the seed before it is planted, it is very apt to transmit the disease to the crop. If, however, the farmer will treat his seed with formaldehyde, he can in a great measure prevent it. In treating the seed, one pound or pint of formaldehyde should be thoroughly mixed with about forty gallons of water. This amount will treat forty bushels. No better rules governing the use of formaldehyde can be given than those presented in Bulletin No. 128 issued by the Ames Iowa Agricultural Station.

"1. Spread out forty bushels of oats on the floor five or six inches deep.

"2. Mix one pound of formaldehyde (40 per cent) with forty gallons of water. Stir well.

"3. Sprinkle the oats with the mixture in the barrel until they are saturated. It is well at this point for one man to shovel the oats into a pile while another sprinkles. They are not exposed to the air for so long a time and less gas is lost. See that the pile is thoroughly soaked when finished.

"4. Cover the pile at once with the blankets and sacks so as to keep the gas in where it will be effective. (It is this free gas that does the work.)

"5. Leave the pile covered for six to ten hours (over night); then remove the blankets and shovel out thin to dry. Shovel them over from time to time.

"These oats may be sown as soon as they are dry enough to run through the drill. Make allowance for the swollen condition of the seed in setting the drill. It is a convenient plan to treat the oats late in the afternoon, then they can be left over night in the pile without danger of heating."

If more oats are treated than are needed for seed, they may be fed after one or two days. All the gas will have escaped.

Oats for Forage

If the oats are sown thick and are cut just as the grain is in the dough and properly cured, they make splendid feed for cows and young stock. In curing, great care should be taken to keep them from getting wet, nor should they be permitted to lie on the ground until they are sun-burned.

The digestive nutrients in oat products are as follows:

	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Crude Protein	Carbo-hydrates	Fat
	Lbs.	Lbs.	Lbs.	Lbs.
Oats	89.6	10.7	50.3	3.8
Ground Oats	88.0	10.1	52.5	3.7
Oat Meal	92.1	11.9	65.1	6.7
Oat Middlings	91.2	13.1	57.7	6.5
Oat Straw	90.8	1.3	39.5	0.8

WHEAT

WHEAT forms the principal food of man, not only in the United States, but in all civilized countries. The origin of this cereal is not known. Evidence exists, however, that it grew wild many thousand years before Christ. History records that it was cultivated in China three thousand years before the Christian era.

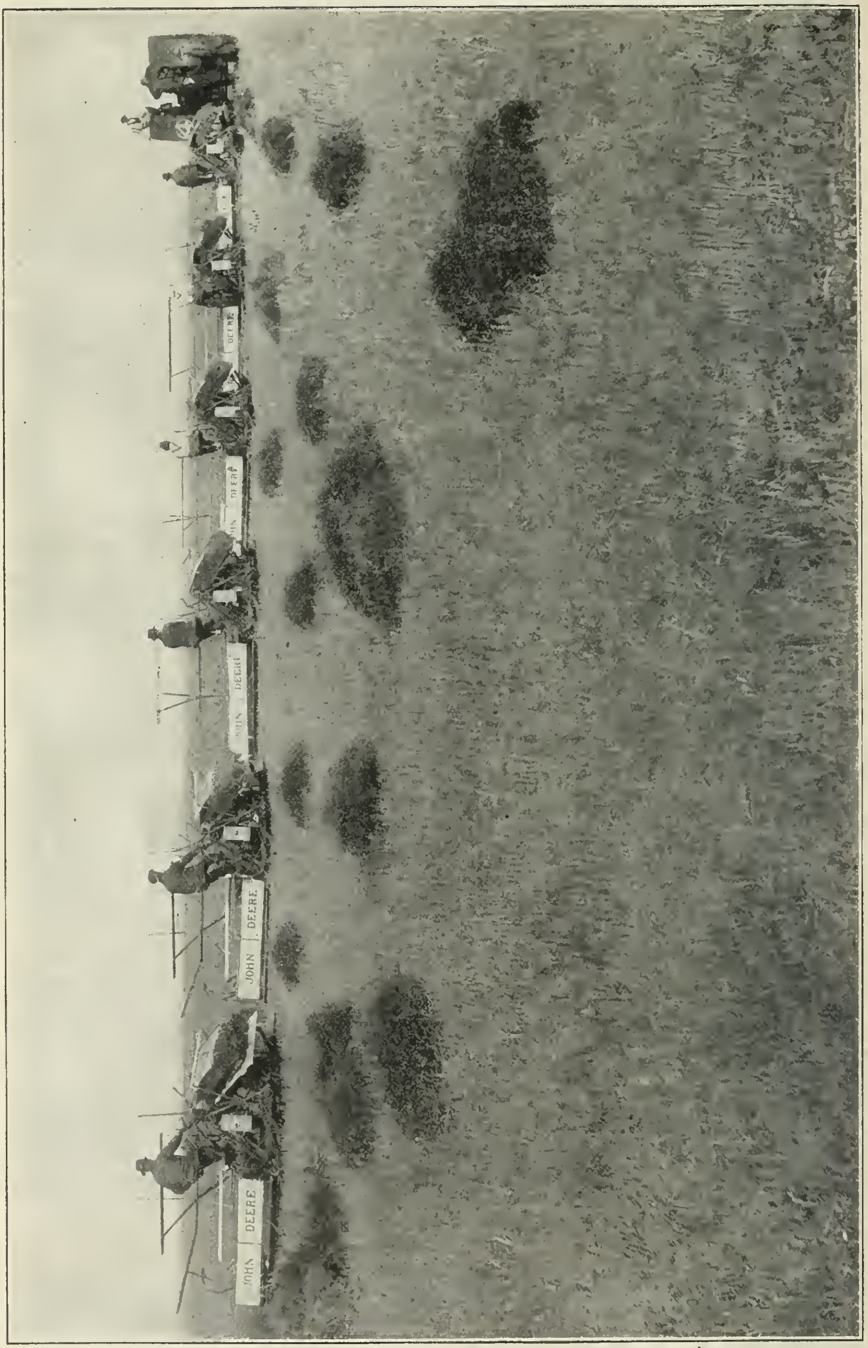
The first wheat of which a record exists had but one kernel to a head. It is assumed that by cultivation, seed-selection and breeding, it has been gradually developed to its present state.

Wheat is grown very universally over the western continent. While it is known that wheat does not thrive well north and south of the equator to a distance of twenty-five degrees at a low altitude, it does thrive at the equator on the mountain plains of Colombia and Ecuador at an altitude of ten thousand feet above the level of the sea.

It thrives on the Klondike river, a latitude of 65 degrees and 30 minutes, at an altitude of two thousand feet. About eighty per cent of the wheat produced in the United States is grown at an elevation of between five hundred and fifteen hundred feet above sea level. One authority states that the greatest elevation at which wheat has been raised is in Asia in the Himalaya mountains at an elevation of eleven thousand feet. In the great wheat belt of Kansas, the elevation is about sixteen hundred feet. Colorado has developed a type of wheat adapted to a region ranging from six to nine thousand feet above sea level.

Varieties

While there are more than one thousand varieties of wheat, there are less than two hundred and fifty varieties grown successfully in the United States. No one variety is regarded best under all conditions;



Cutting Wheat on a Dakota Farm

the climate, soil and precipitation should determine the variety which will be the most profitable. In the United States, a winter wheat known as Turkey Red is the favorite, and Fife and Blue-stem are regarded as the best spring wheat varieties. In the semi-arid west, the Durham or Macaroni are becoming very popular. Farmers should, however, study conditions very carefully and adopt a variety and strain best suited to their soil and climatic conditions.

Soils

The best wheat soil is a clay loam with a clay subsoil, although it does well in any fertile soil where the standing water line is not too near the surface.

The Requirements

for wheat are a rich soil and deep, thoroughly pulverized seed-bed, containing a reasonable amount of moisture and free atmospheric oxygen.

Germination

Three things are necessary to promote germination, namely, moisture, warmth and oxygen. If any one of these features is absent, germination will stop. The period required to germinate depends upon these conditions. Wheat will not germinate below forty-one degrees Fahrenheit, nor above one hundred and four degrees. At the minimum temperature, it requires from six to seven days, and at ten degrees higher the time is shortened to three or four days. Germination is most rapid when the soil is at a temperature between eighty and eighty-five degrees. During the process of germination, wheat requires water. A grain will absorb during the period about six times its own weight.

Loss in Weight During Germination

One authority states that a grain loses about 1.5 per cent of its own weight during germination in twenty-four hours, 6.7 per cent in ninety hours, and 11.8 per cent in one hundred and forty-four hours. From the above, it is plain that wheat loses very materially if it sprouts either in the shock, stack or bin. Deterioration on account of chemical changes is also very material.

Roots

Wheat roots are very abundant and very long. They penetrate the ground from a few inches to five or six feet. Roots have been traced to a depth of seven feet. The development depends wholly upon the condition of the soil. It is stated that if the roots of one plant are placed end to end, that they will reach a distance of from fifteen hundred to seventeen hundred feet.

Stooling

Wheat stools are side shoots, the number varying from five to fifty.

One case is recorded in the United States, where fifty-two bearing stems were formed. Cool weather and early seeding increases stooling. Some remarkable stories are recorded as to the number of stools that a single grain will throw out. Pling states that in Northern Africa and Italy, it is not uncommon to find from two hundred to four hundred stalks growing from a single kernel. Humboldt states that in Mexico a single grain will produce from forty to seventy stalks.

Seed-Bed

The seed-bed should be made deep, provided the subsoil is not a loose sand or gravel and too near the surface. Owing to the fact that the roots are inclined to grow deep, it is advisable, if the subsoil is compact, even in humid regions where the rainfall is abundant, to use a subsoil plow for the purpose of mellowing the ground, thereby facilitating deep penetration. If the seed-bed is not deep, the roots, owing to their fragile condition, will not penetrate a very compact plow sole, but will spread out, taking the course of least resistance, and in the event of drouth, the plant will die or suffer for lack of moisture on account of their nearness to the surface.

If the seed-bed is deep and mellow and the sub-stratum is permeable, delicate roots will penetrate into the soil where water is secured and where some plant food is available. The practice of drilling wheat without plowing, while it may prove successful occasionally, as a general rule means a very deficient crop. The writer had an opportunity to observe the two conditions in the west during an extremely dry season. Wheat drilled in corn ground where corn was listed, but not plowed, made a yield of from four and a half to six bushels per acre. In an adjoining locality where the ground was plowed deep, having been disced before it was plowed and subsequently disced, in spite of the protracted drouth that season, made a yield of over thirty bushels per acre, showing the value of a deep, well-made seed-bed.

In a locality in South Dakota where the ground was plowed shallow, the wheat roots did not penetrate to a sufficient depth to hold the plant, and during a drouth when the wheat was a few inches high, it was completely blown out of the ground by the high wind. Had the same land been plowed deep, the wheat would not have been dislodged by blowing nor would it have perished for lack of moisture, as was evidenced where the deep seed-bed was made in the same section.

It is a safeguard against the possibility of a drouth to disc the ground before it is plowed in order that all trash may be worked into the seed-bed and the surface lumps pulverized so that when the furrow slice is turned, the contact is compact between the bottom of the furrow and the turned portion of dirt. The discing prevents the formation of air spaces, a condition that materially interferes with the upward movement of water. Again, the seed-bed should be thoroughly disced until all of the lumps are pulverized in order to make plant food accessible to the roots. Plant food is held in solution and forms a film; or, in other words, clings to each particle of soil. The little delicate root filaments are thrown around these particles of soil and absorb, through the process of osmosis, the food and moisture. If lumps exist, the roots will not penetrate them; hence, the feeding area is restricted just in proportion to the number and density of the lumps in the seed-bed. The seed-bed should also be compact. Compactness is essential to capillary attraction, and it is also necessary in order that the plant roots can receive a firm hold in the soil.

Air

Atmospheric oxygen is necessary to plant roots; or, in other words, to soil bacteria, which convert plant food into compounds. If the seed-bed is not deep and thoroughly pulverized, it is not well aerated. If, for any reason, the soil becomes surcharged with water, so that the air spaces between the particles of soil are filled up, the air is driven out and the growth comes to a standstill, and if the clogging continues even for a day or two, the plant will smother. Every farmer has seen this condition where water has stood for twenty-four or forty-eight hours in a wheat field.

Rotation

It is well known to every wheat-grower that if he plants that cereal on the same land for a series of years, the production will become less each year, until, finally, he will hardly get his seed back.

It is thought by some that plant roots throw off a deleterious excreta which is a poison to its own kind, but that the excreta is a food or stimulant to plants of a different variety; while others claim that a plant exhausts its specific requirements from the soil to such an extent that there is not enough fertility left to make a crop. Beyond question, both theories have merit in a degree, but certainly the second one is far from being correct, for we know that after wheat has been grown on soil until a crop cannot be produced, the same soil will make a remarkable crop of barley, rye, buckwheat or millet, using practically the same plant food elements, showing that fertility still exists, but for some reason cannot be utilized by the wheat.

A piece of land which produced two hundred bushels of potatoes per acre the first two years, finally failed to grow twenty bushels after it had been cropped for sixteen years, but did make the seventeenth year seventy-five bushels of oats per acre. Many other like experiments might be given.

Regardless of theories, however, we know that a scientific rotation always results in an increased yield. Wheat makes its greatest yield when following a legume. It also does well when sown on corn ground, if corn followed sod or a legume, or after root crops, especially after potatoes. Wheat should not follow oats, rye, buckwheat or barley; it does, however, do well after flax if the flax was grown on new ground.

A splendid rotation for the northern half of the United States is, first year, a legume (clover, soy beans, cow peas or vetch); second year, corn, well manured, and third year, wheat, seeding to clover. In the cotton section of the south, a splendid rotation is, corn, planting cow peas between the rows after the last cultivation. After corn has been harvested, disc thoroughly before plowing and sow wheat. After the wheat has been cut, drill in peas, unless the ground is too hard, in which event disc or plow very shallow. After the peas have attained a good growth in the fall, plow deep after discing and plant to cotton in the spring. The ground can be further enriched by adding barnyard manure.

If the soil is deficient in phosphoric acid, apply acid phosphate several days before planting and disc it into the seed-bed very thoroughly.

The results of rotation in Minnesota have been remarkable. Dondlinger makes the following statement: "Results already reached warrant the statement that the average yield per acre of wheat can be increased twenty-five to fifty per cent by rotating the crops and manureing." He also calls attention to the necessity of having a deep, well-made seed-bed.

Fertility

Like corn, wheat is greedy and exacting. Wheat roots will not tolerate a poorly-made home, nor will they thrive on short rations. If the seed is inferior and the seed-bed shallow and not thoroughly ventilated, atmospheric and water elements are not fully utilized.

Of all the plant food required to make a crop of wheat, ninety-seven and six-tenths per cent of the dry substances of the crop is composed of nitrogen, carbon, oxygen and hydrogen, elements taken from the atmosphere and water. The other inorganic elements amounting to two and four-tenths per cent are taken from the soil. Both groups of elements are inter-dependent; hence, while the small per cent which consists of potash, phosphorus, silica, lime, magnesia, soda and sulphur, seems insignificant, the elements must be in the soil in an available form if a crop of wheat is made.

King says: "The crop of wheat which yields thirty bushels of grain per acre demands, as indicated by chemical analysis, forty-eight pounds of nitrogen, twenty-one and one-tenth pounds of phosphoric acid (which amount to ten and five-tenths pounds of phosphorus), twenty-eight and eight-tenths pounds of potash, nine and two-tenths pounds of lime, seven and one-tenth pounds of magnesia, seven and eight-tenths pounds of sulphur, and ninety-six and nine-tenths pounds of silica."

Dondlinger makes the following statement in his "Book of Wheat": "An acre of very fertile soil contains about 70,000 pounds, or two per cent, of potash on the first foot of ground. A crop of wheat removes about fifteen pounds of potash from each acre. It has been estimated that the first eight inches of soil contain on an average enough nitrogen to last ninety years, enough phosphoric acid to last five hundred years, and enough potash to last one thousand years. This supply is materially increased when we consider the great depth penetrated by the roots of wheat."

Practically all agricultural soils of the United States contain an inexhaustible supply of all of the inorganic elements mentioned, except phosphorus and lime, and, possibly, potash.

We know that these inorganic elements are in the disintegrated particles of rock and that they are found not only in the surface soils, but in all soils below the surface.

It is also known that by growing deep-rooting plants such as the alfalfa, clover and many others, dormant plant food far below the reach of the plow can be made available and utilized by being brought to the plant roots in a soluble state by capillary attraction.

Manures

We also know that one-quarter of the nitrogen and nearly all of the phosphoric acid and potash which enter into a crop of wheat are contained in bran screenings and middlings, and that fully eighty per cent can be returned to the soil if they are fed to live-stock and the manure is placed on the ground. Barnyard manure is an ideal fertilizer for wheat. It furnishes all of the plant food elements which enter into the crop besides organic matter which is the main substance in maintaining nitrogen and soil bacteria. It also places the soil in a good physical condition, making it mellow and permeable. In sections where manure cannot be secured, the organic matter can be provided by plowing under green crops and the inorganic plant food elements such as potash, phosphorus, etc., can be supplied in a commercial form.

Lawes and Gilbert give the results of their experiments with wheat as follows:

"No manure for forty years, averaged 14 bushels; farm yard manure for thirty-two years, averaged $32\frac{3}{8}$ bushels."

Rothamstead average of eight favorable harvests:

	Weight, Per Bushel	Grain, Per Acre	Straw, Per Acre
Farm Yard Manure	62.6 pounds	2342 pounds	6089 pounds
No Manure	60.5 pounds	1156 pounds	2872 pounds

Eight unfavorable harvests:

	Weight, Per Bushel	Grain, Per Acre	Straw, Per Acre
Farm Yard Manure	57.4 pounds	1967 pounds	5574 pounds
No Manure	54.3 pounds	823 pounds	2433 pounds

Lime

is needed, especially in soils that have become sour on account of continued cropping. Soil deficient in lime is dull and stupid, and the wheat stalks are long-jointed and slender, a condition that causes them to crinkle. When the soil seems to be devoid of life, a test should be made, and if lime is needed, it should be supplied in the form of raw limestone ground to a fine powder.

Seed

In selecting wheat for seed, several important things should be taken into consideration:

1. It should be suited to the climate.
2. A variety and strain which is free from diseases and resists diseases.
3. Wheat that has the greatest yielding power and best milling properties.
4. Grain that is free from weed seeds and other growths.

The farmer should keep in mind that regardless of variety, the seed should be plump and healthy. Plump seed, however, without consistency and weight is not desirable.

While wheat that has been burned in the stack or bin, sprouted in the shock, harvested before ripe or frosted before fully matured, will germinate, it does not possess the vitality needed to throw out strong initial roots rapidly and a robust stem. A weak germination will result in a short, delicate root and a sickly stem, a condition which is reflected throughout the entire life of the plant.

Experiments have shown that where all the light and defective kernels are discarded, that the yield is increased from thirty to forty per cent.

As an evidence of what may be accomplished by selecting good seed we give Hallett's experiments. For five years he selected the best head produced from the grains of the best previously selected head:

	Grains	Length, Inches	Number of Grains on One Ear	Number of Ears on One Root
First Year	Original Ear	$4\frac{3}{8}$	47	..
Second Year	Finest Ear Raised	$6\frac{1}{4}$	79	10
Third Year	Finest Ear Raised	$7\frac{3}{4}$	91	22
Fourth Year	Heads Imperfect	..	...	39
Fifth Year	Finest Ear	$8\frac{3}{4}$	123	52

Seed Should Be Adapted to Locality

It is quite important to select seed which is adapted or suited to the locality where it is to be planted. Too often a farmer will ship seed from another state, having been informed that it made a splendid yield, not knowing whether it is suited to his land or his locality. The best results are obtained, as a rule, from seed grown in the locality where it is to be sown, unless a change is necessary on account of the local wheat being diseased or of an inferior quality. It is not advisable to secure wheat from a southern climate to sow in a northern latitude, nor from a humid section to sow in the semi-arid west. In some instances, foreign varieties imported to the United States have made remarkable records. The most valuable importations have been made from Russia. The Red Winter, a Russian wheat, has proven to be, not only a high yielder, but endures extremely cold winters and resists rust better than any of our native wheats. The Durham wheat was also secured from the same country. This variety not only makes a splendid yield, but is very drouth-resisting.

Rusty Wheat

should not be sown, nor wheat affected with smut. How to treat wheat for smut is given in the chapter on oats.

Weeds

Another thing to be carefully considered is keeping weeds and undesirable growths from the field. It is estimated that dockage on account of weed seed depreciates the value of the wheat crop annually in the United States at least five million bushels, not taking into account the loss of moisture and plant food taken by the weeds from the soil. Weeds to be especially avoided are: Russian and Canada thistles, cheat, wild mustard, wild garlic, cockle, wheat thief and yellow berries.

Insects

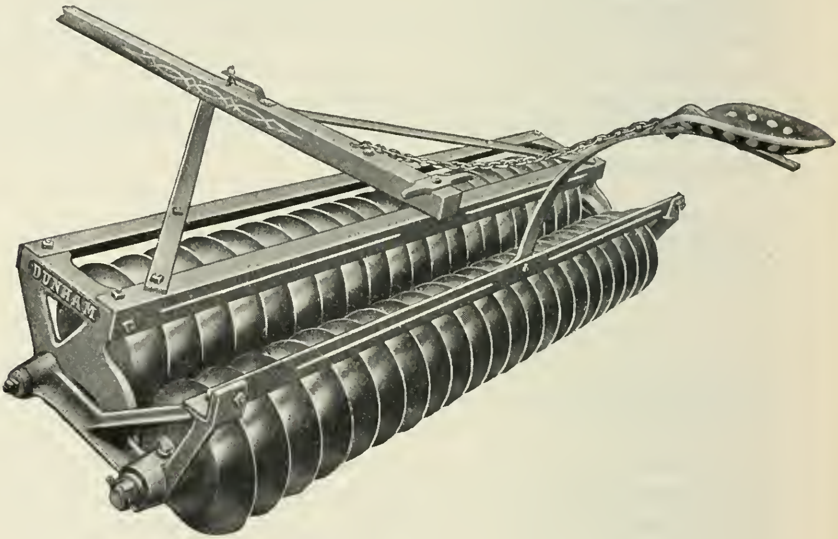
Many insects become very destructive, even to the point of complete annihilation of the crop. While remedies which are said to be beneficial are many, none of them are regarded infallible. In some cases burning stubble, grass and all surface rubbish will destroy them. Early, deep and thorough tillage and crop rotation is sometimes beneficial. For a specific treatment, the writer suggests calling an expert from the local agricultural college. At best, the process of the eradication of destructive insects is very slow and very discouraging.

Seeding

Without question, the best method of sowing wheat is with a drill. It requires less seed and insures a more even depth. If the seed can be covered with one inch of moist earth, germination is rapid and the early growth will tend to smother weeds. The time to seed and the amount of seed to use per acre depends upon the fertility and condition of the soil and the climate. The amount to sow per acre ranges from two to nine pecks, the usual amount being about five and one-half pecks.

Roller and Harrow

If the soil is light and not compact, rolling proves beneficial after sowing. If straw, stubble or manure is well mixed with the soil and the corrugated roller is run at right angles to the prevailing winds, it will prevent, in a measure, the soil from blowing away or drifting.



Corrugated Roller .. This Implement Is Invaluable as a Clod Crusher, Pulverizer and Mulch Former

If the soil is light and loose around the roots of winter wheat in the spring, a corrugated roller will not only pack the loose soil around the roots to the depth of several inches, but forms a shallow mulch which is of material benefit in conserving moisture. Repeated experiments have demonstrated that rolling winter wheat in the spring with a corrugated roller, even when it is beginning to joint, increases the crop from ten per cent to twenty per cent. If the ground is hard and weedy, and the stand thin, a peg-tooth harrow or weeder is of great benefit.

The digestible nutrients in wheat products are as follows:

Kind	Total Dry Matter in 100 Lbs	Digestible Nutrients in 100 Lbs		
		Crude Protein	Carbo-hydrates	Fat
Wheat	89.5	8.8	67.5	1.5
Flour Wheat Middlings	90.0	16.9	53.6	4.1
Shorts	88.8	13.0	45.7	4.5
Wheat Bran	88.5	12.1	37.1	2.8
Wheat Screenings	88.4	9.6	48.2	1.9
Wheat Straw	90.4	0.8	35.2	0.4

BARLEY

BARLEY ranks fourth in production of the cereals in the United States. It is grown for grain, hay, pasture and soiling. Barley is not only used for human food and malting, but it is a splendid food for live-stock, especially swine. When fed with corn to live-stock, it doubles the market value of both feeds, making, as it does, a balanced ration, if given in the right proportions.

While barley can be grown more generally in the United States than any other cereal, its production thus far has been confined very largely to the northern central states. Owing to the fact that it produces more bushels per acre than wheat and usually commands a fair price, it is to the farmer's advantage to give it special attention.

Varieties

The choice of varieties differs in different localities. Wisconsin produces about one-eighth of all that is grown in the country. The results of extensive experiments carried on for a period of ten years in that state are very interesting. The average production from various varieties are as follows:

The Six-Rowed Bearded Variety

Oderbrucker .... Averaged 50.7 bushels per acre.
Manshury .... Averaged 51.4 bushels per acre.
Silver King .... Averaged 44.4 bushels per acre.
Golden Queen .... Averaged 45.5 bushels per acre.

The Beardless Variety

made an average of 28.2 bushels for two years.

The Hulless Variety

made an average of 26.9 bushels for four years.

The Two-Rowed Varieties

namely, Chevalier, Hanna, Princess and Frankleus, made an average for five years of 33, 41, 20 and 26 bushels per acre.

The above indicates that the six-rowed variety is preferable to the two-rowed in Wisconsin, and probably the same results are obtained in Minnesota, the Dakotas, Iowa, Illinois and Nebraska.

Oregon has had the best results from beardless varieties, but in the southern states, Tennessee winter and Union winter are favorites.

Soils

Barley can be grown on any fertile soil, but does best on a porous silt or clay loam. The roots are somewhat delicate and will not penetrate a hard-pan; hence, the necessity of having a well-made, deep seed-bed sufficiently compact to give the roots a firm hold.

In dry sections it is advisable to use a subsoil plow, first, to store moisture, and, second, to make a mellow seed-bed. It is not advisable to plant barley on new sod unless the furrow slice lays flat and is well rotted. Barley does best when planted on fall plowing, for the reason that fall plowing is usually well settled and the turned-under vegetation is thoroughly rotted. If spring plowing is made compact, it is safe to plant to barley, but if too loose and the weather is dry, the crop will suffer as any other cereal would.

Experiments show that barley sown on disced corn land does not yield as well as when sown on land plowed in the fall. If, however, the land was plowed deep for corn and thoroughly disced before seeding, a very good crop can be secured.

Rotation

Barley should be sown in a rotation following corn, wheat, flax or root crops. The rotation should include clover or some other legume if possible. Barley should follow wheat rather than precede it, and barley following flax does better, as a rule, than wheat following flax.

Seeding

It has been demonstrated that drilling is far preferable to broadcast sowing. Reports of the amount of seed to sow per acre differ somewhat, but it is generally conceded that six pecks give the best results. The average in Nebraska for a period of four years is as follows:

2 pecks yielded 17.0 bushels.
4 pecks yielded 21.4 bushels.
6 pecks yielded 24.4 bushels.
8 pecks yielded 22.7 bushels.

In Montana

2 pecks yielded 47.3 bushels.
4 pecks yielded 62.1 bushels.
6 pecks yielded 70.1 bushels.

Any amount above six pecks did not prove economical.

The following statement made in Wisconsin Bulletin No. 212 is certainly worthy of the farmer's attention, especially in view of the fact that the yield of barley is more than 25 per cent greater than wheat.

It is also well to remember that barley ripens earlier than weeds and is more desirable than any of the other cereals as a nurse crop for clover and grasses.

"The classes of barley which have proved the best yielders in Wisconsin have been six-rowed bearded varieties, known as Oderbrucker, Manshury, Silver King and Golden Queen. The new Wisconsin pedigreed varieties have demonstrated their superior value by returning higher average yields than the other sorts.

"Barley as a cash crop deserves careful attention. If one variety of recognized value is grown and care taken that varieties are not mixed, the crop will be more valuable on the market, since the maltsters desire a barley grain which will all germinate at the same time.

"Investigations show that the majority of maltsters prefer the six-rowed bearded barley. Statistics for the entire country show that barley is exceeded only by corn in average yield and value per acre, and in digestible nutrients, which represent its feeding value, it is also second only to corn."

Note

Composition of barley:

Water Per Cent	Ash Per Cent	Crude Protein		Carbohydrates Per Cent	Fat Per Cent
		Fiber Per Cent	N-Free Extract Per Cent		
10.8	2.5	12.0	4.2	68.7	1.8

SPELTZ

SPELTZ, which is sometimes called emmer, is a variety of ancient wheat. The husks adhere to the kernel similar to barley. This cereal is grown quite extensively in some of the northern states.

Speltz will thrive where other wheats will not grow. As a drouth-resisting plant, it is almost equal to kaffir corn. It is used quite extensively as a stock feed. Some very thorough experiments regarding its value as a feed are given in Bulletin No. 100 issued by the South Dakota

Experiment Station. In view of the fact that farmers in the north are anxious to know the value of speltz as a stock feed, we here give the results of the South Dakota trials.

Feeding Speltz to Sheep

"It required 5.09 pounds of barley as compared to 7.47 pounds of speltz to produce a pound of gain. In Bulletin No. 80, results are reported in feeding it to lambs as compared to eight other different grain rations. In this experiment it required 7.2 pounds when fed whole and 8.3 pounds when ground as compared to 5.3 pounds of corn to produce a pound of gain."

Feeding Dairy Cows

"It required two pounds more of speltz to produce a pound of butter fat than it did barley or corn, other conditions being equal. The cows made a gain in weight of eighteen pounds per head during the period. They consumed one-third more of speltz per head daily than did the lots receiving barley or corn. Speltz proved to be a good feed for the dairy cow."

Fattening Range Lambs

"Speltz was fed as a single grain, and mixed with corn, barley and wheat, half and half by weight to four different lots. The record of the lot fed on speltz in this test confirms the results obtained by feeding this grain in former experiments, that it requires from one to two pounds more to produce a pound of gain than with the other grains."

"The lot fed a mixture of speltz and barley, half and half by weight, made a larger gain for feed consumed than the average of the gain made by the two lots fed on barley and speltz. This was also true for lot nine where corn was mixed with speltz in the same proportion as above, but with both lots it required more pounds of the mixture to produce a pound of gain than it did with either lots fed on barley or corn, which indicates that speltz has a greater feeding value for lambs when mixed with other grains than when fed alone."

Feeding Baby Beef

"The lot fattened on speltz made an average daily gain of 1.69 pounds, while the lot fattened on corn made an average daily gain of 1.84 pounds.

"During the grass period, the lot fed on speltz gained 112 pounds more than did the lot fed on corn. It required only 5.16 pounds of speltz for a pound of gain, as compared with 7.03 pounds of corn to produce a pound of gain, during the grass period.

"The lot fed on speltz did not consume as much hay per pound of gain as did other lots, indicating that the husk of speltz is a good substitute for hay.

"Speltz produces a hard fat, about the same as oats; and as good a quality of meat as corn, as may be seen by cut of rib and loin on page 73 of Bulletin No. 100.

"With the exception of the speltz lot, the spayed heifers brought the same price as the steers. In this case a reduction of fifty cents per hundred was made on account of the spayed heifer being smaller than the steers in the lot which brought $6.00 per hundred.

"The lot of calves fattened on speltz sold for 40 cents a hundred less on the Chicago market than did the lot fattened on corn, and dressed two per cent less than did the corn lot."

RYE

THERE are two different classes of rye, namely, winter and spring. The winter varieties, only, are grown to any extent in the United States. Rye is a hardy rustling crop and will make a larger yield on poor land than any of the cereals.

Soil

If rye is grown on soil rich in organic matter and nitrogen, it is very apt to lodge on account of the heavy growth. If sown early in the fall, it makes a splendid winter pasture. Excepting legumes, it is superior to other crops for green manuring. While it adds none of the plant food elements to the soil, if the growth is plowed under, all of the plant food taken from the soil in making the crop is returned. Its value as a manure crop is in the organic matter it furnishes.

Uses

Rye is not only a splendid food for man, but when balanced with concentrates, it makes a profitable food for hogs and cattle.

The digestible nutrients of rye products are as follows:

Kind	Total Dry Matter in 100 Lbs.	Digestible Nutrients in 100 Pounds		
		Crude Protein	Carbo-hydrates	Fat
Rye	91.3	9.5	69.4	1.2
Rye Middlings	88.2	11.0	52.9	2.6
Rye Straw	92.9	0.7	39.6	0.4

Kaffir Corn .. Can Be Grown in Any Latitude Adapted to Corn .. Practically a Sure Crop in Semi-Arid Regions Because of Its Drouth-Resisting Qualities

BUCKWHEAT

BUCKWHEAT is grown for human food and the flower is a favorite with the bee on account of the large amount of honey it contains.

Soil

Buckwheat can be raised on almost any type of soil and in latitudes where but few crops will mature.

It is a hearty feeder and rough rustler. Buckwheat will make a good crop on land that is apparently worn out.

As a green manure crop it is excellent. The writer has sown it as a catch crop after an attempt to raise wheat, which failed on account of an anaemic condition of the soil, and by plowing the heavy growth of buckwheat late in the fall, was able to secure a good crop of wheat the next year. It is very evident that the crop plowed under improved the physical condition of the soil and made available dormant plant food.

Seeding

Buckwheat can be sown broadcast or drilled. The usual amount to sow is from three to four pecks per acre.

The digestible nutrients in buckwheat are as follows:

	Total Dry Matter in 100 Lbs.	Digestible Nutrients in 100 Pounds		
		Crude Protein	Carbo-hydrates	Fat
Buckwheat	86.6	8.1	48.2	2.4

KAFFIR CORN

KAFFIR corn is a non-saccharine sorghum. While it can be grown in any latitude or in any soil that will produce Indian corn, it is also especially adapted to semi-arid regions. It is manifestly a drouth and hot wind resisting plant. During an extremely dry spell it may become dry and apparently dead, but will revive after a rain.

Kaffir corn is a carbohydrate the same as Indian corn and its feeding value is very nearly equal to Indian corn. The results of a number of analyses show that the protein and carbohydrates in Kaffir corn are slightly higher and the fat somewhat lower in per cent than in Indian corn.

It is safe to say that ten bushels of Kaffir corn have approximately the same feeding value as nine bushels of Indian corn.

Kaffir corn is a great safe-guard in semi-arid regions and high altitudes where Indian corn cannot be successfully grown. When fed with alfalfa in the right proportion, it makes a splendid ration for live-stock.

For poultry feed it is equal, and by some regarded as being superior, to Indian corn. When fed to stock the best results are obtained by making it into a meal. In feeding poultry, however, it does better when the grains are fed whole.

The farmer must keep in mind the fact that in order to get the best results from Kaffir corn it must be fed with feeds containing protein.

Planting

Kaffir corn can be planted in hills, drilled with an ordinary corn planter, with a grain drill or sown broadcast. When planted for seed it is better to plant four or five grains in a hill three feet apart; if for a soiling crop it should be sown broadcast or drilled with a grain drill. In dry sections it is advisable to use the lister in planting. The seed should not be planted until the ground is warm, if placed in cold damp ground, it will rot.

MILO MAIZE

MILO maize, like Kaffir corn is a non-saccharine sorghum. In appearance, nutritive value and habits, it is very similar to Kaffir corn. By some it is regarded as being even more drouth resisting.

Feeding Value

H. M. Cottrell states that a bushel of Milo maize will make ten or eleven pounds of pork, or, in other words, the farmer can make four hundred or more pounds of pork from one acre of Milo. He states that it is a never failing crop in the Pan Handle of Texas and that it will yield twenty or more bushels per acre in sections where it is so dry that wheat is an absolute failure and corn cannot be grown. He recommends it very highly for horses and advises that it be fed unthreshed, or, in other words, feeding the entire cured plant. He suggests that if the seeds are fed shelled that many of them are swallowed whole and will pass through the horse undigested, but if fed in the head the grains will be thoroughly masticated. It is recommended very highly for fattening cattle. It should first be fed in the shock, later in the head, and the cattle finished off with the ground meal. It makes an excellent dairy feed and should be fed in the head insuring thorough mastication. When Milo maize meal is fed to calves with skim milk, they make a very rapid gain. In feeding this grain it must be remembered that the best results will be obtained when fed with alfalfa or some feed containing a large amount of protein.

Planting

The same rules governing Kaffir corn will apply to Milo maize.

FLAX

FLAX is grown for seed quite extensively in some of the northwestern states. The greatest amount is produced in Minnesota, North and South Dakota and Montana. In some sections it is grown in a limited way for seed and fiber. Where it is grown for both products and intensive methods are pursued, the crop is very valuable.

Soil

Flax can be grown in any soil or climate where the cereals flourish. The best results, however, are obtained on rich deep loam.

Seed-Bed

Flax requires a deep, thoroughly pulverized and aerated seed-bed. It does not do well on low wet lands nor on heavy slippery clays. It, like the cereals, is improved by careful seed selection and by fertilization.

The seed-bed for flax should be thoroughly pulverized, made compact and as nearly even as possible. The reason for this is to insure a uniform growth and ripening. After the seed-bed has been thoroughly pulverized, it is a good plan to run a corrugated roller over the ground for the purpose of breaking up all surface lumps and making small grooves for the seed. The best implement for sowing seed is a flat tooth weeder with a seeder attachment. Some farmers use a shoe or press drill, running the drill not more than one-half inch in depth. If the ground has been prepared with the corrugated roller before the seed is sown, the flat weeder teeth cover the seed very nicely. It is not advisable to plant the seed too deeply.

Amount to Sow

The usual amount to sow is about one bushel per acre. Some flax growers have received the best results where they have sown but a half bushel. They claim the stalks are larger, have more branches, and the seeds are larger and of a better quality. If sown thick, the stems are straight and slender and the amount of seed is less.

Rotation

Flax should be grown in a five-year rotation, including in the rotation one of the legumes. It should never succeed itself nor be grown on the same land more often than once every five years.

Seed Selection

Unless great care is taken in selecting seed, the flax roots are apt to be afflicted with a wilt, a disease which is poisonous to a succeeding crop of flax.

Professor Bolley of North Dakota Agricultural College, who is an authority on flax, has the following to say regarding it:

"The constantly increasing demand for flax seed for commercial use, year by year, increases the value of the crop as a farm rotation. Flax is not 'hard' on the land. The crop, however, demands an especial care in handling.

"Select a good strain or variety. Select only bright, plump, disease-free seed. Grade to remove chaff, straw and light-weight seeds."

"Do not sow flax on the same land more than once in four or five years.

"All flax seed should be treated before sowing to prevent wilt. Use one pound of formaldehyde to each forty gallons of water, and a half gallon of this solution for each bushel of dry seed. Use a sprayer that throws a fine, misty spray.

"Plow as deep as possible, then pack the soil firmly in any manner that you can, but do not puddle the land while it is wet. Make the seed bed so firm and smooth that the discs of the drill will not cut deeper than one-half to three-quarters of an inch. Use rollers and stone-boats for packing.

"Drill at earliest date possible and yet avoid last real freeze. Late seeding often brings good results, but the crop is liable to be caught by fall rains and frosts. Frost in the spring does less damage than in the fall. Sow from ten to twelve quarts of seed per acre.

"Cut with a binder wherever possible. Thresh as soon as dry or stack when dry. Select your seed from your most mature crop. Home-grown seed is best."

RICE

WE fully appreciate the fact that rice culture belongs to the specialists, and that a full and comprehensive description of all of the many requirements of the plant under a variety of conditions and locations is impossible in this book; hence, we will mention only a few of the many operations for the purpose of discouraging the novice from recklessly plunging into rice growing rather than to instruct the planter who has made it a profession.

Rice culture is carried on in the United States only in the south and is limited to the south Atlantic and Gulf states excepting Arkansas and California, where some is being grown. The production annually amounts to 23,000,000 bushels of rough rice, the amount being a little less than our consumption.

While rice is chiefly grown on lands that are low and easily irrigated, there are varieties which can be grown on fertile uplands without irrigation.

Soils

The best soil for rice is a medium clay loam. In Louisiana where rice is grown more extensively than in any other state, the best yields are produced on a stiff, buckshot clay underlain by a semi-impervious subsoil. Gravelly or sandy soil is not adapted to rice culture unless the light soil is underlain with a firm clay subsoil. Rice is successfully grown on delta lands, inland marshes which can be drained, and on rich level prairie lands which can be irrigated. Upland rice can be grown quite successfully on any soil adapted to wheat or cotton, provided climatic conditions are favorable.

Seed-Bed

While shallow plowing is advocated by some rice growers (they believing it insures a compact seed-bed), it has been demonstrated conclusively that a deep seed-bed made so by plowing deep, gives the best results. Rice roots rarely grow deeper than the plow sole; hence, it is reasonable to suppose that the plant would have more accessible food in a deep bed than in a shallow one. If the ground is too loose, it should be packed before the rice is sown, or if lumps exist, a heavy roller should be used. A roller not only pulverizes lumps, but it packs the soil and assists in conserving moisture.

Drainage

Perfect drainage is very essential to rice culture for the following reasons:

1. Alkali salts are carried away through the drain tile. If these salts are allowed to accumulate, the soil will soon become barren.

2. Drainage at harvest time is very necessary. If the water cannot be removed rapidly when the grain is ripe, much of it is lost, due to the delay in harvesting. If water can not be drained off rapidly, harvesting by hand is necessary, an operation which is very expensive.

3. If the land remains wet after harvesting, water grasses will grow very rapidly, but if the land can be drained thoroughly, a legume of some kind can be planted. Any legume is profitable as a crop and very beneficial to the soil for the reason that it supplies nitrogen and humus, and, in a measure, prevents water grasses and weeds from growing.

Seeding

Great care should be taken to sow seed that is free from red rice, grass and weed seeds. The seed should be uniform in quality and size of kernel, well filled, flinty and free from sun cracks.

Knapp says: "Uniformity of kernel is more essential in rice than in any other cereal because of the polishing process."

The amount of seed to sow varies in different sections, and with different methods of sowing. One to three bushels per acre is the usual amount to sow.

The United States Department of Agriculture says that "rice should always be planted with a drill and not sown broadcast. The seed-bed should be well prepared and a roller should precede in order to crush all lumps and make the seed-bed compact. Horses should not tread the ground after the grain has been sown, for the reason that much of it will be punched into the deep soil, causing an uneven growth and ripening."

Flooding

Rice should not be flooded until it is eight or ten inches high unless more moisture is required to germinate and produce early growth than is furnished by rains. If early irrigation is necessary, it should be only sufficient to moisten the ground. Flooding water should not be permitted to become stagnant, for such water promotes the growth of injurious plants.

Fertility

If the straw and chaff are returned to the land and the irrigating water is from a river, the soil will not become depleted of its fertility. River water usually carries with it large quantities of organic matter containing all of the plant food elements, but pure brook or spring water does not.

Rice, like other crops, requires nitrogen, phosphoric acid and potash. Continued cropping will finally reduce the amount in the soil to the point where the crop will not be profitable; hence, it must be replenished in some way. Legumes as a catch crop will furnish nitrogen, and leaf mould, ashes and yard manures will furnish phosphoric acid and potash. If these substances can not be secured, acid phosphate and kainit should be applied, or the same elements in some other form. In China and Japan, King says, remarkable crops are produced by fertilizing with straw, leaves, leaf and wood mould, sediment from ditches and ponds, and night soils.

Harvesting

The mode of harvesting depends upon conditions. When the water can be drained off rapidly, the binder is used as it is in harvesting grain, but if the water cannot be drained off or the land is soggy, it then becomes necessary to use the hand sickle. After the grain is cut, great care must be taken in shocking to protect the grain from the heat of the sun and storms.

Uses

Rice contains about 88 per cent of nutrients. It is probably more easily digested than any of the cereals. The proportions of protein to carbohydrates is 1 to 10.

By-Products

Rice bran, hulls and polish are rich in protein, fat and carbohydrates. They have a stock-feeding value equal to the by-products of wheat. Rice straw is equal to good prairie hay for stock. It contains 4.7 per cent of crude protein, 32 per cent of carbohydrates and about 2 per cent of fats.

POTATOES

POTATOES are probably more universally used by mankind for food than any product of the soil. Some years, when the yield is unusually large, they command a low price on the market, but the average price for a series of years gives the farmer a greater net return than any other field crop. The yield per acre depends upon the nature of the soil, amount of moisture, the character of the seed and the care given to the growing plant.

Soil

The ideal potato soil is a deep, sandy loam, rich in active humus. If the farmer does not have such a soil, he can attain a fair degree of success on almost any type if he will give the soil the right kind of treatment.

Heavy clay soils are made mellow and friable by adding an abundance of humus, either in the form of barnyard manures, or by plowing under a green crop, preferably cow peas, soy beans, clover or alfalfa. It is always best to plow the ground intended for potatoes in the early fall in order that the organic matter turned under will be thoroughly decayed in the spring. Clay soils are also improved by adding lime.

Sandy soils require humus and lime. Lime tends to improve the mechanical condition by making it more compact and humus furnishes plant food and is of material assistance in maintaining moisture.

Wet lands should be thoroughly drained, first, to carry off surplus water; second, to admit atmospheric oxygen, and, third, to admit warmth.

Soils which are inclined to puddle easily are very undesirable for potatoes on account of their extreme hardness after rains. The tendency to pack, however, can, in a measure, be overcome by the free use of organic matter.

Depth to Plow

The seed-bed should be deep; therefore, it is necessary to plow the ground to a depth of eight or nine inches. If the soil is sandy, it is not necessary to plow so deep, or if the subsoil is gravel, deep plowing is not advisable.

The object of a deep seed-bed is to give the roots an opportunity to easily penetrate below the line where the tubers form, which is usually not more than four inches below the surface. If the seed-bed is only four or five inches deep and the bottom of the furrow is inclined to be hard, the roots, seeking the course of least resistance, will spread outward instead of downward, and in case of drouth, the plant suffers, and if deep cultivation is practiced, the roots are apt to be pruned. If, however, the ground is plowed deep and is subsequently made loose and mellow by discing, the roots take the downward course, and when they reach the bottom of the seed-bed, they have stability to penetrate into the deeper subsoils where they usually secure an abundance of moisture.

If a hard-pan exists which is so compact that water cannot percolate into the deeper subsoils, it is advisable to use the subsoil plow, which simply cuts a gash, admitting air and moisture into the deeper subsoils which tend to mellow the hard-pan. It is not necessary, however, to use the subsoil plow oftener than once in four or five years.

In order to secure the best results, the ground should be thoroughly disced before plowing, in order to secure a compact contact between the bottom of the furrow and the seed-bed, to mix thoroughly throughout the seed-bed any trash that may be on the surface, and to pulverize all lumps.

Depth to Plant

The depth to plant depends upon the character of the seed-bed, the nature of the soil and the probable supply of moisture.

In heavy, wet lands where rains are frequent, the potatoes should not be planted more than three or three and one-half inches in depth, but if the soil is light, it is necessary to plant them deeper. In semi-arid regions, potatoes should be planted deeper than in humid sections. Extensive experiments have demonstrated that potatoes planted four inches deep in average soils with an average rainfall made a yield four and one-half per cent greater than those planted to a less depth, and eight per cent more than those planted in a greater depth. It has been demonstrated, however, that potatoes planted deep gave the best quality and the largest per cent of merchantable potatoes.

Fertilizers

An acre of potatoes consumes from seventy to eighty pounds of nitrogen, from ten to fifteen pounds of phosphorus, and from eighty to one hundred pounds of potassium. The crop also requires from five hundred to five hundred and fifty tons of water. Light, sandy soil requires more water than heavier soils rich in humus. If the plant food elements do not exist in the soil in abundance, they should be furnished in some economical way.

Nitrogen, which is the most expensive, can be furnished by planting some of the legumes, either clover, alfalfa, cow peas, soy beans or vetch. The best yield of potatoes is made on land which has been cropped to clover and the crop turned under the previous fall. Cow peas and soy beans can usually be grown in any section of the country.

Phosphorus can be furnished by applying barnyard manure. Ten tons of barnyard manure applied to an acre places in the ground an abundance of this useful element. The manure also tends to make available phosphorus which may exist in disintegrated particles of rock, the inorganic substance of the soil. It is never advisable, however, to apply barnyard manure to ground the year it is to be planted to potatoes. It should be applied the previous year; otherwise, scabby and diseased potatoes may result.

Potatoes require a large amount of potassium, and if it does not exist in sufficient quantities, it is necessary to apply it in the commercial form. Many potato growers find it very profitable to apply a complete fertilizer containing nitrogen, phosphorus and potassium in such quantities as may be indicated by a chemical analysis of the soil.

Peaty lands are always deficient in potassium; hence, it is useless to attempt to grow potatoes on such land without adding potassium in some form. While it is customary, and good results are gained by applying commercial fertilizers in the hill when the potato is planted, the better plan is, in order to have the entire seed-bed brought to a high state of fertility, to apply a mixture to the entire surface and thoroughly disc it in. It is not advisable to apply the fertilizer directly on the potato. Where the mixture is applied throughout the entire seed-bed, the potatoes are more uniform in size, and the following crop, whatever it may be, will secure the benefit of the fertility not utilized by the potatoes.

Cultivation

The seed-bed should be deep, mellow and free from lumps. It should be thoroughly double-disced before the seed is planted and made compact by using a roller or packer. After the seed is placed in the ground, the land should be harrowed, using a spike-tooth harrow or a flat-tooth weeder until the tops are well out of the ground. Subsequent cultivation should be shallow.

Ridging or hilling potatoes should never be practiced, unless there is danger of water accumulating on the surface; in other words, only where surface drainage is absolutely necessary is hilling desirable. Deep cultivation tends to dry out the seed-bed and to prune roots which is sure to lessen the crop. It is a good plan to surface cultivate often enough to maintain a mulch to prevent the escape of moisture until the ground is thoroughly covered with the tops. A straw mulch or well-rotted manure can be applied between the rows, after one or two cultivations, to good advantage. The mulch not only prevents the escape of moisture, but it enriches the soil and prevents the hills from cracking, thereby exposing potatoes which have grown near the surface.

Seed

Potatoes for seed should be regular in form, medium in size and free from diseases. It is not a good plan to plant small shriveled seed or tubers which are not marketable. While it is conceded that potatoes yield best if slightly sprouted, it has also been demonstrated that if potatoes are well sprouted and the sprouts are removed or destroyed in the act of planting, that the yield is decreased from thirty to fifty per cent. It has also been demonstrated that tubers sprouted in the light grow rapidly and give better results than when sprouted in a dark bin. A better plan is to plant when the sprouts are just starting. If the sprout has become long and is then removed, which of necessity it usually is, a great part of the vitality of the potato is gone, and the second sprouts will be slow and the growth anaemic.

Opinions differ as to how the potato should be cut. In considering this question, the price of seed and the value of the farmer's time should be taken into account. While a potato cut into single eye pieces and each eye planted separately will yield more potatoes than it would had the potato been planted whole, the aggregate weight is not enough greater to pay for the extra labor of cutting and the number of merchantable potatoes is less. The best results have been obtained by cutting a medium-sized potato into two or three pieces and planting one piece in each hill. In cutting, care should be taken to secure two or three good eyes in each piece.

The results given by the Ohio State Experimental Station coincides with hundreds of other experiments which have been made. The Ohio experiments were as follows:

Size of Seed	Bushels Per Acre Planted	Bushels Per Acre Yield	
		Marketable	Unmarketable
One Eye	10.	164.2	25.1
Two Eyes	15	204.3	25.1
Half Potatoes	25.	217.1	35.7
Whole Potatoes	40.	223.	51.8
Small Potatoes	22.6	145.2	48.2

Diseases

Primarily, we should know something of the potato plant. It consists of foliage, stems and underground roots and stems. The roots usually grow deep, if the seed-bed is made right, and secure the moisture and part of the plant food which goes to make up the top as well as the tuber. The foliage secures a part of the plant food from the air. The leaves are the lungs of the plant. These little delicate lungs breathe in the carbon dioxide; hence, it is plain that in order to secure a rapid and healthy growth and to provide the plant both above and below ground with an abundance of the elements from the atmosphere, the leaves should be strong and healthy. If because of any reason they are diseased or infested with insects, or if because the soil does not contain a sufficient amount of nitrogen, the stems and leaves are diminutive and unhealthy, the entire plant suffers as a result; hence, the farmer should guard against this contingency by first furnishing an abundance of nitrogen, and, second, treating the foliage with the right kind of spray. Probably the best material for diseased leaves and tops is Bordeaux mixture, which is made as follows:

Copper Sulphate (Blue Vitriol)	4 pounds
Fresh Lime	5 "
Water	50 Gallons

When this mixture is used thoroughly and as often as conditions demand, the yield is always increased and often doubled.

Scab, rot and other diseases of potatoes are best prevented by soaking the seed for two hours in a solution of formaline, one pound to thirty gallons of water. Place the potatoes in a gunny sack and suspend in the solution. If they are not planted at once, they should be spread out to dry. If left in the sacks or placed in a pile while wet they are apt to heat and lose their germinating power. It is of little use, however, to treat potatoes and then plant them in diseased soil. It is known that germs of potato diseases will remain in the soil five or six years. In this connection it should be known that after a potato is cut, the sooner it is planted, the better. If permitted to lie for a day or two, or even a number of hours, germination will be extremely slow, for the reason that a part of the vitality is wasted through the process of drying.

Planting

Potatoes should not be planted until the soil is warm and all danger of frost is past. If they are placed in cold, damp ground, they are very apt to rot. If the ground is rich in humus and warm, germination takes place rapidly and the initial growth is strong.

Method of Planting

The potato planter gives by far the best results. The depth is uniform and the potato is usually planted in moist soil and immediately covered by the automatic appliance on the planter. If planted in a trench and covered by a plow furrow or with a hoe, the seed is apt to have a top covering of dry dirt.

Harvesting

The potatoes should not be harvested until they are thoroughly matured, and, as a general rule, it is best to leave them in the ground until there is danger of freezing.

The Most Economical and Easiest Method of Harvesting Potatoes

The power potato digger possesses many features which recommend it over the fork, hoe or plow. A good digger can be run to a depth below the tubers, which obviates the danger of cutting the potatoes, and the carrier sifts out tops, dirt and trash and leaves the potatoes laying free and clean upon the surface where they dry rapidly, a matter to be considered in storing.

Storing

Potatoes should be stored in a dark, cool, well-ventilated cellar or vault. The temperature should not be below 33 degrees nor above 37 degrees. The more uniform the temperature, the less is the loss, in what might be termed evaporation or respiration, which amounts in six months to ten or fifteen per cent of the total weight of the tubers.

THE SWEET POTATO

THE sweet potato is a delicious food for man and a very profitable crop for the farmer. If his soil is adapted to sweet potatoes and he complies with the necessary requirements, his net profit from the crop will be far greater than from most other farm crops. The tops or vines are nearly as rich in nutrients as clover, alfalfa or cow peas, making a splendid food for live-stock. If the vines are worked into the seed-bed, it is improved both chemically and mechanically.

In a fair soil 150 bushels per acre is considered a good crop, but in an ideal soil and by pursuing intensive methods, three or four hundred bushels can be raised on an acre. Sweet potatoes usually command a high price, especially in the north. A suitable soil will make from $100 to $200 per acre.

Soil

An ideal sweet potato soil is a light, sandy loam, rich in organic matter, although a medium crop can be raised on any soil containing a fair amount of sand. A very light sand can be made to yield an enormous crop by mixing with the soil leaf mould or muck. Dense clays, heavy black muck or soggy land will not produce good sweet potatoes.

Seed-Bed

The seed-bed should be made deep, be thoroughly pulverized and aerated. To secure a maximum yield, the farmer should select a sandy piece of land, manure thoroughly in the spring, plow shallow and sow to cow peas or soy beans. When the crop is well advanced, plow the growth under, running the plow about nine inches deep. If weeds grow after the ground has been plowed, they should be destroyed by discing or harrowing. The following spring the ground should be disced thoroughly after it is warm and plowed again. If wood ashes can be secured, make an application of 400 or 500 pounds to each acre and disc in thoroughly. If the ashes cannot be secured, apply 250 pounds each of kainit and finely-ground lime rock or hydrated lime to each acre and disc in. Well-rotted manure, leaf mould or muck are all splendid fertilizers.

The ground should now be made into low, wide ridges; that is, the top of the ridges should be eight or ten inches wide. If the soil is inclined to be heavy and cold, splendid results are secured by making a trench eighteen to twenty inches deep and placing in the bottom three or four inches of well-rotted horse manure. The trench should then be filled and rounded up and subsequently rolled with a heavy roller in order to make the soil and manure compact. It should then be ridged and immediately planted. The manure not only enriches the soil, but warms it very perceptibly, an important matter in the northern states, where the nights are cold. The roots are stimulated to make a rapid, deep growth by the artificial warmth produced by the manure. By adopting this method, the plant roots secure the benefit of the plant food in the manure, and the potatoes are not injured by coming in direct contact with the manure.

Planting

The plants should be set out when the ground is warm and all danger of frost ispast. When th e plants are pulled from the hot bed, the roots and as m uch of the stem as was under the ground should be laid in a sappy mi xture of cow and hen manure and leaf mould. Care must be taken not to use too much hen manure in the mixture. The best results are obtained when one part of hen manure, five parts of cow manure and twenty parts of muck of leaf mould are made in a mixture and well moistened. They should be placed in the ground in a dripping condition and the dirt well packed around the root and stem. It is not advisable to set the plants out during the heat of the day. The object in using this rich fertilizer is to secure a rapid early growth, a matter of great importance for the reason that most of the substance of the potato is secured from the atmosphere through the leaves; hence, the more abundant and healthy the leaves are, the greater their absorbing capacity. If the vines are delicate and the leaves are small and sickly the crop will be deficient.

Cultivation

Weeds should not be permitted to grow in sweet potatoes if the best results are to be secured; hence, it is necessary to hoe and cultivate them often enough to keep the weeds down before the vines spread. Sometimes it is a good plan, just as the vines are beginning to run, to cover the ground with a straw mulch. This mulch prevents the escape of moisture, and, in a great measure, lessens the growth of weeds.

Harvesting

Sweet potatoes should not be dug until they are ripe. The farmer can ascertain by breaking one in half or cutting it. After it is broken, or cut, if the potato does not ooze much fluid and remains the same color, it is ripe and ready to dig, but if it turns a yellowish or blackish color, it is still green. While a light frost is not detrimental, if the vines are permitted to freeze, the end of the potato will rot and have a bitter taste.

When the potatoes are ready to dig, an ordinary walking plow should be run an inch or two deep between the rows to gather the vines so that they can be cut off with a sharp hoe. After the tops have been removed, the potatoes can be dug by using a fourteen or sixteen-inch plow, running it so that the hill of potatoes is inverted. The potatoes can now be taken out, the dirt knocked off and placed where they will dry. Great care should be taken not to bruise or cut them. Injured ones should not be placed in storage, for they will not only rot, but spoil others.

Storing

Great difficulty is experienced in keeping sweet potatoes. This is due to the fact that they contain a great deal of moisture. If the ground where the potatoes are grown is thoroughly drained, there is less moisture in the potatoes, the potatoes are harder and of better flavor, and there is less danger of rotting.

Various plans for keeping them are used. Probably the best one is to place the potatoes in a dry, well-ventilated room until they have passed through the sweat and are slightly wilted; then cover them in layers with dry sand. Some have found it practical to wrap each potato in a paper and place them in barrels and store the barrels in a dry room having a uniform temperature.

SUGAR BEETS

THE sugar beet industry has developed in the United States during the past few years until it ranks as one of our principal crops. The production of sugar beets in 1899 was only 81,729 short tons. It increased to 218,406 tons in 1902, 501,682 tons in 1909, and 700,000 tons in 1912, an increase of 100,000 tons over the 1911 crop. The production of 1912 is about one-fifth of the national consumption of sugar.

In view of the fact that sugar beets can be successfully grown in all of the western and northern states and many of the eastern states, the crop will in a few years be equal to our consumption, if the law continues to afford a reasonable protection.

The value of the crop is not alone in the sugar it contains. The by-products which are utilized for stock is an important item. A crop of twelve tons per acre of beet roots, which is about the average production, containing approximately $22\frac{1}{2}$ per cent of dry digestible substance, is accompanied by about 9.6 tons of fresh tops containing 15 per cent of dry digestible substances. This furnishes more than four tons of dry digestible substance per acre. The tops can be fed either green, dry or siloed. The roots in addition to the pulp contain about $12\frac{1}{2}$ per cent of sugar. Even in localities where the sugar content cannot be utilized as sugar, it will pay the farmer to raise a few acres of beets for his live-stock.

Soils and Fertilizers

Sugar beets require a deep, rich, mellow loam. They are especially adapted to alkali soils containing from one-half to one per cent of the alkali salts. They demand an abundance of potash, but not an excessive amount of nitrogen. If too much available nitrogen exists in the soil, the plant is apt to grow to tops and small roots. If the soil is deficient in potash, a high grade of sulphate of potash should be used. If the soil is at all inclined to be sour, it should be thoroughly limed.

Barnyard manure makes an excellent fertilizer, and, in addition to furnishing plant food, it puts the land in splendid physical condition. If manure is applied in a green, rough state, it should be plowed under early in the fall, giving it ample time to rot. Well-rotted manure can be applied in the spring before the ground is plowed.

Seed-Bed

The seed-bed should be mellow, well-ventilated and watered. It should be as deep as the roots will grow. If the soil is compact and not thoroughly pulverized and the bed is shallow, the roots will have a rough irregular surface, be short and stunted, and the effect will be reflected in the composition of the beets.

Beet land should be plowed early in the fall and disced from time to time in order to insure the destruction of weeds. It should again be plowed in the spring after it has been thoroughly disced. It should then be disced and harrowed until it is as mellow as an onion bed before the beets are planted. It has been demonstrated that a well-pulverized, deep seed-bed will make a yield of fifty per cent more than a shallow, poorly-made one.

Irrigation

In sections where irrigation is necessary, every means should be used to store an abundance of water in the deeper subsoils before the beets are planted, thereby avoiding the necessity of frequent subsequent irrigations. If the land is underlain with drain tile and a subsoiler is used to a depth of sixteen or eighteen inches below the bottom of the furrow, in order to increase the amount of stored water, and frequent surface cultivations are made, the beets will not only make a more rapid growth, but will contain a larger percentage of sugar than a crop which is frequently watered. No crop will respond to dry-land farming operations more satisfactorily than beets if care is taken to store an abundance of water during the fall and winter and after the last plowing in the spring.

Drainage

Drainage is beneficial in three ways:

1. The texture of the soil is improved and the temperature is raised.
2. Surplus water in the seed-bed is removed and the soil is thoroughly aerated.
3. Alkali salts, in a measure, are removed.

Thousands of acres of land which at one time were ideal for sugar beets are practically barren today because of the presence of an excessive amount of alkali which could be removed by having a system of underlain drain tile.

Cultivation

Intensive cultivation is very necessary.

1. To remove weeds.
2. To keep the ground mellow.
3. To conserve moisture.

To irrigate frequently and cultivate at long intervals, usually means a very deficient crop. The best results are obtained if the beets are cultivated often enough to maintain a fine surface mulch and sufficient water stored early to mature the crop. In arid regions, however, it is impossible to store enough prior to seeding to make a crop.

After the beet plants are up, they should be blocked out with a sharp hoe and subsequently thinned, leaving one sturdy plant every eight inches.

Rotation

By adopting a system of rotation, the beet crop is not only increased, but every other crop grown on the same land is increased. Experiments on one hundred and fifteen farms demonstrated the benefits to other crops grown in rotation with beets, as is indicated in the following table:

Crops	Average Yield Per Acre			
	Before Beets	After Beets	Increase	
			Actual	Per Cent
Wheat, bushels	28.88	43.07	14.19	49.1
Corn, bushels	41.6	53.1	11.5	27.6
Oats, bushels	40.9	60.6	19.7	48.1
Barley, bushels	38.97	59.14	20.17	52.0
Rye, bushels	---	------	--	39.0
Potatoes, bushels	151.97	222.2	70.25	46.2
Hay, tons	5.7	7.7	2.0	35.0
Beans, bushels	15.66	20.26	4.6	29.5

In planting a rotation, alfalfa or some legume should be included.

COTTON

COTTON is the planter's main crop in the south and corn is the farmer's mainstay in the north. Corn differs from cotton, however, in that it can be grown very successfully in the southern states. Cotton requires a season at least six months long and a temperature ranging from sixty to one-hundred degrees Fahrenheit. It also requires an abundance of moisture during the growing season and fruiting period, and dry weather while the bolls are opening and during the harvesting.

While the season is a material factor in the production of cotton, the production depends largely upon the character of the seed-bed, the amount and proportions of the fertility in the soil, the seed and cultivation.

The Seed-Bed

The seed-bed should be deep, thoroughly pulverized and fairly compact. While the cotton plant requires a great deal of moisture during the growing period, if it exists in the seed-bed or in the upper stratum of the soil to such an extent that the air spaces between the particles of soil are clogged, thereby hindering the free circulation of atmospheric oxygen, the plant, will either perish or be deficient. The water should be stored in the deeper subsoils and should be carried to the cotton roots by capillary attraction. Cotton ground should be drained. Drain tile accomplishes three very important things.

1. They carry off superfluous water.
2. They admit atmospheric oxygen, an element which is necessary to maintain soil micro-organisms.
3. They influence the temperature of the soil.

It has been fully demonstrated that drained ground in the south is several degrees warmer in the spring than undrained ground. This is a matter of great importance to the cotton grower. If he can plant his cotton ten days or two weeks earlier in the spring, he, in a measure. defeats pests and his crop matures before the early frosts. If the ground is thoroughly drained after a heavy rain the surplus water which cannot be stored in the subsoils will be carried away thereby permitting the planter to plant and cultivate his soil, whereas, if he is obliged to wait until the water soaks into the ground and the seed bed dries, the weeds are apt to make him a great deal of additional work. The writer has seen a splendid stand of cotton abandoned because of a two weeks' growth of weeds and grass.

The seed-bed should be deep in order that the plant roots will have an abundance of room. Two often a cotton crop will be deficient, not because of an unfavorable season nor because of a lack of plant food but because the seed-bed is not more than three or four inches deep and a hard-pan exists which prevents the plant roots from penetrating to the deeper subsoils.

Fertility

Cotton requires nitrogen, phosphorus, potassium, lime and some of the minor inorganic elements. It is not enough to have an abundance of any one of the elements mentioned and a deficient amount of another, but all the elements must exist in sufficient quantities so that the plant can secure a full balanced ration. It is ridiculous to presume to prescribe a complete fertilizer which will meet all of the requirements of cotton under all conditions. The planter should either determine by analysis or experiment which, if any, of the elements are deficient and whether or not they exist in the soil and are not available. He should then supply them, either in the form of a complete commercial fertilizer made in the right proportions or such amendments as may be required. If the proper course is pursued, cotton exhausts the soil of its fertility less than any of the staple crops. A 190 pound crop of lint cotton (this being the average per acre in the United States) consumes 40 pounds of nitrogen, 15 pounds of phosphorus, and 24 pounds of potash. If the roots, stems, leaves and bolls are left in the ground and the seed and lint taken away, all but thirteen pounds of nitrogen, $5\frac{1}{2}$ pounds of phosphorus and $5\frac{3}{4}$ pounds of potash are restored to the soil. If the oil is taken from the seed and the meal returned to the soil, the crop which made 190 pounds of lint cotton then takes away the small amount of $1\frac{3}{4}$ poundsof nitrogen, phosphorusand potash combined. It can be seen that if the planter is fair with his land, the fertility can be maintained at an expense of less than 12 cents per acre. If the planter will utilize some of the legumes, he can secure the nitrogen from the atmosphere and use his meal for feed. Or, if he will feed the cotton seed meal to live-stock and place the manure on the ground, he will return to the soil eighty per cent of the nitrogen used in making the crop. Many combinations of fertilizing elements are recommended, and beyond question most of them are beneficial, but in order to secure the best results at the least expense the planter should note the needs of his soil in order that he will not apply some element which is not required.

W. R. Perkins of the Mississippi Agricultural Experiment Station made some very extensive and complete experiments with the various fertilizers. He applied on different plots, kainit, acid phosphate and cotton seed meal alone. On other plots he made various combinations. On still another plot he used barnyard manure alone. The best results by far were obtained from the field fertilized with barnyard manure alone. The next best production was where manure and lime were used and the next where manure and kainit were used. This indicates that manure alone did best and that the amendments were greatly improved by mixing with barnyard manures.

Many planters find it profitable to make a compost using such amounts of potash, phosphorus and nitrogen as they, from investigation, may deem advisable. The Louisiana Station recommends a compost made of two tons of acid phosphate, one hundred bushels of stable manure, one hundred bushels of green cotton seed, applying thirty bushels of the compost to an acre. The planter can always rest assured that barnyard manure not only contains a well-balanced formula of the plant food elements, but that the organic portion of the manure when placed in the ground makes available inorganic elements which were placed there by nature and will remain dormant until the end of time unless stimulated to activity by the application of organic matter.

Rotation

There is no feature of cotton raising more important than rotation. Land becomes cotton sick, it becomes diseased, it harbors cotton pests and becomes weary from producing the same crop year after year.

Rotation gives it new life, improves the texture, relieves the drain and supplies elements from the atmosphere. Probably the best rotation that has been suggested is one used in Louisiana which is as follows:

Three fields are selected. Field No. 1 the first year is planted to cotton. Field No. 2 to corn with cow peas in the corn after the last cultivation and field No. 3 to rust-proof oats with cow peas after the oats are harvested. The second year the cotton field is planted to corn and peas. The corn and cow pea field is planted to oats. In October or early November, the field of oats and peas is planted to cotton. Thus in three years each field has produced one crop of cotton, one crop of corn, one crop of oats and two crops of cow peas. Each plant has taken different quantities of plant food from the soil and the roots of each plant have penetrated to different depths and the cow peas have not only furnished an abundance of humus, but have fixed in the soil a large amount of nitrogen. Where clover can be grown it should be placed in a four years' rotation, for none of the legumes are as beneficial from every standpoint as clover. Alfalfa is a splendid crop to grow in a five years' rotation permitting the alfalfa to stand five years before it is plowed.

Seed

It has been demonstrated in Mississippi, Louisiana and some of the other cotton states that by carefully selecting plump healthy seed which has not deteriorated because of heating or exposure, the crop is very materially increased. One planter made a test of seed which was carefully selected in the field from the earliest maturing and the largest and healthiest stalks, and made an increase of one hundred per cent over seed which was not selected.

Cotton, like corn is true to heredity and will usually produce its own kind, hence this feature should be observed by the planter in order that he may be amply compensated for his labor and investment.

Diseases and Pests

Wilt or black root is a very serious disease affecting cotton in some sections of the cotton district. It made its first appearance in Georgia and seems to be more prevalent in the southern part of the state and other states than north. When the plants are first affected, they turn a pale yellow and in a few days they are dead. Prof. Warsham made a systematic study of the disease. Mr. A. C. Lewis has issued a bulletin giving the results of the Professor's investigations that seems so comprehensive and valuable that we take the liberty to reproduce some of the statements made by him.

"The first outward symtoms of black root is generally a wilting of some of the leaves. Many of the young plants die within a few days after the symptoms of the disease appear, which is usually when they are about six weeks old. Plants will continue to die now and then until frost. Some of the plants attacked may partially recover from the disease, and put out side branches near the ground, but as a rule these branches do not produce much cotton. In the course of time plants killed by the black root disease lose all their leaves, and the small branches drop off leaving only the blackened stem standing. Many plants that are not killed outright by the disease are much stunted in growth and their yield reduced. This phase of the disease is often overlooked by many planters. In several instances nearly whole fields have been found in this stunted condition and the owner was not even aware that the cotton was diseased.

"The internal symptoms of the disease are very characteristic, so that it is not difficult to tell black root from any other disease that cotton is subjected to in Georgia. If the roots and stem of a diseased plant are examined by cutting lengthwise, it will be found that the woody portions are black or much discolored. This is the symptom that has given the disease the name 'black root.'

"The cause of the cotton disease commonly called 'black root' or 'wilt' is a fungus, which attacks the roots and stem of the plants. During the winter the fungus lives on the decaying cotton roots and stems and in the soil mainly in the form of spores. (The spores corresponding to the seeds of the higher plants.) In the spring when the cotton begins to form rootlets and roots these are attacked by the fungus. The fungus penetrates the roots and grows up into the stem following the water ducts and plugging them with its mydelium. This prevents the upward flow of sap from the roots, thus cutting off the food supply and stunting or killing the plants.

"Some seasons the black root disease is worse than in other seasons. This may be due to one or two causes, the weather conditions or the number of nematodes in the soil. Thus it has been observed that the disease is more severe during a wet season than a dry one. Frequently we have received letters from cotton growers stating that in a few days after the last rain, much of their cotton wilted and died. They wanted to know the reason for this, not suspecting before the rain that the cotton was diseased. While it is true that wet weather is favorable and dry weather unfavorable, to the disease, weather conditions such as heat or cold have never been known to exterminate the fungus.

"As the fungus causing the black root disease of cotton only attacks cotton and okra, it follows that planting the land in other crops will slowly starve out the fungus. Thus far though all attempts have failed to completely eradicate the fungus from the soil of infected fields, even with a rotation of ten years. Rotation of crops is important, however, in the control of the black root disease on account of the nematode worms.

"Our experiments and those conducted by Prof. W. A. Orton show that fungicides, such as Bordeaux mixture, copper sulphate, copper carbonate, liver of sulphur, formalin, sulphur, sulphur and lime, are of no value in controlling the black root disease of cotton.

"In variety tests made in 1900 by Prof. W. A. Orton, the Jackson Limbless was found to be the most resistant to the disease of the varieties tested. By continued selection of the most resistant plants from this variety, he has secured a strain of this type of cotton which is very resistant to the black root disease of cotton. This restraint strain he has named the Dillon. The Dixie originated from a selection made by Prof. W. A. Orton, in Alabama, in 1901. In 1905 Prof. Orton kindly furnished us some seed of both of these varieties. Each year in our tests they have proven to be quite resistant to the disease, only ten per cent to fifty per cent dying, where seventy-five per cent to ninety-five per cent of the ordinary varieties died."

Other Diseases

We will not attempt to enter into a discussion of other diseases of cotton, but will simply refer to them.

Anthracnose

A disease known as Anthracnose attacks bolls, stems, and leaves. It appears in the form of a fungus parasite in all stages of the growth of the plant.

Leaf Blight

Leaf blight is a fungus that attacks mainly the older leaves of the plant.

Mildew

This is also a fungus disease that affects the leaves.

Mosaic Disease, or Yellow Blight

is a disease due to the poor condition of the soil and surroundings. If the plant is kept healthy, clean and growing, it is not usually attacked by this disease.

Red Rust

This disease is caused by the red spider. Strong healthy plants are not usually affected.

Remedies

While many remedies are recommended and probably all have some merit, the best remedy suggested by thorough cotton growers is fitting the plant to its environment and adopting a systematic rotation. It is conceded that where planters rotate their crops, keeping their land free from weeds and trash, they eliminate to a great extent, all varieties of diseases. A deep seed-bed thoroughly drained and pulverized, an abundance of organic matter and plant food, good seed and the right cultivation are preventives of diseases, which are far more effective than any of the cures that are recommended.

BOLL WEEVIL

SO much has been written about this pest both from a practical and theoretical standpoint that we will offer but four simple suggestions which if adopted by the planter will be of material benefit in eradicating this insect.

1. Drain the land in order to insure an early rapid growth of the plant.
2. Select strong seed from the best and earliest maturing plants.
3. Keep the land where the cotton is grown and all adjacent strips absolutely clean.
4. Grow cotton in rotation making a legume one of the crops in the rotation.

For a number of years the Bureau of Plant Industry and Entomology of the United States Department of Agriculture have been untiring in their efforts to solve the problem of eradicating this arch enemy of cotton. Their researches are so valuable that we take the liberty of presenting them.

"1. The cotton boll weevil feeds upon nothing but cotton.

"2. It goes into winter quarters mainly in or near the field of its depredations.

"3. Comparatively few weevils survive the winter and emerge in the spring.

"4. The overwintered weevil feeds upon the terminal buds of the young cotton plants until the forms or squares develop, then the female deposits her eggs in the squares, exclusively at first, but later deposits them also in the immature bolls.

"5. The life of the adult weevil when supplied with food is about 70 days. If deprived of food it lives only 6 or 7 days, except in hibernation.

"6. For a period after emergence from winter quarters the weevil is comparatively sluggish and while feeding upon the cotton plants it may be picked or poisoned.

"7. The weevils remain mainly in the field where they locate in the early spring until they become very numerous. Their principal period of migration is in the fall.

Based upon these life habits of the weevil, the Bureau of Plant Industry has planned its fight for the production of cotton, which may be summarized as follows:

(1) Under boll-weevil infestation the fields selected for cultivation should be well drained, because a successful crop will then depend upon the possibility of cultivating them at the proper time. The low, poorly drained lands should be devoted to other crops. They have always been an uncertain factor in cotton production. It is not the intention to state that well drained alluvial land should not be planted to cotton.

(2) The early destruction of the cotton stalks before frost and the burning of all rubbish in and about the infested fields are imperative.

(3) Break the field deep as early in the fall as possible with an implement that does not bring too much of the subsoil to the surface. Some winter cover crop should be grown if practicable; if not, harrow occasionally during the winter. Before planting, thoroughly pulverize the soil and make the best seed-bed possible.

(4) Care must be taken to secure seed of an early-maturing variety and of the highest vitality, not necessarily a small-boll variety, for on uplands we have been more successful with some large-boll varieties.

(5) Plant reasonably early in rows somewhat wider apart than under non-boll-weevil conditions. Planting should be delayed until all danger from frost is past and the soil is warm enough to produce rapid germination and growth.

(6) The use of the section harrow before planting and after planting, and again just as soon as the plants are well up, is advised.

(7) Use intensive, shallow cultivation of the crop and never lay by the cotton till picking commences. Late cultivation is very important.

(8) In case it is evident that a large number of weevils have been overwintered, it is advisable to hand-pick or poison the early appearing weevils.

(9) As soon as the weevil commences to work, as evidenced by the punctured squares, attach a pole or brush to the handles of the cultivator so as to knock the squares off. Most of them will fall of their own accord in a few days after they are punctured.

(10) Persistently pick up and burn the fallen squares.

"The burning of the stalks is very destructive to the weevils in the field, but its value depends considerably on when and how it is done. It must be done early and before frost. Demonstrations have been made showing that it caused the destruction of as many as 97 per cent of the weevils if done early and properly, but if delayed it might allow as many as 45 per cent to escape.

"There are several methods of destroying the stalks. First, every third or fifth row may be allowed to stand and the rows on each side uprooted and thrown against it. Second, all the stalks may be cut and thrown into piles of convenient size. In either case, some of the adult weevils will collect in the windrows or piles and be destroyed when the stalks are burned.

"The object in destroying the stalks is a twofold one: (1) to deprive the adult weevil of food and breeding places; (2) to kill the vast number of weevil eggs, larvae, and pupae contained in the squares and immature bolls at this time. To make this destruction complete, the stalks should be burned as soon as possible after being cut and piled. As soon as the foliage will burn readily fire should be applied, although the main stem and branches may not yet be dry enough to burn. All rubbish in and about the field should also be burned and the field immediately broken.

"If this single instruction to destroy all cotton stalks in the fall while still green could be carried out by every grower, it would practically solve the weevil problem. The difficulty is that only part of the growers follow the plan. It requires early-maturing cotton and rapid gathering to get the crop out in time to do this work to the best advantage."

TOBACCO

TOBACCO culture is an agricultural specialty. To successfully grow the plant and secure a high-grade product, requires a scientific knowledge of the requirements of the tobacco plant and thoroughly seasoned experience. The best advice we can give to any one who contemplates engaging in the business is to secure all the data available from the state agricultural college or experimental station where he contemplates beginning operations, and then spend one year or more with an experienced grower, not in a library or under a shade tree, but in the field, from the day the seed-bed is being made until the plants are sorted, cured and baled.

We are convinced that the most learned theoretical dissertation which could be produced would fail to remove many stumbling blocks which the novice is sure to encounter, hence our advice to take a preliminary course in the school of experience.

DRY-LAND FARMING

DRY-LAND farming is a name given to tilling the land in sections of the country where the annual rainfall is scant. The principles involve intensive cultivation and proper management with a view of storing water in the deeper subsoils and subsequently preventing needless waste by evaporation.

The principles, however, applied to dry-land farming are applicable to any section of the United States, and when all farmers adopt the same thorough method of tillage that the dry-land farmers are obliged to, if they are at all successful, the increase in production will be far greater than the increase in our population. What is termed dry land will not tolerate careless work or neglect. All operations from the seed-bed to the harvest are interdependent, and the harvest will correspond to the weakest step in the several operations.

An improperly made seed-bed is like a shifting sand foundation for a house. The seed-bed is the foundation for the crop. It must be so made that it will readily receive and absorb rainfalls, be they light or heavy. Primarily it must be deep and mellow. A deep, mellow seed-bed acts as a temporary reservoir to receive and hold water until it precolates into the deeper subsoils. If it is shallow, a rainfall of two or three inches during one shower will not be absorbed, but as soon as the hard-pan is reached the surplus will run away.

A deep seed-bed insures a rapid and strong development of young roots with strength to penetrate deep. A shallow seed-bed means delicate roots which seek the course of least resistance in the loose surface soils. That statement can be verified by any farmer who will take the trouble to make a careful investigation. A deep seed-bed means good ventilation and an abundance of room for plant food. It must be remembered that plant roots first seek water and they will go to it if they have strength, hence the farmer should exert every effort to encourage their early development.

In order to make this subject plain, let us start with a field of ripe grain. The grain shades the ground, and in a measure, prevents the broiling sun from drawing away moisture. Moisture is the elixir of plant life, and every particle possible must be saved. How can this be accomplished? You know that the surface is full of cracks, you know that as soon as the grain is cut, every stalk is an escape chimney. You know that moisture will escape by both cracks and stems. What should be done?

The answer is easy. Stop up the leaks. Follow the binder with a disc harrow. That implement forms a mulch that effectually closes up the little openings, and at the same time works into the soil the stubble. You have accomplished three very important things. First, you have checked the escape of moisture, second the surface is made mellow, an essential condition in the event of rains. Third, you have worked the stubble into the seed-bed so that when the plow turns the furrow slice the trash will not act as an insulation to prevent capillary attraction.

The next step is plowing. The sooner the ground is plowed after harvest the better, provided that the plow is followed with implements calculated to place the soil in a condition to store and conserve moisture. If the ground is plowed and left loose and lumpy, it would be better not to plow it at all until seeding time, unless the plowing is done late in the fall.

The harrow, disc or packer should follow the plow if the plowing is done at any time other than just before winter sets in. If the ground is lumpy and much trash exists, the disc gives the best results. If the soil is well pulverized, harrowing is sufficient. If the ground is loose and lumpy, a subsurface packer should be used. On light soil, a corrugated roller firms the surface, and at the same time leaves the soil in little ridges, a desirable condition to absorb rains.

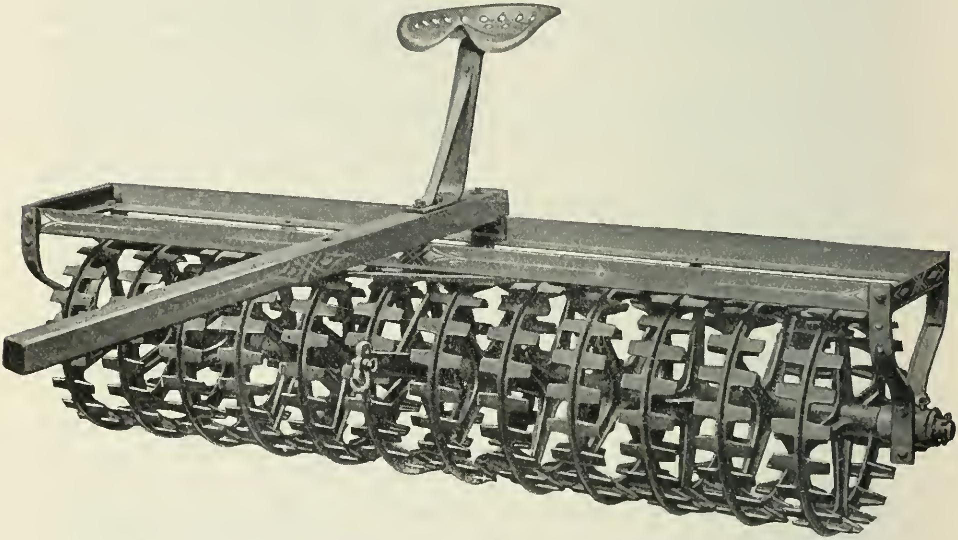
Kind of Implements to Use

In this connection, I desire to emphasize the necessity of using the right kind of implements. It must be remembered that thorough work can be accomplished only by having good, suitable tools, and without them the dry-land farmer will fail. The plow should be a keen cutting steel implement, capable of turning a furrow 8½ or 9 inches. The disc harrow is indispensable both before and after plowing. A double disc is preferable to the single. A disc is, on account of the sharp blades, very searching. It pulverizes and packs the soil uniformly from the surface to the bottom of the furrow.

The subsurface packer is of great value as a pulverizer of both surface and deep clods, packing the soil to a depth of several inches. Often there are lumps or air spaces at or near the bottom of the furrow and unless they are crushed and the air spaces closed up, capillary water will not come from the deeper subsoils to the seed-bed. Again, plants gather food and moisture from the soil particles which are coated with moisture, holding plant food in solution. If lumps exist, the delicate roots are unable to penetrate them, but spread over the surface, securing the benefit of only a small per cent of territory in the seed-bed. The particles of soil are so small that it requires one thousand or more laid side by side to make an inch, hence, if a lump has an area of one inch from which the little roots gather food, the area is increased one thousand fold if the lump is thoroughly pulverized.

Packer

The subsurface packer is indispensable to the dry-land farmer. In fact, it is practically useless to undertake to produce crops in many regions where the rainfall is abnormally low during the growing season, unless the seed-bed is made compact. The wedge-shaped wheels pack



"V" Flexible Pulverizer and Packer .. Indispensable to the Dry-Land Farmer and Beneficial in Most Localities

and pulverize the soil, just as a fork crushes a boiled potato, or the railroad builder's spade packs the dirt under the ties. This implement used on forty acres of wheat land in a normal year will increase the yield in one crop enough to pay for the tool and the cost of labor.

Corrugated Roller

The double gang pulverizer, known as a corrugated roller, packer and clod crusher is valuable for at least three things. First, it pulverizes the surface. The back roll of wheels is so placed that the cutting edge of each wheel mismatch the pulverizing done by the wheels of the front gang. This hit-and-miss arrangement of wheels insures that no clods are missed and the ground is left in little ridges, a very desirable condition to catch and absorb rains. If used after seeding, the soil is made compact around the seed, thereby hastening germination.

Second, in sections where it is not advisable to use the smooth roller on account of the soil drifting or the sub-surface packer because it is not needed, this implement gives remarkable results. If the roller is run at right angles to the prevailing wind, it prevents, in a great measure, the soil from blowing. The hollow spaces between the ridges, which are from one to one and a half inches deep, contain dead air and the current of dead air above holds it in place and supports the edges, on the same principle that water in a little bayou on the border of a swift stream is always still, held as it is in place by the pressure of the stream. This feature alone is of great value in windy sections.

Third, the fluted shape of the wheel so pulverizes the soil that a mulch is formed which prevents rapid evaporation of moisture. The implement is used to good advantage on grain after it is up. The soil is made compact about the roots and the mulch prevents the escape of moisture.

Storing Water

Farm crops require water, and without it they will not grow. It requires 300 pounds of water to make one pound of dry matter, or from 400 to 700 tons to mature an acre of cereals, corn, hay or root crops.

In semi-arid regions where the rainfall is from ten to eighteen inches and the greater portion of that during the winter and early spring, it becomes necessary to store the water in the subsoils to be utilized during the summer or growing season. It is not uncommon to produce a good crop without rain during the entire growing season, if care is giving to storing and conserving moisture.

No fast rules can be laid down regarding the amount of water which can be stored in the soil. The amount depends, 1st on the amount of rainfall, 2d on the physical condition of the soil, 3d on its holding power; 4th on the amount of evaporation due to heat and wind; 5th upon the surface tillage or the vegetable growth.

The irrigating farmer floods his land, thereby furnishing moisture from the surface. The humid-section farmer depends on occasional showers to make his crop, and the dry farmer irrigates from below upwards.

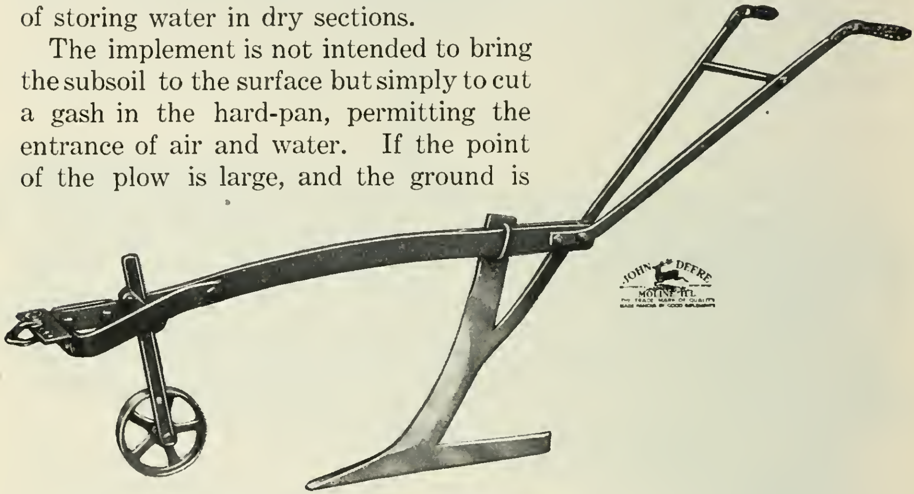
The dry-land farmer who fails to store water in the subsoils is in the same predicament as the irrigating farmer who fails to fill his reservoir. If the supply is inadequate in either case during one season, they must wait until a sufficient amount is provided. The irrigator waits until his reservior is replenished, the other summer-fallows.

Water obeys the law of gravitation. When it strikes the surface it follows the course of least resistance. If the surface is porous the water soaks in rapidly, but if it is hard and impervious, it runs away or is lost by evaporation. If the porous condition is eight or nine inches deep, it will take care of two or three inches of rainfall, but if it is shallow, as soon as the porous stratum is filled, the surplus is lost. Hence, the necessity of at all times maintaining a depth and porous condition of the soil that is conducive to rapid absorption. More failures are due to shallow plowing than any other cause.

Sub-Soiling

The subsoil plow is invaluable if the condition of the soil requires it, and the implement is of the right type. If the subsoil is porous, it is of no special benefit, but if a hard-pan exists, or the ground below the reach of the ordinary plow is so hard that it does not absorb water readily, it is of great assistance in storing water. In fact it practically solves the problem of storing water in dry sections.

The implement is not intended to bring the subsoil to the surface but simply to cut a gash in the hard-pan, permitting the entrance of air and water. If the point of the plow is large, and the ground is



The Taylor Subsoil Plow .. This Implement Solves the Problem of Storing Water and Breaking Up a Hard-Pan

hard, it forms air spaces which prevent capillary attraction, hence, the only safe subsoil plow to use is one with a thin blade and very small point. The point should not be more than an inch in thickness. The small point forms a reservoir for water and from it the water naturally spreads outward and obeying the law of capillary attraction, it moves upward followed by air. Air and water acting in that way mellows the soil, thereby destroying a hard-pan or any extreme compactness of the ground that may exist. The blade or cutter should not exceed one-half inch in thickness. Such a plow can be drawn by two horses, cutting a gash ten or twelve inches below the bottom of the furrow. Engine gangs can be equipped with a subsoil attachment, placing one on each alternate plow. In sections of the country where the weather is cold during the winter months, late plowing, leaving the surface rough is very advantageous because land in that condition catches and holds snow and rains much better than when it is smooth and frozen. During the intervening time, however, between harvesting and late fall, the surface should be kept in a condition to readily receive and retain moisture. In southern latitudes where the ground does not freeze, to leave the surface in a rough state would assist evaporation. The farmer should be governed by conditions and adopt the best possible plan to prevent the loss of water.

Conserving Water

Conserving water is just as essential as storing it. We know the amount of water required to make the crop. We know that it can be stored in the subsoils nearly as well as in a cistern, provided it is not carried off with an under-flow or the subsoil is not a deep sand or gravel, and we know that unless proper means are used, water will escape by evaporation to the extent of one or more inches during a hot, windy day. An acre inch of water weighs 112 tons, or one-fourth of the amount required to make an acre of good wheat; hence, negligence for two or three days may cost the farmer a year of toil.

The amount of evaporation depends upon the type and character of the soil. Shuebler made some extensive experiments with the following results:

Kind of Soil	There evaporated in four hours at 60 deg.F.from 100 pounds of water in the wet earths	Equal weights of the wet earths became nine-tenths dry at 66 deg. F. in	
	Pounds of Water	Hours	Minutes
Quartz Sand	88.4	4	4
Calcareous Sand	75.9	4	44
Clay, containing 60 per cent clay and 40 per cent fine sand	52.0	6	55
Loamy Clay, 76 per cent clay and 24 per cent fine sand	45.7	7	52
Vegetable Mould	20.5	17	33
Garden Loam	24.5	14	49
Loam from a plowed field	32.0	11	15

It will be seen from the above table that a soil containing organic matter such as we find in vegetable mould, garden loams and loams from plowed fields, lose less water by evaporation than sandy soils and clay loams or any soil which is not thoroughly impregnated with humus. It is also true that the best soils for agricultural purposes possess a medium absorbative power. A good grain soil has a water-holding capacity of between 40 and 70 per cent.

Limestone soils and sandy soils are not desirable for dry-land farming purposes for the reason that they do not retain moisture. It has frequently been demonstrated in light and loamy soils, that the power to hold water is much greater when the soil has been well manured than it was before the manure had been applied.

A very fine sandy soil absorbs water very freely and has a high capillarity, but at the same time it tends to hold water quite forcibly. This is not true of coarse sand, however. Clay soils, on acccount of their density, do not absorb water readily, but by the addition of manure, their permeability is greatly increased, likewise their ability to retain moisture.

Quoting from Widtsoe: "In 1868 Nessler found that during six weeks of an ordinary German summer, a certain soil under cultivation lost 510 grams of water per square foot, while an adjoining compact soil not cultivated lost 1680 grams, a saving due to cultivation of nearly 60 per cent. Wagner's experiments along the same lines resulted in saving more than 60 per cent by cultivation. Johnson, in 1878, confirmed the truth of the principle above mentioned on American soils. Stockbridge found that cultivation diminished evaporation on clay soils 23 per cent and on sandy loam 55 per cent, and on heavy loam 13 per cent. Fortier, working under California conditions, determined that cultivation reduced the evaporation from the soil surface over 55 per cent. At the Utah Station the saving of soil moisture by cultivation was 63 per cent for a clay soil, 34 per cent for a coarse sand and 13 per cent for a clay loam.

The process of conservation is simple. A surface mulch is effective, and if maintained there is little danger of losing cultivated crops, and grain crops are in a great measure protected by it.

The corrugated roller is beneficial to grain by forming a surface mulch, even when the grain is grown to the extent of jointing. It firms the soil about the roots, and at the same time closes effectually surface cracks. If the soil is hard, the harrow is of great benefit. Either plan is very beneficial until the grain has attained a growth sufficient to shade and protect the surface from wind and heat. In cultivated crops the mulch must be renewed as soon as cracks form after rains.

Capillary Attraction

Capillary attraction is nature's process of moving water from the deeper subsoils to the surface. Stored water passes upward from soil particle to soil particle, forming a film around each atom of soil until it is consumed by growing plants, or passes into the air by evaporation. Water will rise from a few inches to several feet, depending upon the character of the soil. Deep-rooting plants, such as the lucernes, will secure moisture from a depth of twelve to eighteen feet. The rapidity of the movement of capillary water depends upon the compact, uniform proximity of the soil particles to each other. In coarse ground, the movement is slow, and in lumpy ground where air spaces exist, it is materially retarded or entirely stopped. Hence, we emphasize the necessity of carefully pulverizing the surface before plowing, the seed-bed after plowing, and subsequently making it compact. It must be remembered that trash not worked into the seed-bed before plowing will form an insulation on the bottom of the furrow that effectually stops the upward movement of capillary water. Too often a crop is lost after the moisture in the seed-bed has been consumed which would have been saved had the contact between the furrow slice and the bottom of the furrow been made compact.

Hygroscopic Moisture

Hygroscopic moisture is the vapor that exists in the air. Surface soils, if they are of good tilth and rich in humus, absorb air and with the air moisture. While the amount is not sufficient to produce crops, it is of material benefit in localities where heavy dews and fogs prevail. Hygroscopic moisture is sufficient to maintain plant life in deserts.

Summer-Fallowing

Summer-fallowing, or summer culture, as it is often called, is another method of storing and conserving moisture. In some localities the annual rainfall is insufficient to grow crops each year; hence, the necessity of cropping the land alternate years. The plan that has been successfully adopted in California, Wyoming, Utah, Western Kansas and Nebraska, is as follows:

As soon as the frost is out of the ground in the spring, land that has been plowed the previous year is disced until the soil is loose and porous enough to absorb any rains that may occur. After rains and as soon as a crust forms, the harrow is used for the purpose of forming a mulch blanket and to destroy weeds. This operation is continued until early fall, when the ground is again plowed, disced, and if lumpy and loose, made compact by using a sub-surface packer. Wheat is then drilled and the surface made compact by using the corrugated roller. To summer-fallow and not cultivate the land is of no benefit, but, on the contrary, a detriment if weeds are permitted to grow, for they not only consume as much water and plant food as a crop, but in the absence of a mulch blanket, moisture escapes.

Widtsoe has the following to say in regard to summer-fallowing:

"King has shown that fallowing the soil one year carried over per square foot in the upper four feet 9.38 pounds of water more than was found in a cropped soil in a parallel experiment, and, moreover, the beneficial effect of this water was felt for a whole succeeding season."

Widtsoe states: "Water storage is manifestly impossible when crops are growing upon the soil. A healthy crop of sage brush, sunflowers or other weeds consumes as much water as a first-class stand of corn, wheat or potatoes. Weeds should be abhorred by the farmer. A weed fallow is a sure forerunner of a crop failure."

Surface Mulch

A surface mulch is beneficial in preventing the escape of moisture, but is not practical on a large scale. Mulches are formed of straw, manure, leaves or any other organic substance. It has been demonstrated that soil under a mulch during the heat of the day is from one to three degrees cooler than bare soil and the amount of evaporation is much less. It is not advisable, however, to place a mulch on ground where hoed crops are planted until after they have been cultivated once or twice. Mulches, in addition to preventing the escape of moisture and keeping the ground cool, hinder the growth of weeds, if the mulch is thick and compact. They are used very extensively by truck gardeners and are especially beneficial to potatoes, but should not be used until after the potatoes have been cultivated at least twice. After a mulch has been placed on the ground, it should not be disturbed for the reason that roots grow very close to the surface owing to the moist condition of the soil under the mulch, and if the mulch is removed, the plant will suffer for lack of moisture.

Fertility

The dry farmer must not lose sight of the necessity of maintaining a high state of fertility. The moisture-absorbing and retaining power of soil depends upon the amount of organic matter it contains and the depth and tilth of the seed-bed. Soil deficient in organic matter will not retain moisture long unless it is a heavy clay. Humus is necessary to hold nitrogen, and it is absolutely essential to maintain soil bacteria. Nitrogen can be maintained by planting alfalfa, cow peas and soy beans. If the soil is deficient in phosphorus, and manure is not available, it should be supplied in commercial form. Humus can be supplied by plowing under green crops, such as peas, buckwheat, rye, vetch, etc. A deep seed-bed is also important, for in such the roots grow deep and are usually very abundant. The fertility in dry land is more lasting than in humid sections for the reason that less is lost by washing away and by leaching.

Rotation

Rotation of crops should not be overlooked. Alfalfa is not only a drouth-resisting legume, but it improves the soil in every way. It furnishes organic matter and nitrogen. It renders the soil porous, and makes available latent plant food. A good rotation for the dry farmer to adopt is wheat, peas, potatoes, running alfalfa six years. Other drouth-resisting crops can be placed in a rotation system. Whether in a semi-arid or humid section, any crop grown on the same land year after year will gradually decrease in production.

Planting

When the climate will permit, it is advisable to sow seed in the fall. It is quite important, however, to secure a good germination and a strong growth before winter; otherwise, the crop will winter-kill. If the kernel simply germinates and freezes, it will die. If it germinates and the growth is stopped on account of the soil being devoid of moisture, it will start again if it receives rain. Instances are on record where a grain has germinated five times, securing at last a fairly good crop.

The farmer should use good judgment in selecting the time to plant. If he can manage to plant just before or just after a rain, the seed will germinate very quickly and the growth will be rapid, for the reason that summer-fallowed land is more fertile—especially in the nitrates, in the early fall than in the spring. It is well known that nitrates disappear to a great extent as soon as the weather becomes cold.

Depth to Plant

In this the farmer must again use good judgment. The depth to which seed may be safely placed depends upon the vitality of the seed, the nature of the soil, and the amount of available water and the physical condition of the soil. We know that the seed must contain a sufficient amount of nutrition within itself to germinate, throwing out holding roots and a stem above ground far enough to breathe in carbon-dioxide before plant food can be taken out of the soil. If the seed is planted too deep, the vitality may be exhausted before the stem reaches air. Again, if planted too shallow and rains do not come or moisture is not drawn from below, germination will not take place. If, however, the seed can be placed in moist soil at a reasonable depth, the germination is so quick and strong, if the seed is exceptionally rich, that there is little danger of the vitality being exhausted before the leaf begins to absorb carbon. It is always a good plan for the farmer to anticipate a loss of a per cent of the seed by sowing a greater quantity than is expected to grow. In sowing grain the drill should be used. Broadcasting has proven to be a failure in dry-land farming.

After the farmer has sown the seed, he will greatly facilitate germination and materially assist capillarity by using the corrugated roller. In sections where high winds prevail, the roller should be run at right angles to the predominating wind.

Seed

The dry-land farmer should select seed and strains that are known to possess great drouth-resisting qualities. He should, as far as possible use seed that was grown in his vicinity, unless he can secure some from about the same latitude in a dry-land section. Great care should be taken in selecting seed that was fully matured and received proper pare from the time it was harvested. Immature seed, or seed heated in a stack or bin makes a slow germination and a weak growth.

It must be remembered that the farmer should use all his ingenuity in storing water, pulverizing, packing the seed-bed, making the contact compact between the bottom of the furrow and the furrow slice and maintaining a mulch, if he expects to secure profitable crops for his labor. The neglect of any one step, be it ever so slight, is generally reflected in the final production.

Drouth-Resisting Crops

Crops are susceptible to discipline. Many varieties can be bred to meet climatic conditions and environments. Seed grown in a humid country will be a failure in a dry-land section. The best results are obtained from seed grown for a series of years in the immediate locality where it is to be planted.

While no specific varieties for every section where dry-land farming is practiced can be recommended, our best authorities, based upon their experiments, suggest the following. The writer regards Dr. John A. Widtsoe, Professor of the Agricultural College of Utah, as being one of our best authorities upon this subject. While he mentions several varieties of spring wheat, he states that in order to have a reasonable assurance of a crop, the seed must become thoroughly acclimated. Of the winter wheats, the Crimean group is recommended. The most drouth resisting being Turkey, Kharkow and Crimean. These wheats originated in Russia and were brought to this country many years ago. A winter variety of oats known as the Bosswell, a black variety, is highly recommended. Oats, like wheat, must be acclimated. Of barleys, the six-rowed variety is suggested. A winter variety known as the Tennessee Winter is giving splendid results. Rye is regarded as one of the best drouth-resisting plants for the dry farmer. Emmer, an ancient wheat, probably after becoming thoroughly acclimated, is more drouth-resisting than any of the grains mentioned. A variety of corn which was brought to Mexico, does very well in semi-arid regions. The stalk is short and the ear small and is located near the ground. Sorghums are very drouth-resisting. The best varieties are broom corns, sweet sorghums, Kaffirs and Durras. The broom corns are raised only for their brush. The most desirable Kaffirs to raise include red and white Kaffirs, Black-hulled White and White Milo. The Durras are grown almost exclusively for seed and include Jerusalem corn, Brown Durra and Milo. Widtsoe states that Milo is one of the most important dry-farm crops. Lucernes are being very successfully grown in dry-land sections. Cow peas and soy beans are successfully raised after being acclimated.

In Conclusion

the writer desires to impress upon the dry-land farmer or the prospective dry-land farmer several essential points.

First, he must make a deep seed-bed. This can only be accomplished by plowing deep. He should use a subsoil plow, an implement helpful in storing water. If land cannot be plowed deep on account of a gravel or sandy subsoil, it is labor lost to attempt to farm it.

Second discing before plowing in order to insure a compact contact between the bottom of the furrow and the furrow slice is also necessary. If this feature is not observed, stored water is of no avail.

Third, discing after plowing and packing, is another feature that cannot be overlooked.

Fourth, if the rainfall during one season is insufficient to make a crop, summer-fallowing and summer cultivation is necessary, for crops cannot be grown without water.

Fifth, the corrugated roller, as a mulch maker and packer, is invaluable. The maintenance of a surface mulch is one of the prime features in conserving moisture.

Sixth, a goodly supply of humus must at all times be provided; otherwise, there will be a deficiency of nitrogen.

Seventh, to plant other than healthy, plump, acclimated seed usually spells failure.

ALFALFA

ALFALFA really needs no introduction to the American farmer. It has become famous from the far west to the extreme east and from the northern boundary to the Gulf of Mexico.

No other crop grown on the farm possesses as many splendid qualities as alfalfa. There are sections in the United States where the climate and soil do not seem suited to the plant, but with the great advancement that has been made during the past year in introducing and cultivating different strains, it seems possible that it will soon become a universal stock feed.

Often failures are due to the farmer not complying with all of the requirements which are essential. This is due largely to a lack of knowledge of the needs of the plant. The eastern farmer who has never raised alfalfa is apt to be governed by statements made by the western alfalfa grower. In Nebraska, Kansas, Colorado, Idaho, California and other states, alfalfa needs little attention. The soil possesses all of the requirements and the climate is ideal, and if the eastern, northern and southern farmers follow directions which are simply to

Alfalfa .. Third Cutting on a Deere Modern Method Farm in Western Illinois plow, harrow and sow, not knowing that all lands do not possess the essential qualities, they will meet with disappointment.

Requirements

Alfalfa requires a deep rich thoroughly pulverized seed-bed. If the ground water is too near the surface, that is, within five or six feet, the roots will rot as soon as they enter the water. If the ground is surcharged with water, alfalfa will not thrive for the reason that the bacteria, known as nitrogen gatherers, demand atmospheric oxygen. If the air spaces between the particles of soil are clogged with water, the air is necessarily driven out and the bacteria will perish; hence in such soils the land should be drained and the deeper the better. It is practically useless to attempt to raise alfalfa on the flat lowlands of the corn belt unless they are thoroughly drained.

Alfalfa Requires a Sweet Soil

Soil on account of continued cropping or because of a large accumulation of organic matter becomes sour. This condition can be remedied by the application of lime.

Inoculation Sometimes Necessary

It is often necessary that the soil be inoculated with a bacteria peculiar to alfalfa, and without that inoculation the plant will not thrive. These bacteria have the power to take nitrogen out of the atmosphere and fix it in all parts of the plant. All soils west of the Missouri River evidently contain these bacteria, but most of the soils east of the river are devoid of the micro-organisms and in order to raise the alfalfa successfully the ground should be inoculated.

Qualities of Alfalfa

Alfalfa possesses many valuable qualities.

1. In fertile soils it makes a rank rapid growth, producing from two to six crops annually, depending upon the length of the season. It is not uncommon to secure from five to six tons per acre where the season will permit.

2. Alfalfa has the power to take nitrogen from the atmosphere and fix it in the soil. Nitrogen being absolutely necessary to plant growth and being expensive in the commercial form, this valuable plant has proven a great boon to farmers, in that nitrogen can be secured and made available without cost.

3. Alfalfa as a feed is extremely rich in nitrogen, an element necessary to promote a rapid growth of animals. When mixed with carbohydrates in the right proportion, its value as a feed is greatly increased. As a pasture for hogs and dairy cows it has no equal.

4. Alfalfa has a splendid effect upon the physical condition of the soil. This is due to its large, abundant and extensive roots. The roots grow to a depth of from five to sixteen feet if they are not hindered by standing water. They improve the physical condition by loosening the soil, thereby admitting water and air. They improve the chemical condition by the formation of humus resulting from the decaying of the roots. The humus thus formed, together with the air and water combines with other elements in the deeper subsoils rendering them soluble. Such compounds are then carried to the seed-bed by capillary attraction. This accounts for the increased yield which the farmer is sure to secure from any crop planted where alfalfa has been grown.

When to Sow

Young alfalfa will not tolerate weeds, hence the seed-bed should be prepared and thoroughly cultivated until all weeds are thoroughly destroyed before the alfalfa is sown. If it is sown in the spring, the ground should be plowed early in the fall and disced or cultivated from time to time until winter, and again disced and cultivated in the spring, insuring the destruction of all weeds and grass. If the winters are not too severe, a good stand can be secured by sowing the latter part of August. The ground should be plowed in the spring and cultivated at intervals during the summer. The summer cultivation serves a double purpose, namely, water is conserved and weeds are killed. It is a good plan the first year to leave the last cutting on the ground as a protection against freezing.

Amount of Seed to Sow

The amount of seed to sow per acre ranges from ten to twenty pounds. If drilled it does not require as much as when sown broadcast. The seed-bed should be made extremely mellow and after the seeds are sown they should be immediately covered by harrowing very lightly and subsequently by running over the ground with the corrugated roller. If the sun is extremely hot and the seeds are not covered, their vitality is greatly weakened. Alfalfa does not do well if covered too deeply.

Bacteria

When the ground is not inoculated naturally, the bacteria must be provided, otherwise the plant will not thrive. This can be done by sowing on the ground, after it is thoroughly prepared, soil from an old alfalfa field or soil where wild sweet clover has grown. The wild sweet clover (melilotus alba) grows in most sections of the country along the fences and the roots are usually covered with nodules containing bacteria. These bacteria are identical with those found on alfalfa roots. It is not a bad plan in securing soil from the wild sweet clover beds, to dig up with the soil the roots, place them in the manure spreader and spread as evenly as possible. Dirt containing bacteria should be sown either early in the morning, late at night or during cloudy weather, for the reason, that a hot sun seems to destroy the life of the micro-organisms. The German-American Nitragin Company of Milwaukee, Wisconsin, is recommending a preparation which is claimed to inoculate the seed. This fall the writer planted twelve acres inoculated with this preparation. A splendid stand was made, but the final results will not be known until next summer.

Instances are reported east of the Missouri river where artificial inoculation has not been resorted to, and the following year nodules were found on the roots of the plants. This can be accounted for only by presuming that the seed planted had in some way become inoculated.

Cultivation

Alfalfa should be cultivated, first to remove weeds that may be growing between the plants, second to loosen the compact soil about the roots, and third to break up crowns, thereby thickening the stand.

The Alfalfa Cultivator .. This Implement Breaks Up the Crowns, Stimulates the Growth of Plants, Removes Weeds and Thickens the Growth

The farmer need have no fear of destroying his crop by cultivating too much. If he will use the alfalfa cultivator, tearing up the crowns and roots until it has the appearance of a plowed field, he will do no harm, but on the contrary will increase the stand very materially.

It is safe to say that ninety-eight per cent of all the failures to raise alfalfa is due to neglecting some of the essential features we have mentioned, namely, the lack of lime, a poor seed-bed, failing to inoculate the soil, or because of sowing at the wrong time. If all of the requirements are religiously complied with, there will be few failures recorded.

The digestible nutrients and fertilizing constituents in alfalfa are as follows:

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
	Crude Protein	Carbo-Hydrates	Fat	Nitrogen	Phosphoric Acid	Potash
93.6	11.7	40.9	1.0	26.1	6.1	17.9

CLOVER

THE production of clover and the utilization of barnyard manure, is and has been the foundation of agriculture since man first began to intelligently till the soil. Clover and manures made the fields of ancient countries fertile before the Christian Era, and to their use the richness of farms in our eastern and central states, is due. In western states, where alfalfa is grown, clover is not made a feature, and in other sections where the plant is not being successfully raised, other legumes such as cow peas, soy beans and vetch take its place.

The value of clover, like other legumes, is because it possesses the power to absorb nitrogen from the air and make it available, not only as a plant food in the soil, but in its own substance which is used for stock feed. Were it not for legumes, the nitrogen content of our soils would soon become exhausted. We must not lose sight, however, of the necessity of an abundance of live humus in the soil, which can be maintained by applying barnyard manure, for organic matter is the substance which holds the nitrogen in the soil until it has been utilized by the growing plant. In fact clover will not grow in soil devoid of humus.

During recent years many complaints have been made that it is very difficult to secure a stand of clover. It is said, the soil is clover sick, that it has exhausted the soil of some of the inorganic plant food elements, that the winters are too severe, etc. Undoubtedly there is some merit in all of the reasons given, but regardless of the many failures, clover can be grown as successfully today as when our soils were new, if the essential requirements of the plant are provided.

Requirements—Soil

Clover does not do well on light, sandy or gravel soil, nor on thin clay soil. The best results are obtained in deep heavy clay or sandy loams where the water line is not too near the surface. If the soil contains too much clay, the plant will die in the early spring when the ground thaws and freezes, causing a heaving which tends to break the tap root and other deep roots.

Seed-Bed

The seed-bed should be deep, mellow and free of lumps.

Roots

Clover roots grow deep, hence during their early life the little delicate roots should have a deep mellow home which will permit them to penetrate early into the deeper subsoils. If the subsoil is extremely compact or a hard-pan exists, it is advisable to use a subsoil plow.

Clover roots, or in other words the nitrogen-gathering bacteria which are attached to the roots, require atmospheric oxygen, hence the soil should be drained in order to admit air. Again, clover will absolutely fail if there is any considerable proportion of free acid in the soil, or, in other words, if the soil is sour. A large per cent of the failures to grow clover in old soils is undoubtedly due to acidity and a lack of drainage.

Acid Test

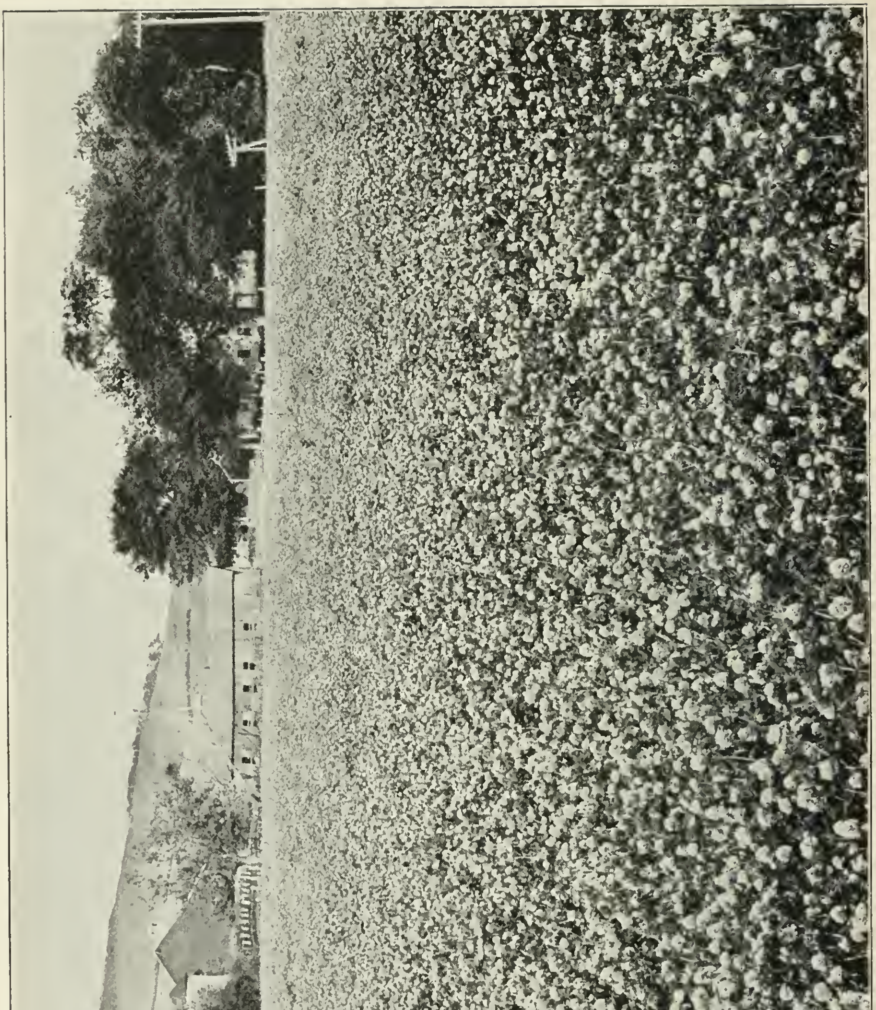
The farmer can determine whether or not his soil is acid by making the litmus paper test, or a better plan is to select two plots about twenty feet square adjoining. To one plot apply twenty-five or thirty pounds of air-slaked or hydrated lime and disc in deep. Then apply manure or any fertilizer to both plots and plant to ordinary table beets. If lime is required the plot which has been limed will produce the largest crop.

Lime Needed

It is safe to say that most of our lands in the corn belt need lime to successfully grow clover. While the amount required varies, one or two tons per acre of the raw limestone finely ground will not be too much.

Bacteria

Clover will not thrive if sown on ground which is not inoculated with a bacteria peculiar to clover. Years ago it was thought that all of the eastern and central lands were naturally inoculated, but recently it has been determined that it is necessary to reinoculate in some localities in order to secure a stand.



A Fine Stand of Red Clover

Fertilizers

Clover requires a rich soil, in other words the soil must contain a sufficient amount of organic matter carrying nitrogen to give the roots a start until they have attained a sufficient size to absorb nitrogen from the air to supply its needs. It is a mistake to think that clover can be started successfully in soil not containing nitrogen and organic matter. Clover also requires phosphoric acid and potash. Most soils contain large quantities of potash which can easily be made available by applying a little lime. Phosphoric acid can be supplied by using barnyard manure. If manure cannot be secured, it will then be necessary to supply acid phosphate or raw rock phosphate. If the raw rock phosphate is used it must be either plowed under with a heavy green crop or in a manure compost, otherwise it will be of no benefit.

Winter-Killing

Top dressing clover with barnyard manure or straw is a safeguard against winter-killing. The manure should be evenly applied with a manure spreader. If spread with a hand fork, unless great care is taken, many places will not be covered and others will receive too much, which, if not removed early in the spring, will cause the plants to die from smothering. The dressing not only protects the plant, but furnishes a rich mulch which is beneficial in many ways. Straw does nearly as well as manure. If, however, a great amount is put on, it may be necessary to run a rake over in the spring for the purpose of removing the larger bunches which, like manure, might, if very compact injure the growing plants.

Seeding

The time to seed depends upon the locality. In the clover states it is customary to sow in the spring with a nurse crop. Winter wheat and other grains sown in the fall should be seeded early in the spring. Sometimes it is advisable to run over the field with a peg tooth harrow with the teeth set slanting before the clover is sown. If the ground is not too wet, a corrugated roller following the seeding, not only packs the dirt around the roots of the grain, but covers the clover or presses it into the soil where it germinates quickly. As a rule it is not advisable to sow clover on spring plowing because of its extreme looseness. It can be done safely, however, if the ground is made compact and rolled with a heavy roller after the seed has been sown. The writer has secured a splendid catch by using the roller on the grain after it was sown, then distributing the clover seed and subsequently harrowing it very lightly.

On lands that are somewhat depleted, or in other words, do not contain a sufficient amount of active fertility to support both a grain and clover crop, a good stand can be secured by sowing clover alone. The ground should be plowed deep during the fall and the seed sown as early as possible in the spring. Unless the early summer is very dry a good crop can be secured the first season.

Clover seed should be planted if possible in moist soil from one-half to an inch deep.

Varieties

The most common varieties are Red Clover, Crimson Clover, Mammoth and Alsike.

Common Red Clover

has been a favorite for many generations. Because of its extensive root system, it furnishes a large amount of humus and nitrogen in addition to greatly improving the physical condition of the soil. The roots loosen compact earth making it more permeable and very easy to till.

After clover has been grown on land, water and air are more freely admitted and the roots of other crops penetrate deeper. If conditions are favorable, red clover produces two good crops in a season and in some localities three. The second crop is usually cut for seed. If the farmer will use a header in harvesting clover for seed, he can then plow under all of the plant food elements consumed in making the plant except a very small per cent in the heads. If the clover hulls are spread on land, they not only fertilize the soil but inoculate it with the required bacteria. Quite often it has been found that one field on a farm will contain the required bacteria, while another field is barren.

Amount of Seed to Sow

It requires about fifteen pounds of seed to sow one acre broadcast. If drilled a less amount is sufficient. It is a good plan to test the seed before it is sown. If a hundred grains are taken indiscriminately and tested, by knowing the number which germinates, it can be easily determined whether or not the amount as stated should be increased or decreased.

Mammoth Clover

This variety resembles red clover, except it is coarser and yields heavier. It is better adapted to wet lands than the red variety. The Mammoth blossoms later than the red, hence it is better to mix with timothy and other grasses than varieties which blossom earlier. On account of the heavy growth it makes, the second crop is often used for green manuring. If the second crop is very heavy and the land is deficient in phosphorus, the soil will be greatly improved by distributing four or five hundred pounds of raw rock phosphate per acre before the crop is plowed under. The process of decomposition which takes place causes a small per cent of the phosphorus in the raw rock to become available the following year.

Crimson Clover

Crimson clover is becoming a favorite in some of the eastern and southern states. While it is regarded as a cool weather plant, it will hardly stand the cold winters of the north. It is often planted as a catch crop after grains, but like other clovers, it requires a good seed-bed, plenty of humus and plant food, especially phosphoric acid and potash. This variety excels all others for grazing purposes for the reason that it remains green very late in the fall and starts to grow in the spring very early. It makes a splendid fertilizing crop if sown between the rows of corn after the last cultivation.

Alsike

This variety is more hardy than any of the others mentioned. It rarely winter-kills even in the extreme north. Alsike does not stand up well, but is inclined to creep, hence it is better to plant with some other plant that does stand up well such as timothy or some of the grains. It does much better on low wet lands than other varieties but not so well on uplands. Alsike seeds are about one-half the size of the other varieties, hence it requires only about ten pounds to sow an acre.

Burr Clover

Burr clover is grown in the south very extensively as a fertilizer and soil improver. It is said to be superior to any of the legumes as a nitrogen-fixing plant. The burr-like seeds carry with them the bacteria for the inoculation of the soil and it is believed that the bacteria are identical with those belonging to alfalfa. This variety does not do well in the north. In a medium latitude, however, it can be sown on land intended for alfalfa and is very beneficial on account of its ability to inoculate the soil.

Lespedeza

Lespedeza or Japanese clover is a legume which was introduced into the United States from Asia a few years before the Civil War. It is not a northern clover, but is grown very successfully south of an imaginary line from New Jersey to southern Kansas.

Lespedeza is a summer annual, requiring from early in the spring until September to mature. As a dry stock feed, it is equal to alfalfa and for a pasture, when mixed with Bermuda grass or red top, it has no superior. As a hog pasture it is more enduring and more nutritious than either the cow pea or vetch. When mixed with other grasses for either pasture or hay, it necessarily dies in winter but seeds itself, coming up early in the spring.

It is customary for the farmers in the south in cutting Lespedeza for hay to leave now and then a small strip for the purpose of securing seed. The seed being light, it blows over the ground thereby furnishing a sufficient amount of seed to make the crop the following year. If the hay is fed to stock, there is usually enough seed in the manure to re-seed a new field if the manure is scattered on the ground.

Rotation

A good rotation is cotton, corn, oats and Lespedeza, or corn, oats and Lespedeza. It has been repeatedly demonstrated that if this legume is grown in any kind of a rotation, or even alternated with any crop that it very materially increases the crop following Lespedeza.

Harvesting

If intended for hay it should be cut just as it is coming into blossom. If cut just before the blossoms come, a second crop will mature for seed. When harvesting for seed it should be raked into windrows or made into small cocks as soon as it is cut. If raked when dry, much of the seed will be lost by shelling. It is a good plan to rake or cock when the dew is on. In hauling and handling great care must be taken or a large per cent of the seed will be lost. It is always a good plan to use a tight wagon box in hauling the hay to the thresher.

Following is the digestible nutrients and fertilizing constituents of cured clovers.

	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
		Crude Protein	Carbo-hy-drates	Fat	Nitro-gen	Phos-phoric Acid	Potash
Red Clover	84.7	7.1	37.8	1.8	19.7	5.5	18.7
Mammoth	78.8	6.2	34.7	2.1	17.1	5.2	11.6
Crimson	90.4	10.5	34.9	1.2	24.3	4.0	13.1
Alsike	90.3	8.4	39.7	1.1	20.5	5.0	13.9
Burr Clover	91.0	8.2	39.0	2.1	21.8	---	----
Lespedeza	89.0	9.1	37.7	1.4	22.1	--	----

COW PEAS

THE cow pea is a legume which can be grown in any soil or in any location where corn can be produced. If the season is short and the growth is rank, the berry will not mature. In nutrients it is almost equal to alfalfa, but is not relished by stock as well on account of the stems being more woody, until a taste has been acquired.

Cow peas are very beneficial in any rotation, always increasing the following crop. Like clover and alfalfa, it improves the soil both chemically and physically. The plant gathers nitrogen from the air, the roots grow deep and are abundant, and when the crop or any part of it is plowed under, it always adds greatly to the organic content of the soil.

Uses

The cow pea is splendid for soiling and silage. It should not be placed in the silo alone, but with corn. If the farmer exercises great care and has a knowledge of the nutritive value of peas and corn, he can make a splendid balanced ration as he fills his silo. A good plan is to drill the peas a few inches from the hill after the last cultivation of corn. The vines will cling to the stalks and can be harvested with the corn when the silo is being filled. Cow peas also make an excellent pasture for hogs. Their value is increased if sown with rape or oats.

When to Plant

They can be planted as a catch crop after grain and used for late pasturing or plowed under. Or they can be planted in the spring about the time corn is planted if intended for hay or seed. They should not, however, be planted until after the ground is at least above forty-five degrees Fahrenheit, for the reason that they will rot in cold damp ground. They can be sown broadcast or drilled. If intended for seed it is advisable to drill far enough apart to permit of cultivation. They germinate very rapidly in a warm, moist, mellow soil and in rich ground make a remarkable growth.

Amount to Sow

When sown broadcast one and one-half bushels is sufficient, but if drilled one bushel will make a splendid stand.

Varieties

The Whippoorwill is probably the best variety to plant in the northern states. The growth is rank and rapid. They should, however, be planted with corn or sorghum if intended for pasture. Mount Olive, Warrens, Hybrid, New Era, Black Eye and Hammond's Black are all good varieties.

Cow Peas on the Deere Modern Method Farm, Moline, Illinois

Following is the digestible nutrients and fertilizing constituents of the cow pea.

	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
		Crude Protein	Carbo-Hy-drates	Fat	Nitro-gen	Phos-phoric Acid	Potash
Cow Peas	85.4	16.8	54.9	1.1	----	---	----
Cow Pea Hay	89.5	5.8	39.3	1.3	14.3	5.2	14.7

SOY BEANS

THIS legume can be successfully grown in a northern climate as well as in the south. Where the season is short the bean will not mature. Unlike the cow pea, it has no vine but one strong stem with many branches. Like the pea, it is a nitrogen gatherer. Hence its great value as a green manure to build up depleted land.

The soy bean makes a splendid pasture for pigs and calves. Pigs given one-fourth ration of corn and a soy bean pasture, will make a remarkable growth. One peck per acre of oats sown with the beans is very desirable.

On account of the woody stem, it is not as desirable as alfalfa for hay, but if cut when the pods are half grown, it makes a splendid soiling crop. If used for silage, it should be placed in the silo with corn, alternating the layers and using one ton of bean forage to seven tons of corn.

Land that will grow corn is adapted for beans. Like corn, the richer the land the larger will be the crop. They should be planted about the same time as corn, but not in hills. The best plan is to sow broadcast with a seeder, or drill with an ordinary grain drill.

The depth to plant varies according to conditions. In a heavy wet soil shallow planting is best, but in a light dry soil three or four inches is not too deep. One and one-half bushels will plant an acre if broadcasted or drilled, but if planted for the seed in hills, or drilled four or five inches apart, three pecks is sufficient. If planted early in cold wet ground, the seed will rot.

Varieties

There are several varieties, but the Mammoth Yellow is the most desirable for northern sections. The Early Yellow, Buckshot, Guelph, called the medium green, Butterball, Kingston and Ogema do well in most sections of the United States.

Soy Beans Growing in a Corn Field on a Deere Modern Method Farm, Moline, Illinois .. Soy Beans Make an Excellent Pasture and a Splendid Fertilizer

Following is the digestible nutrients and fertilizing constituents of the soy bean.

	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
		Crude Protein	Carbo-hy-drates	Fat	Nitro-gen	Phos-phoric Acid	Potash
Soy Beans	88.3	29.1	23.3	14.6	53.6	10.4	12.6
Soy Bean Hay	88.2	10.6	40.9	1.2	23.8	----	----

VELVET BEAN

THIS legume is grown only in the extreme southern states. It is a great climber and a great producer of hay. It is very valuable as a stock feed on account of the protein it contains, but it should be fed with corn in order to secure the best results. In open fields it makes an excellent cover crop eradicating effectually troublesome weeds. Like other legumes it is of great importance as a soil improver having the power to gather nitrogen from the air. The larger per cent, however, of nitrogen is contained in the vines, leaves and seeds, hence in order to secure the greatest benefit as a fertilizer the crop should be plowed under. It is estimated that a good crop plowed under furnishes as much nitrogen to the soil as a ton of cotton-seed meal. A ton of beans in the pod contains fifty-four and eight-tenths pounds of nitrogen, thirty-one and eight-tenths pounds of potash and thirteen and eight-tenths pounds of phosphoric acid, having a fertilizing value of ten or eleven dollars. The hulls contain a much higher percentage of phosphoric acid and potash than the berries. In Florida it is reported that the oat crop is increased four-fold when grown in rotation with velvet beans. In Alabama it doubles the sorghum crop. As a forage crop in the south it has four times the value of German millet.

The Time to Plant

depends upon the season and the use to be made of the crop. The beans should be planted ten or fifteen inches apart in the drill and the rows four feet apart or at the rate of about a peck of seed per acre. The better plan, however, is to plant in rows six or eight feet apart, alternating with rows of corn or sorghum, to help support the vines.

At the Alabama Experiment Station a yield of 7,300 pounds of hay per acre was obtained by planting in drills two feet apart while the best yield obtained by broadcasting was 5,360 pounds.

It has been demonstrated in Florida that commercial fertilizers were of no value, or at least they did not make an increase great enough to pay for the fertilizer used. It must be borne in mind that it is necessary to inoculate the ground before the beans are planted. This is done by distributing soil from an old field.

The velvet bean being a highly nitrogenous feed, should not be fed alone, as such feeding has been reported, according to the United States Department of Agriculture, as causing abortion among cattle and hogs, and blind staggers among horses. The hay when fed exclusively to horses is likely to cause kidney trouble, but this danger can be overcome by mixture with an equal amount of crab grass hay or if fed with the proper amount of corn the bad effects are obviated and the great feeding value of the bean is secured.

Following is the digestible nutrients and fertilizing constituents of the velvet bean.

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
	Crude Protein	Carbo-hydrates	Fat	Nitrogen	Phos-phoric Acid	Potash
90.0	9.6	52.5	1.4	22.4	----	----

VETCH

THIS legume, being hardy, can be grown in nearly every section of the United States and in any type of fertile soil. The variety known as the hairy vetch seems to be a favorite. On account of the way it sprawls on the ground when growing, it should be sown with oats, wheat or barley, otherwise it will become so matted that it is difficult to harvest. There are two varieties, i.e., spring and winter. The winter variety is grown only in the southern states. It not only makes an excellent feed for live-stock, but is a splendid soil improver.

The Pennsylvania Agricultural Experiment Station reports that in 1898 six pecks of seed were sown per acre producing July 15th 11,504 pounds of green forage and 2,980 pounds of air-dried substance, and again August 13th 6,500 pounds of green forage and 1,287 pounds of dry substance. The same plot was cut again in June 1899 producing 1,250 pounds of green forage.

Following is the digestible nutrients and fertilizing constituents of vetch.

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
	Crude Protein	Carbo-hydrates	Fat	Nitrogen	Phos-phoric Acid	Potash
88.7	11.9	40.7	1.6	27.2	9.7	24.4

BEGGAR WEED

THIS is another legume grown only in the south. It flourishes well on the poorest land and in rich soil it grows to a height of from six to ten feet and will make five or six tons of excellent hay per acre. It is used for feed and as a soil improver. If grown in rotation with cotton and corn, it is said to double the crops.

Following is the digestible nutrients and fertilizing constituents of the beggar weed.

Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizing Constituents in 1000 Pounds		
	Crude Protein	Carbo-hydrates	Fat	Nitrogen	Phos-phoric Acid	Potash
90.8	6.8	42.8	1.6	18.9	---	----

Warning

It must be remembered that while all of the legumes are splendid feed for stock, either as hay, silage or pasture, the full feeding value cannot be secured unless the required amount of some carbohydrate, preferably Indian corn or Kaffir corn, is added to make a balanced ration. We must not forget that the natural laws governing growth are exacting and we cannot disregard them if we are to secure the best results from feed. The farmer must also keep in mind the fact that legumes will not thrive nor will they fulfill the object for which they were intended, i.e., to gather nitrogen from the atmosphere, unless the soil is inoculated with the bacteria peculiar to the legume. If the soil is not naturally inoculated, the bacteria should be provided.

GRASSES

WE will not attempt to enter into a lengthy discussion of grasses, but simply give some of the most important features to be observed in growing them.

To successfully grow most of the varieties of grasses, five essential features must be observed.

1. Adaptation to soil and climate.
2. Character of the seed-bed.
3. Fertility.
4. Seed.
5. Care.

Adaptation to Soil and Climate

It is just as useless to attempt to grow grasses as it is cereals or any other plants not adapted to the soil and climate to which they were evidently intended. Some grasses are peculiarly adapted to the southern sections and will perish in a northern latitude and vice versa. Some plants demand low ground and a large amount of moisture while others will thrive only in semi-arid sections. The rye and oat grasses grow profusely in drouth stricken regions where timothy would not survive.

Character of the Seed-Bed

Grasses respond to a well made seed-bed and an abundance of fertility as readily as do cereals. Poor seed and neglect result, as a rule, in a deficient crop with these plants as it does with corn, wheat, oats, barley, etc., hence, in growing grasses the farmer must exercise the same good judgment that is required to produce other crops.

Varieties

The grasses which are the most useful to farmers are Timothy, Kentucky Blue Grass, Redtop, Orchard Grass, Brome Grass, Johnson Grass, Western Rye Grass and Bermuda Grass.

Timothy

This grass is a hardy perennial and is cultivated more generally and is more valuable than any of the other varieties for hay.

Soil

It is adapted to a great variety of soils, but yields most abundantly on rich bottom land. It does fairly well on clay if sufficient moisture can be secured, but on high dry sandy soils it is a failure. It responds to manure, especially when top-dressed with a well rotted manure in the fall.

Uses

When mixed with some of the clovers, it makes a splendid balanced ration for cows, sheep and calves. Clear timothy is better for work horses than when mixed with clover and usually brings a higher price on the market.

Seeding

Timothy is usually seeded with winter wheat or rye early in the fall. The earlier it can be sown the less is the danger from winter-killing. When mixed with clover, the timothy should be sown in the fall and the clover early in the spring.

Without a Nurse Crop

To insure a good stand the ground should be plowed in the fall and subsequently cultivated from time to time to insure the destruction of weeds and seeded without a nurse crop.

The seed can be sown the last of July, in August or as late as the first of September. Just before the ground freezes it should have a thin coat of manure, for the purpose of protecting the roots during the winter and furnishing a rich mulch during the coming season. Fifteen pounds of good clean seed is sufficient to sow an acre. If clover is to be sown in the spring with the timothy, eight or ten pounds is enough, and six or seven pounds of clover. It is a mistake not to harrow timothy after it is sown. The seed-bed should be made mellow, free from lumps and the seed sufficiently covered with moist earth to insure rapid germination. After the seed has been sown and lightly harrowed or brushed, it is a good plan to roll with a corrugated roller. The roller not only crushes any surface lumps that may exist, but it packs the soil around the seed.

Kentucky Blue Grass (Often Called June Grass)

This grass grows more generally over the United States than timothy. It stands first as a pasture grass just as timothy ranks first for hay. Blue grass is a hardy perennial. If left undisturbed, it does not die; but on the contrary, thickens and finally drives out all other grasses and weeds. It makes a very desirable sod for yards and a splendid pasture for stock.

Soil

It thrives best on limestone lands, but not well on sandy soils, especially if the season is dry. This is due to the fact that the roots do not grow deep. While it will dry out during a time of drouth, and have the appearance of being dead, it revives very quickly after a rain. It is the earliest green grass in the spring and the latest in the fall.

Seeding

It can be sown with a nurse crop either in the fall or spring or alone at almost any season of the year. The most serious obstacle to overcome in making a good stand is to secure good seed. Twenty-five or thirty pounds will seed an acre if the seed is good, but, as a rule, it will be found that a large per cent of the seed will not germinate.

Redtop

This grass grows very generally over the country.

Soil

While it is best adapted to wet lands, it does very well on a great variety of soils, both in humid sections and in arid countries.

Uses

Redtop is valuable both for hay and pasture. It makes an extremely tough sod and is very lasting.

Orchard Grass

This grass is noted for its drouth-resisting qualities. It starts early in the spring and blooms early.

Uses

It is useful for hay and pasture, but if not eaten closely or as fast as it grows, it is shunned by stock, for it loses its palatability as it becomes older. Unless cut for hay when in blossom, it becomes very woody.

Seeding

It can be sown with a nurse crop either during the fall or spring, or alone. The best results are secured when sown in the spring and cultivated lightly by using a peg tooth harrow. Twenty to thirty pounds is usually sown per acre, if intended for hay. If the object is to secure seed, a less amount should be used.

Brome Grass

This grass is noted for its ability to resist drouth and extreme cold. The plant has a very deep and abundant root system, and requires a fertile soil.

Uses

It is said to be more valuable for pasture than for hay. In nutrients, it equals timothy, but does not command as high a price on the market.

Harvesting

It should be harvested for seed when the heads have assumed a deep, purplish shade. If left until they are brown, much seed will be lost by shelling. It is customary to cut with a binder and handle like grain. If the stubble is left high, the undergrowth can be mowed for hay after the seed crop has been removed.

Seeding

Thirty-five or forty pounds sown with a nurse crop is sufficient to seed an acre. The best results are obtained when sown with oats or barley. The seed should be covered from one-half to one inch in depth.

Johnson Grass

This grass has its virtues and its faults. It is adapted only to a warm climate. It can be cut from two to five times during a season and will yield from one to three tons per acre of good hay at each cutting. It is a splendid soiling crop, but should not be pastured too closely. The stems grow to a length of from three to six feet long under ordinary conditions, but in very rich, moist soil, they attain a much greater length. After the plant is well established, it is almost impossible to eradicate it. In some sections of the south, it is regarded a pest because of its persistent growth and tendency to spread.

Johnson grass seed resembles flax and possesses a very strong vitality. Twenty-five pounds will seed an acre. It can be sown at almost any season of the year.

Rye Grass

Rye grass, or bunch grass, grows vigorously from the middle states into Canada. It stands cold weather better than any of the grasses, and it excels all others in drouth-resisting qualities. It grows wild on the western prairies and resembles rye. It is rich in nutrients both in the green and dry state, whether cut or standing. In the north, it is cultivated very successfully. This grass can be depended upon to grow and make a crop where other varieties fail. About fifteen pounds of seed will seed an acre.

Bermuda Grass

This grass flourishes in tropical and semi-tropical countries. It is a creeping perennial, giving off a root at every joint and a number of leaves also grow at each joint. It is manifestly a grazing grass, but is often cut for hay. It makes a tough, hardy sod, and on account of its long surface roots, it prevents soil from washing. On account of containing a high per cent of protein, it makes a valuable feed. It should be grown with other grasses which contain more carbohydrates in order to supply a balanced ration. Usually when a new crop is started, it is done by transplanting the roots.

Quack Grass

This grass is not classed among the desirables, but, on the contrary, has a very unenviable reputation. It does not seem to know when to quit. When once started, it spreads, and its creeping roots have no respect for other crops, but seem to delight in being monarch of everything in sight.

Quack grass, however, has two redeeming qualities. It makes a very good pasture when the stems are young and tender, and it serves as a splendid soil binder. It will stop hillsides from washing and gulleys from deepening. When it secures a grip on the soil, it holds fast.

The question of most interest to the farmer is not how to grow quack grass, but how to get rid of it. The best plan is to plow it with a broad, sharp-shared plow, having a long, slanting moldboard. It should be plowed when the ground is dry at a depth of not more than three inches. If all the roots are cut off clean and the slice is inverted, during the heat of summer, the hot sun will kill the roots. This is because of a physiological dependence between the roots and the stems. The roots depend upon the tops for their sustenance, and if they are cut off, the roots will perish. If in plowing, however, a few roots are left when the slice is turned, enough nourishment will be carried down and distributed to maintain life in a great series of connecting roots. The writer has talked with farmers who have plowed it under and claimed the plant would not die. This was because all of the roots were not severed. The farmer should see that the plowshare is broader than the furrow slice, and that it is very sharp.

Effect of Grasses on Soil

Grasses protect, renew and build up soil. Grasses do not gather nitrogen from the atmosphere as the legumes do, but nitrogen in the soil is stored up in grass roots and when the roots decay, forming humus, the nitrogen is available for succeeding crops. Other elements are also formed into compounds through the action of roots, to be subsequently used by other plants. The deeper rooting grasses are especially useful in making available such elements as potash and phosphorus that exist in the deeper subsoils. Grass roots also improve the physical condition of the soil by making it more permeable and friable.

We know that soil becomes weary after being tilled for years, and nothing revives its latent energies more effectually than to give it a grass vacation.

Grasses should be treated fairly. They are always improved by occasionally giving them a thin coat of manure. If they are pastured too closely, those having bulbs are liable to be injured and those having very shallow roots are apt to be pulled out.

It is always a good plan to leave, if possible, a fair growth in the fall. Such a growth not only protects the plant during the severe winter, but forms a splendid fertilizing mulch.

MAKING or curing hay is an important step which requires a knowledge of the plant and good management. Too often, after the crop is grown, a large per cent is damaged because of rains, heavy dews, by being exposed for a long time to the heat of the sun or to mismanagement in gathering. Rains and dews are especially detrimental to legumes. After alfalfa or clover has been wet, even slightly, the hay is very much like tea leaves after they have been steeped. Mild rains and heavy dews do not affect timothy and other grasses as much as the legumes. Hay exposed to a broiling sun for a day or more not only loses its appetizing flavor, but many of the leaves, on account of their being dried rapidly, break off and are wasted. A hot sun will dry and crinkle the leaves preventing the escape of moisture from the stems which should take place through the leaves. Moisture thus retained in the stems when placed in the stack or mow, will mould. Hay should be cured and not sun-burned. In order to cure hay, it should not only be subjected to a reasonable amount of heat, but to the action of the air.

The old plan of curing hay was a very good one, but it entailed losses and unnecessary expense. After cutting the hay would lie in the swath until it was dry. It was then raked into windrows and subsequently made into cocks where it would remain until cured. The modern plan and the one which is regarded as best among our most extensive hay makers, is to mow the grass and let it remain until it is thoroughly wilted, but not dry. If the crop is extremely heavy, a tedder should be used for the purpose of stirring it up and airing it thoroughly. Before the leaves are dried, it should be raked into windrows with a side-delivery rake. The side delivery rake is far preferable to the other type. The direct rake does not ventilate the hay, but rather packs it together and leaves it in a compact bunch or solid windrow. The side delivery rake forms a roll or cylinder through which the air circulates freely, thereby curing the hay very rapidly.

It has been fully demonstrated that the stems of hay raked with the side delivery rake, on account of the perfect ventilation it receives in the windrows, contain fifty per cent less moisture after a certain period than hay formed in a windrow with the direct rake. It has also been fully demonstrated that when the hay has been thoroughly aired both with the tedder and with the side delivery rake, it is in better condition to go into the stack or mow than when raked with a direct rake after it is apparently dry in the swath and subsequently placed in the cock for a period of two days.

After the hay has been placed in the cylindrical windrow it is, if the weather is good hay weather, about ready to be placed in the stack.

The Dain Side-Delivey Rake Solves the Problem of Curing Hay Rapidly

It can be gathered up with the loader or with the sweep rake and conveyed to the stacker. Either process reduces losses to a minimum and the work can be accomplished very economically.

Baling Hay

Baling hay and straw is being practiced by the farmers very generally. They find that it not only saves feed, but is more economically handled than in bulk. Baled hay does not require nearly as much room in the barn as when loose and it is more easily handled and fed, and makes less litter. Since straw has become valuable, many farmers are baling it as soon as the threshing is done. They find that they can make a great saving in the material as well as in the handling. In many sections it is safe to bale hay as soon as it is cured in the field. In the western states, where alfalfa is grown very extensively, farmers have learned that by using the side delivery rake, they can cure hay very rapidly on account of the clear drying atmosphere and bale it immediately without danger of moulding. In Kansas, Nebraska, Colorado, and other states where wild hay is grown very extensively, it is safe to bale the second day after it is cut. In humid sections it is not advisable to bale alfalfa and clover or timothy and clover mixed, on account of the danger of there being too much moisture in the stems, until after it is thoroughly cured in the stack. It is not advisable to bale stacked hay until it has passed through the sweat, except native prairie hays.

Capacity of Baler

The amount that can be baled in a day depends entirely upon the size and power of the machine and the availability of the material. When a horse-power machine is used, from eight to twelve tons is considered a fair day's work, but with the motor-power baler from twenty to thirty tons of hay or straw can be baled in a day.

MILLETS

MILLETS are grown very generally throughout the United States. They are adapted to any climate where other farm crops will grow and to a great variety of soils. In rich bottom lands the millet grows to an enormous size.

Varieties

There are a great many varieties, but the most important ones cultivated in the United States are the German or Golden Millet, Golden Wonder, Siberian, Hungarian and Japanese Foxtail.

A Loader Saves Time and Money

Millet can properly be classed as an emergency hay crop. After the farmer is convinced that his hay crop is going to be short, he can sow millet any time before the first of August and secure a large yield unless the weather is extremely dry.

Uses

Millets are used for hay and grain. They make splendid soiling crops, are useful for green manuring, and while young make a very good pasture. They are not regarded especially good for silage for the reason that the stems are apt to become mouldy in the silo. Millet is a carbohydrate like corn, and to secure the full feeding value it should be fed with hay or concentrates containing a large per cent of protein. One hundred pounds of millet grains contain seven and one-tenth pounds of crude protein, forty-eight and five-tenths pounds of carbohydrates, and two and five-tenths pounds of fat. One hundred pounds of hay without the grain contain nine-tenths pounds of crude protein, thirty-four and three tenths pounds of carbohydrates and six-tenths pounds of fat. If the grains are fed to animals other than poultry, they should be ground, for the reason that they are apt to pass through the animal undigested. If millet is fed with corn alone, the gain made is very slight, but if balanced with alfalfa, clover, cotton-seed meal or some other nitrogenous feed, splendid results are obtained.

Hungarian millet is probably the best variety for hay. The stems are more slender and the heads are smaller and the leaves very abundant. The best time to cut for hay is just as the heads are forming. Usually a crop can be cut within sixty or seventy days after the seeds are sown.

Seeding

Millet should be sown on a well made seed-bed and lightly covered with a harrow, sowing from two to three pecks to the acre.

Harvesting

On account of the green stems containing a great deal of moisture, after the hay is begining to wilt, it should be teddered and before it is sun-dried should be placed in a cylindrical windrow with a side-delivery rake in order that it will be air-dried rather than sun-cured.

RAPE

A VARIETY of this plant known as Winter Rape is grown in the southern states both for forage and seed. The spring variety is grown very extensively in the north.

A Dain Stacker at Work

Soil

While rape can be grown on a variety of soils, the best results are obtained from a light rich loam. The seed-bed should be deep, thoroughly pulverized and rich in organic matters.

Time to Sow

Rape can be sown as soon as the danger of freezing is past or after grain has been harvested in July. If sown in the spring it makes an early pasture and if care is taken will last until the middle of August or the first of September. If sown in July it will usually make a splendid fall pasture provided there is sufficient rain. It can be sown broadcast or drilled. If the land is very weedy, it is advisable to drill in rows far enough apart to permit of cultivation. From 4½ to 5 pounds of seed will sow an acre broadcast and from 2 to 3 pounds when drilled. The value of rape is increased by sowing two pecks of oats per acre with it.

Uses

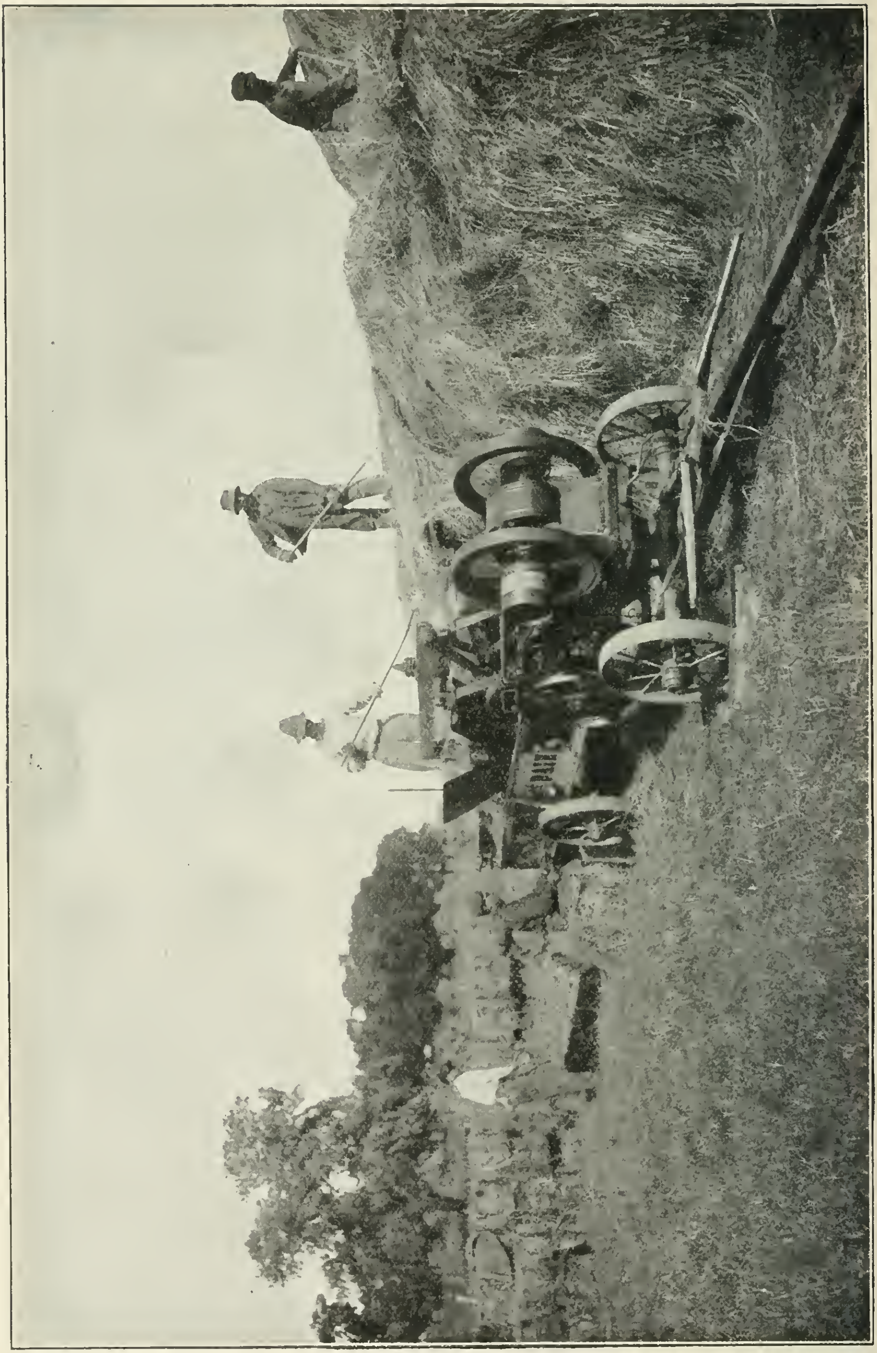
Rape makes a splendid cheap pasture for both hogs and sheep. The animals should not be turned in until it has attained a growth of from twelve to eighteen inches. If not pastured too closely, it will continue to grow until late in the summer. A good plan is to have two rape lots, changing from one to the other every two weeks. Rape is palatable, succulent and rich in nutrients. The ratio of protein to carbohydrates being about one to five. When used for soiling it should be fed before it wilts. It is not advisable to feed it to dairy cows on account of the peculiar flavor it has which is apt to affect the milk. If, however, it is fed just after milking, there is no perceptible odor or taste of the plant in the milk.

Pigs make a remarkable growth on a rape pasture if supplemented with a small amount of corn. Lambs should have a grass pasture in connection with the rape.

The seed is valuable as a food and oil. The oil is used for lubricating and lighting purposes and a meal made from the seed is used as a stock food. A good growth of rape will supply a pasture for from fifteen to twenty hogs per acre for a period of fourteen or fifteen weeks. It is estimated that an acre of good rape has a pasturing value of about $50.00.

SILO

A SILO is a receptacle for the preservation of green fodder. It may be constructed of stone, cement, brick or wood. Silos are usually circular in form, deep, with perpendicular walls with a smooth inside



A Dain Power Baler Baling Thirty Tons of Straw Per Day on a Deere Demonstration Farm surface. On account of the enormous weight of its contents, the structure should be well reinforced, otherwise it is liable to crack and bulge.

A silo preserves green fodder such as corn (both stalk and ear), alfalfa, clover, soy beans, cow peas, or any vegetation for stock-feeding, just as the Mason jar preserves fruit and vegetables for the family.

While many rough stock foods can be preserved, corn is utilized to a greater extent than all other crops. Corn stover and ears in a green state are chopped in small pieces and placed in the silo and made compact by tramping. The tramping, however, is confined to the edges, as the weight of the mass keeps the body well packed. After it is placed, fermentation takes place. The process is carried on by acid bacteria that preserve and fix the food ingredients. After fermentation has taken place, the silage has a slightly tart taste and is extremely succulent and appetizing.

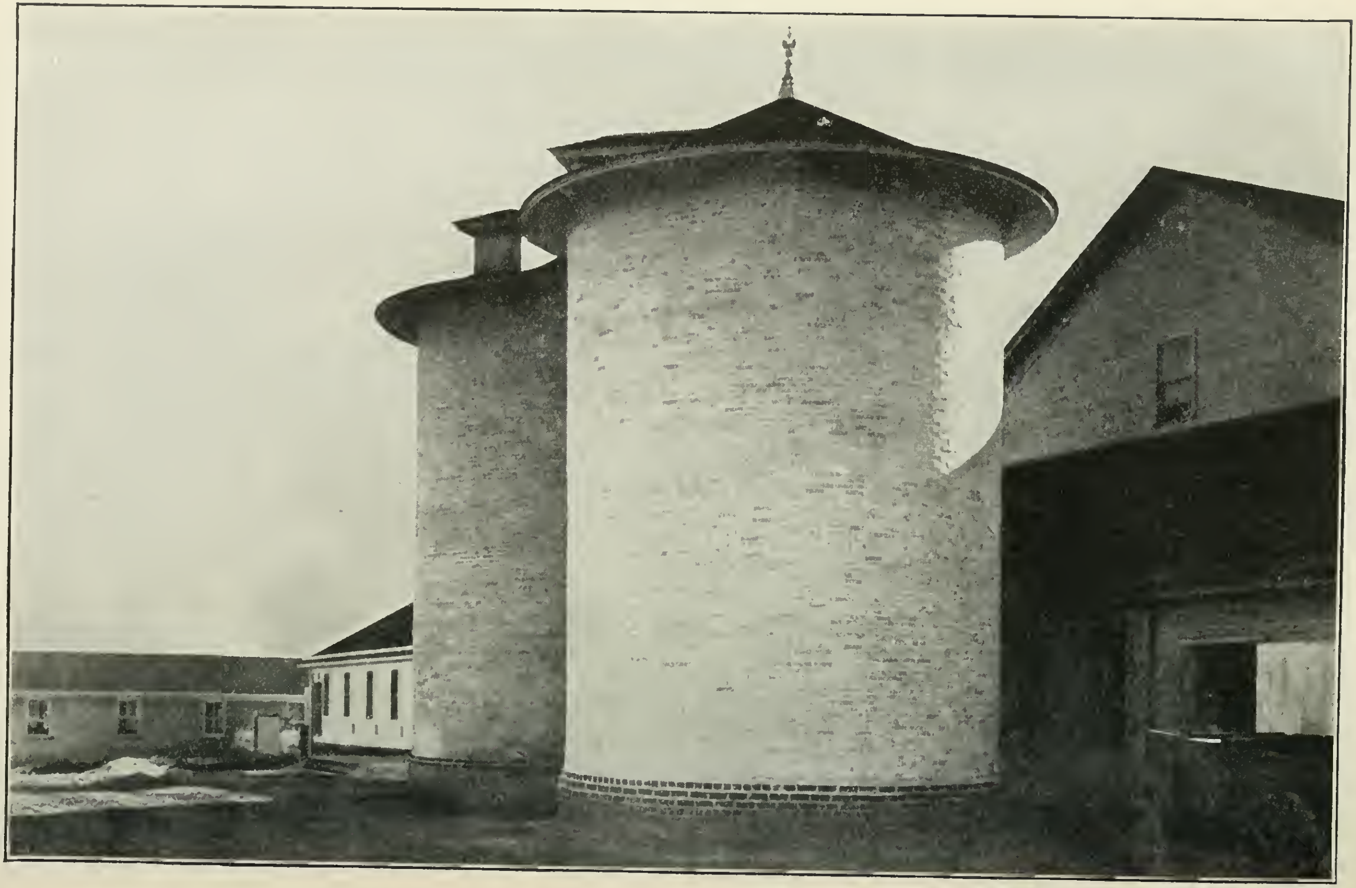
Food Value of the Corn Plant

The entire corn plant has a feeding value, but it is to be regretted that at least one-third of its value is lost unless it is preserved in a silo. Sixty per cent of its food value is in the ear and forty per cent in the stalk. If the corn is husked and the stalk left standing, approximately eighty-two per cent of the weight and fifty-five per cent of the feeding value is lost. If corn is shocked, the loss in weight is seventy-five per cent and forty per cent in feeding value. If the corn is properly preserved in a well constructed silo, the loss is very little and the product is nourishing and relished by all kinds of live-stock.

When to Fill the Silo

Corn should be placed in the silo at the time when the kernels are beginning to dent or glaze, and other fodders previously mentioned before the stems pass into the woody stage. If the fodder is too green and too full of moisture, there is danger of rotting. If the crops are too ripe and dry, fermentation does not take place unless water is applied to the mass.

A silo must be free from cracks and crevices, or in other words, air tight below the top of the silage. If air is admitted below the surface, putrefactive bacteria produce a rotting which causes the silage to become mouldy and worthless. Smooth inside walls and well packed edges preclude air spaces within the mass, a matter of great importance if a uniformly well preserved food is secured. Pea and soy bean vines, clover and alfalfa, should be cut and left on the ground until wilted before being placed in the silo with corn, unless the corn is quite well matured. In that event, it is best to store them as soon as cut, for they furnish the needed moisture to start fermentation. Nitrogenous plants such as the legumes, when mixed with corn in the proportion



Silos .. On a Deere Modern Method Dairy Farm, Moline, Illinois .. Silos Are Filled with Corn, Soy Beans and Cow Peas of one ton of the former to seven or eight tons of corn, make a well balanced ration for dairy cows. A good plan is to drill corn intended for the silo and after the last cultivation plant cow peas between the rows. The pea vines will climb the stalks and can be cut with the corn when it is ready to be placed in the silo. By pursuing this course, much labor is saved and a fairly accurate balanced ration is secured. Sunflowers are sometimes added with good results. It is not advisable to place millet in the silo for the reason that the stems seem to mould.

After the silo has been filled, the top should be covered with a layer of hay or straw after running through the cutter. This top cover should be wet down and made compact. The heavy gases, the result of fermentation, should be allowed to escape through a ventilator in the top. Until after fermentation has ceased, caution should be used in entering a silo for fear of an accumulation of carbonic acid gas. The presence of that deadly gas can be ascertained by lowering a lighted lantern into the silo before entering. If gas exists in dangerous quantities, the light will be extinguished.

Feeding

If silage is exposed to the air for a few days, it begins to spoil; hence the farmer should carefully consider the number of cattle to be fed when he constructs the silo. About two or three inches of the surface should be removed each day, and, if even more can be fed, there will be less waste.

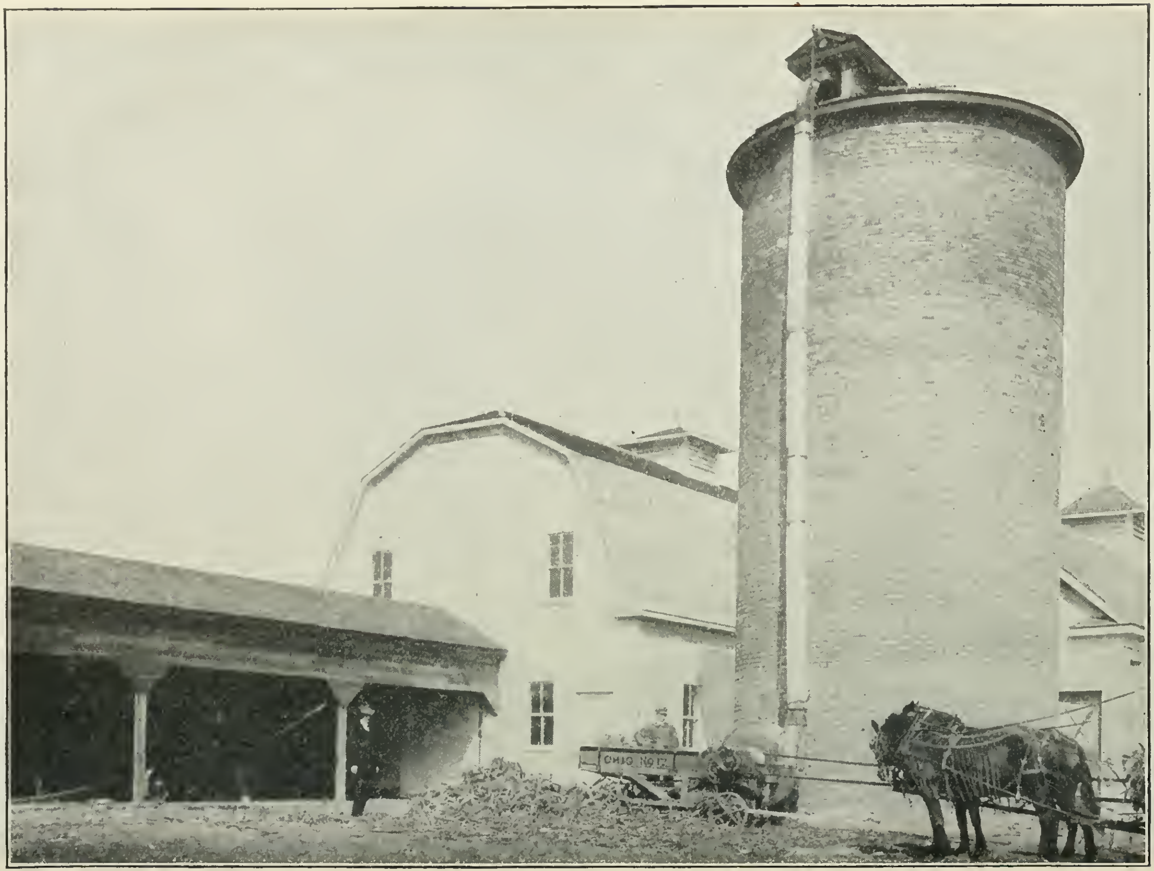
It is always advisable to build the silo high and less in diameter. By so doing the surface exposure is lessened and the silage is more compact

Materials Used in Construction

Wooden silos can be constructed at little cost, and, as a rule, give good results. The foundation must be of concrete or stone and the ground floor thoroughly tamped. The sides should be made of good material, fir being preferable, free from cracks and knots. It should be tongued and grooved and bound with very heavy, substantial iron bands. If studding is used and the silo is lined for the purpose of creating an air space, that air space must be well ventilated; otherwise, it will become mouldy and unsanitary because of dampness from the silage.

If a wooden silo is protected by painting occasionally and the joints are leaded when the structure is built and the iron bands are tightened whenever the wood shrinks, it will be very durable and give excellent service for many years.

If cement, stone or brick construction, the walls should be made thick, reinforced, and great care taken that the inside is made perfectly smooth. On account of the great pressure, such silos are apt to crack unless care is used in construction. Like the wooden silo, if an air space is made it should be ventilated.



Ohio No. 17 Ensilage Cutter .. Filling a 45-Foot Silo on the Deere Homewood Farm

Capacity of a Silo

A silo properly filled—that is, if the contents are made compact throughout—contains one ton of silage for every fifty cubic feet of space. To illustrate the economy of a silo to store stock food as compared with a barn, a ton of hay required 400 cubic feet of space. A farmer can easily figure how much a silo will contain by the following rules:

Multiply the square of the diameter by 0.7854, that will be the area of the circular floor. Multiply the area of the floor by the height, that will give the number of cubic feet. One cubic foot of silage weighs 40 pounds. Multiply the cubic feet by 40, and the result is the number of pounds of silage. Divide that by 2000 to find the number of tons.

Example

If a silo is 16 feet in diameter and 26 feet high, 16x16x0.7854 equals 201.1 square feet; 201.1x26 equals 5228.6 cubic feet; 5228.6 cubic feet multiplied by 40 pounds would make 209,164 pounds of silage, or a little more than 104 tons.

The following table gives the size of a silo, capacity in tons, number of acres required to fill it, estimating 15 tons per acre, and the number of cows it will feed six months, giving them 40 pounds daily:

Diameter	Depth	Capacity in Tons	Acres to Fill 15 tons to acre	Cows it will keep 6 months, 40 pounds feed per day
10	20	28	3	8
12	20	40	3	11
12	24	49	$3\frac{2}{5}$	13
12	28	60	4	15
14	22	61	$4\frac{1}{2}$	17
14	24	67	$4\frac{2}{3}$	19
14	28	83	$5\frac{2}{3}$	22
14	30	93	6	23
16	24	87	$6\frac{2}{5}$	24
16	26	97	7	26
16	30	119	8	30
18	30	151	$10\frac{1}{5}$	37
18	36	189	$12\frac{1}{3}$	45

Summer Silo

The benefits of a silo to preserve food for winter feeding are beyond question. The farmer who combines stock and grain farming cannot afford to be without one. The summer silo is of equal importance. It is the exception rather than the rule to have good and sufficient pasturage during the entire summer. Usually one month, and often several during the summer are very dry. The pastures dry out and stock suffers for succulent food. A summer silo solves the trouble. Twenty or twenty-five pounds of silage daily will maintain a full flow of milk, feeders will continue to grow and fattening cattle will gain even faster than on grass, provided the same amount of grain is given with the silage that has been given them in connection with pasture.

LIVE-STOCK

PRODUCING crops is no more important than raising live-stock on the farm. The two features should receive equal consideration for they are absolutely interdependent.

If the farmer is at all desirous of making his occupation profitable, he should keep enough live-stock to consume the coarser products of his farm and the by-products of wheat, rye and possibly a few other grains. If he is mindful of his duty to coming generations he should conserve the manure from the stock and apply it to the land, for manure is the one thing available or can be made available, that will perpetuate the fertility and productiveness of our soils.

The exclusive grain raiser is a miner, he is not a farmer. He removes fertility from the soil and impairs its physical condition and returns nothing, not even the organic matter which is essential to make available the inorganic elements existing in the disintegrated particles of rock which make up the substance of the soil.

The exclusive stock feeder is a party to the crime, for he, as a rule, wastes fertility which belongs to the land that produced the boughten feeds.

Relation of Stock to Prices of Products

When the farmer feeds the major portion of the products of his soil to live-stock, whether it be for beef, dairy, mutton or pork, if the feeds are given in a balanced ration, he will receive double the market value for the feed consumed by the stock and have the manure to enrich his land.

Under the stimulating influence of better farming teaching and a very attractive price for all kinds of farm crops, the soil of the United States have made a very remarkable increase per acre during the past (1912) year. The market value of farm products is governed by the inexorable law of supply and demand. During the past few years, the demand has been greater than the supply, hence the high prices.

It was thought by many that our soils were becoming depleted of fertility, that they had reached their maximum ability to produce and henceforth the yield would be a little less each year until the final depletion would seal the fate of the nation. Teaching better farming methods did not fall on deaf ears. The farmer was ready to embrace all practical suggestions which would increase his harvest. Barnyard manures were utilized to a greater extent during the past year than ever before. The value of clover was recognized, the benefits of rotation were seen, deep plowing and more intensive tillage methods made available dormant plant food; all combining to make the 1912 crop the greatest in the history of this nation. In consequence thereof, the price of the principal crops has very materially decreased, simply in obedience to the law of supply and demand. The supply of corn is nearly three-quarters of a billion bushels greater than it was in 1911, and the price is practically one-half of what it was then.

What is the solution? What can be done to give the farmer a fair return on his investment and for his labor regardless of how much he may produce? There is but one answer; create a greater market, and the farmer is the master of that proposition. The price of meat has been increasing since the day the homeseeker began to encroach upon the western range. The corn and grain farmers east of the plains have not made up the deficit in stock caused by the restriction of those vast and once free pastures. When our exports of meat dwindled, Europe turned to South America for her supply of meat and for a time the supply met the demand, but their free pastures like ours, are being pre-empted by the new farmers. In view of the shortage of beef cattle in the United States, which amounts to approximately fourteen million head since 1907, and the growing scarcity in South America and the constantly increasing demand for meat, the prospect for cheap meat is very remote. It seems, therefore, that the demand will continue to increase not only at home, but abroad; hence it should require no argument to convince every farmer that it is to his interest to create a market for his corn and other products by raising enough live-stock to consume them, for by so doing he will surely be able to obtain a very attractive price for his corn and other rough feeds, if scientific principles and good judgment are observed in selecting breeds, giving the animals proper care, and feeds that will make the best gains.

Relation of Stock to Fertility

To those who are not in sympathy with the stock-raising feature of farming and are advocating that permanent fertility can be maintained only by adopting other means, we will ask them to explain how it is that the soils of many countries have been made rich and more productive with each passing century by the use of organic matters as fertilizers and by pursuing intensive farming methods. We admit that some soils are naturally deficient and can be made useful only by supplying elements in a commercial form, but often poor crops are more apt to be due to mismanagement and abuse of the soil rather than to depletion. It is very evident, however that the soils of the central and middle western states especially, are not depleted nor impaired, but are bristling with fertility and possess a potential power which cannot be estimated if rightly handled. The remarkable yield made during the past year does not indicate that the fertility of the soil is waning, but on the contrary it proves conclusively that it is very rich, and no man can anticipate its maximum possibilities when scientifically tilled and managed, any more than he can forsee the future inventive development of the genius.

Stock-Raising Profitable

Stock-raising like tilling the soil, is profitable just in proportion to the amount of practical science, right management and good judgment the farmer devotes to the business.

There are three fundamental principals to be observed and they are interdependent and the ultimate profit will be in keeping with the step or feature which is neglected. The essential things to be considered, are

1. Breed
2. Care..
3. Feed.

Breeds

We will not attempt to recommend any special breed (they all have merit), believing that the farmer can himself best determine what breed is best adapted to the climate and conditions where he lives. We also feel that he can best judge which variety or kind of stock he should raise.

Cattle For Beef

The main characteristics of a typical beef animal are:

Small lean head.

Broad muzzle.

Large full clear eyes.

Short neck, but very full and thick at the shoulders.

Chest broad and deep.

The section behind the shoulders should be nearly circular.

The brisket should be deep and project well forward, shoulders upright, wide and thick at the top. There should be no hollow behind the shoulders and the back should be straight, broad and level.

The hip bones should be far apart, rumps high and well covered with flesh.

The quarters should be long, straight, thick and well developed to the lower part of the thigh. Ribs should spring out broadly from the back and be deep and the flank should be deep, wide and full.

The tail should be flat and broad at the root and tapering.

In a typical beef animal, the tail is attached high up, about on a level with the rump.

In general, the body of the typical beef critter is long and deep, thick, both before and behind. The legs should be short and stout and be set at the corners of the animal rather than at the end. The skin should be thick but very soft and elastic. During the winter the hair is thick and long, but in the summer it is short and lighter.

Herefords

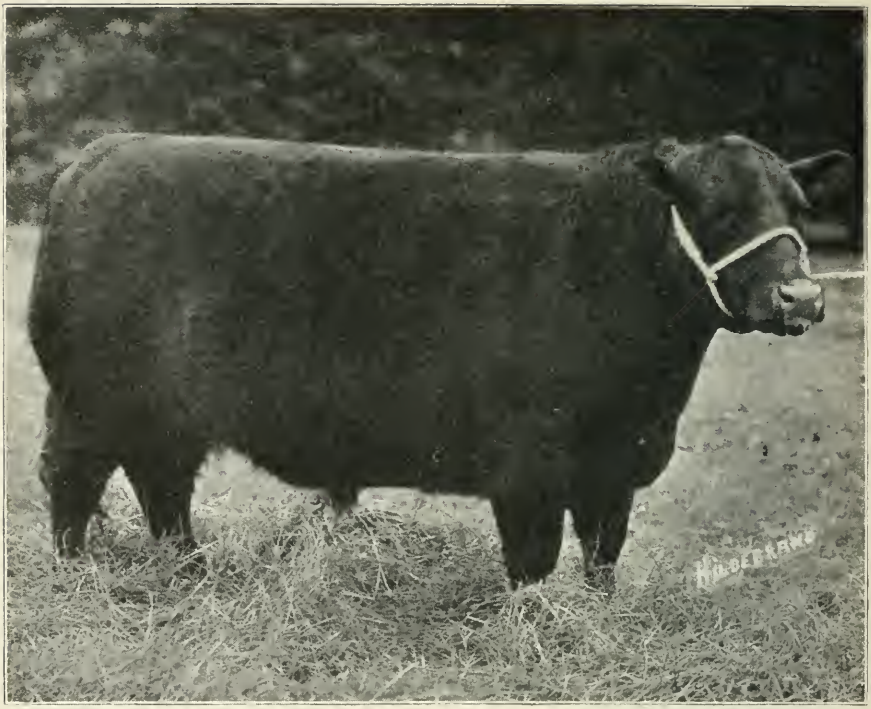
The Hereford is a native of England. Only a few were imported in the United States prior to 1850. The Herefords are hardy rustling animals and it is thought that they make better gains on pasture than other beef breeds. They respond to corn very rapidly while on pasture, and can be made prime steers in a remarkably short time. For many years they have rivaled the Shorthorns in contests, neither breed, however, having any marked advantage over the other. No more beautiful live-stock sight can be seen than a bunch of these white-faced cattle in prime condition.

Shorthorns

Shorthorns must be classed with the composite or made breeds. They descend from herds of excellent cattle long preserved in the counties of York, Durham, and Northumberland. The breed was greatly improved during the last century by Mr. Dobson who selected some very superior bulls in Holland. While the Shorthorns are the favorite cattle for beef, and more of them are raised in the United States than any other breed, a dairy type is being bred which is making remarkable records. With many they are regarded as ideal for general purposes. Several varieties of Shorthorns have been developed, all possessing splendid qualities. It is indeed difficult for the farmer to decide between the Herefords and Shorthorns as to the best breed, as both breeds have been developed in the United States to a high state of perfection.

Galloways

Galloway cattle take their name from a district in Scotland where the breed took its origin. They are hornless and entirely black in color. On account of their long thick hair, which is almost a fur, they are adapted to cold climates. They are especially adapted to the western plains on account of their ability to rustle and endure cold. In size they are slightly under the other breeds mentioned. The meat, while it is not so fat, is regarded as excellent.



A Typical Beef Animal

Aberdeen-Angus

The Aberdeen-Angus in color and shape are very much like the Galloways, except that they are a little larger. Like the Galloways they are of little value as dairy animals.

Sussex

This breed attains a good size and in some sections of the United States are raised for oxen. After they have served their purpose as beasts of burden for a time, they can be put in prime condition and sold on the market for a good price.

Other Breeds

While there are other varieties of beef cattle, we realize that the average farmer is not especially interested in any of them as much as he is in the Herefords, Shorthorns, Galloways and Angus.

Dairy Cattle

We can furnish no better description of the typical dairy cow than is given by Brooks, which is as follows:

"*The Ideal Dairy Type.* All the different dairy breeds show certain peculiarities in common. While differing to a considerable extent in minor points, the various breeds should all closely approach a certain type which we may call the ideal type.

"*Head.* Small, lean, and bony, with large muzzle and mouth. The nose and face should be free from fleshiness.

"*Eye.* Full, large, lively in its expression but at the same time mild, clear, and bright. The whole expression of the face and eye should be motherly.

"*Forehead.* May be either straight or dishing, but the latter gives a more well-bred appearance.

"*Ear.* Thin, large, active, and for most breeds should be of an orange color within.

"*Neck.* Should be rather thin, especially near the head, and long. It should be free in most breeds from loose, pendent skin.

"*Shoulders.* The animal at the shoulders may be from two to four inches lower than at the hips. The shoulders themselves should be thin, especially at the top, lean and bony.

"*Chest.* Should be deep, i.e., it should have a large measurement from top to bottom. It is less broad and roomy than in beef breeds. The section through the animal behind the shoulders should have an elliptical outline. Too great thinness behind the shoulders is, however, a mark of a weak constitution.

"*Back.* Should be rather long and rugged. The vertebrae of the backbone should be rather wide apart so that the fingers may be pressed down between the points in the ridge of the back. This is only one feature of the general looseness of structure which is looked for in the dairy type, as contrasted with the close, compact structure which is desirable in the beef type.

"*Loins.* Should be fairly broad. The hip bones rather high and well apart. The bones, moreover, are often rather farther forward than in the beef type. This gives a long and strong hind quarter.

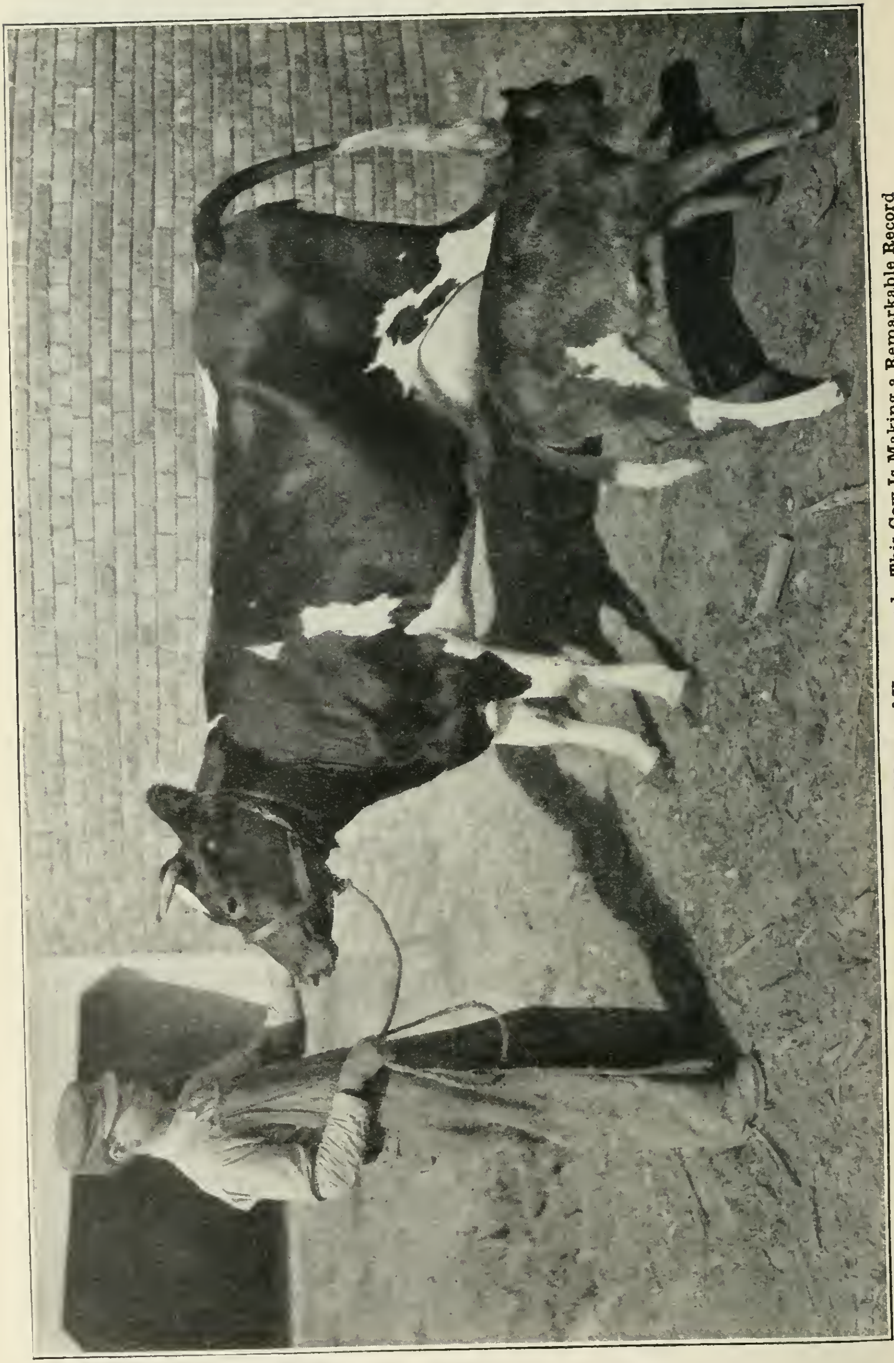
"*Thighs.* The thighs should be thin, especially on the inside, in order to give room for a large udder.

"*Flank.* The flank is well up, and rather thin.

"*Legs.* The legs should be rather short and the hind legs may be rather crooked. The bones of the legs should be moderately fine. The fore legs are comparatively near together, the hind legs wide apart.

"*Tail.* The tail should be long and fine, with a long switch. A long tail is belived to indicate that the vertebrae of the backbone are somewhat loosely connected, which, as has been pointed out, is considered highly desirable.

"*The General Outline.* When looked at from the side, the general outline should be that of a wedge, the upper line or line of the back-



Imported Dorset Daisy No. 31982 and Calf Venus of Homewood .. This Cow Is Making a Remarkable Record bone and the lower line or line of the belly approaching each other from behind. When looked at from behind or from above, the animal should also present a wedge shape, the lines of the wedge approaching each other from rear to front. The dairy cow, therefore, shows a double wedge. The ribs, to harmonize with this general wedge shape are rather flat immediately behind the shoulders. At this point they do not spring out very widely but, toward the posterior part of the animal, the ribs spring out from the backbone more and more broadly in order to give room for large internal organs, for a big workshop.

"*The Udder.* The udder should not be very pendent but should obtain capacity by breadth, being wide from side to side, extending well forward, well backward also, and high up between the thighs. It should be broadly and firmly attached to the abdomen. The skin of the udder should be thin and delicate. The udder should be well filled out at the bottom between the teats, and the latter should be wide apart, squarely placed, and of good size.

"The veins leading from the udder forward, just beneath the skin of the belly, should be large, tortuous, and rapidly branching. They should pass in through the walls of the abdomen through large openings. These veins do not, however, become fully developed until the cow reaches maturity. They are the passages through which the blood returns from the udder to the heart and, since a large amount of blood passing through the udder is essential to the production of a large amount of milk, the development of these veins in a mature cow is a point of much importance.

"In general appearance. the dairy cow is somewhat loose and angular as compared with the beef type. An animal of this type is not as pleasing to the eye as one which is more compact, smoother, and plumper in general appearance, but it should be remembered that 'handsome is what handsome does,' and that cows with these peculiarities will do 'handsomely.'

"*The Skin.* The skin should be moderately thin, flexible, and elastic, the hair soft and fine. A skin which is too thin or papery indicates lack of constitution. The skin of the dairy cow, however, should be somewhat thinner than that of animals of the beef breeds. When the animal is in good condition, the skin will move somewhat freely beneath the outspread hand and it can be rather easily raised between the thumb and finger over the ribs.

"According to Hoard, a large navel is one of the most certain indications of strong constitution and he insists that since strong constitution is essential to large production, this is an exceedingly important point to be noted in selecting a dairy cow."

The most popular breeds of dairy cows in the United States are,

Holsteins

The Holstein is called the milkman's cow because she gives, if given an abundance of succulent feed, a very heavy flow of milk. While her milk is low in butter-fat, the net results at the end of the season compare very favorably with other breeds. The Holstein is a large hearty cow, being the largest of the dairy family. She is well adapted to cold climates, thrives on rough feeds and is a splendid rustler. While she possesses many of the characteristics of the typical dairy cow, she is also a very good beef animal.

Jerseys

are said to be the most economical producers of butter-fat. The cow is small in size, easy to keep and as a rule quite gentle. Her milk contains a high per cent of butter-fat and as a typical dairy cow, ranks among the first.

Guernseys

The Guernsey cow is slightly smaller than the Holstein and larger than the Jersey. She gives a fairly large quantity of milk and in points of butter-fat has no superior. Her milk often contains as high as six per cent butter-fat. The cream is a rich yellow, making a beautiful golden colored butter. The Guernsey cow is naturally very gentle and the bulls have none of the vicious characteristics peculiar to most other breeds. Dairymen with mixed breeds often are able to increase the percentage of butter-fat and improve the color and raise their herd in a few years to a high standard by using a pure-bred Guernsey bull. We do not, however, advise doing so if it is possible to secure pure-bred cows.

Ayrshires

This cow is a native of Scotland. She attains a medium size, gives a fair flow of milk containing 3½ to 4 per cent of butter-fat. The Ayrshire is a tough rugged rustler and will yield better results on a rough short pasture than any of the dairy breeds.

Other Breeds

namely, Devon, Dutch Belted, Red Polls, and dairy Durhams are considered splendid general purpose dairy cows. The Brown Swiss is regarded a remarkable milk and butter-fat producer and is considered by many far superior to all other breeds. In Switzerland, where dairying is the principal business, few other breeds are found.

SWINE

A FARM without a good sized drove of thrifty hogs is a lonesome place, and the farmer who ignores this class of livestock casts aside a splendid source of easy money.

The hog develops about as rapidly as a corn crop and generally insures a very profitable return. Success, as in raising other kinds of stock depends upon breed, feed and management. Briefly stated, the essential things to be observed in raising hogs are,

1. Select a breed which will make a marketable weight in seven or eight months.
2. Plan to have the pigs come early in the spring.
3. Provide a diversified pasture and a properly balanced diet of concentrates.
4. Supply plenty of pure water for the hogs to drink and clean water in cement wallows.

Types

There are two distincts classes or types of hogs, namely the lard hog and the bacon hog.

Lard Types

The most common and popular breeds of the lard types are,

Poland Chinas

This breed represents the typical American breed of lard hogs. There are two types of the breed, one being smaller than the other. The small type is a little smoother and a little easier to mature, but not as prolific. The large type has a long heavy body, heavy ears and longer legs than the other type and the meat is a little coarser grained. This type of hog grows to an enormous size, but the writer does not regard it profitable to feed for the purpose of increasing the weight after the hog has attained a fair marketable size which is from 190 to 225 pounds. The Poland China cannot be made ready for market as quickly as some of the other breeds.

Duroc Jerseys

The Duroc Jersey is also an American breed. The Duroc is of a dark reddish color, develops to a good size, is easy to fatten and probably more prolific than any of the other breeds. This breed is certainly a very desirable hog to give quick returns if crowded during the first seven or eight months of its life.

Berkshires

The Berkshire is regarded as an English breed. This hog grows to a good size, is about as prolific as the Poland China, and withal a very desirable lard hog.

Pure Bred Hampshire Hogs on the Deere Modern Method Stock Farm, Moline, Illinois . . Cement Feeding Place, Running Water and Cement Wallows Are Used to Prevent Diseases

Chester Whites

This breed, like the Poland China, develops to an enormous size if crowded for a period of a year and a half or two years. They are very good feeders, develop rapidly and when eight or nine months old usually weigh, if properly fed, 200 or more pounds. They are regarded with favor by the packers on account of the whiteness of the carcass. They are very good mothers and fairly prolific, but are not regarded as great rustlers.

Essex

Hogs of this breed are small and compact, are easily fattened but are not as prolific as many of the other breeds. For quick returns they are superior to any other breed although they do not develop to the same weight that the larger breeds of lard hogs do during the summer season. In the matter of keeping, they are very economical.

Bacon Types

There are three prominent breeds of the bacon type, namely, Hampshires, Tamworths and Cheshires.

The Hampshire

formerly called the Thin Rind, has a long clean-cut body, mediun long legs and snout. The body is black, except a white band over the shoulders and down the front legs. The Hampshire is a very hardy active rustler and well adapted to rough pastures. While it takes on considerable fat, it makes splendid bacon and hams if marketed when it weighs from 180 to 200 pounds.

The Tamworth

is a red hog with a long gaunt body and long snout. This breed is probably more hardy and a greater rustler than any other breed or type of hog known. On account of the length of legs and their active disposition, they excel all other breeds in the matter of speed. The Tamworth is purely a bacon hog, excelling all other breeds.

The Cheshire

is a native of New York. It is white in color, has a long cylindrical body and long legs, but the bones are not large. While the Cheshire is usually called a bacon hog, it is really a medium between the bacon and lard types.

FEEDING LIVE-STOCK

TO secure the best results from feeds, the farmer should know what substances are necessary to promote growth and how to proportion them. He should also know the nutrient value of his feeds. The laws governing growth are very exacting. Haphazard feeding is not profitable, but if the animal is fed scientifically, or in other words, given a properly balanced ration, the results are usually very satisfactory.

Feed should contain protein, carbohydrates and fats.

Protein

Protein is a name given to the nitrogenous compounds of a plant. It forms the muscles, tendons, ligaments, hide, blood, nerves, all internal organs and a part of the organic portion of the bones. Protein is absolutely necessary to growth and if not provided in the right quantities the growth is impaired. If food contains no protein or protein alone is given, the animal will soon starve.

Carbohydrates

Carbohydrates are composed of starch, sugar, gums and fibers of all nutrients free of nitrogen. Carbohydrates are the source of heat and muscular energy, and fat.

Fats

In some cases the plant stores carbon in the form of fat. Vegetable fats are formed from the same elements that exist in the carbohydrates, hence, when carbohydrates are mentioned, the fat content is considered. Carbohydrates alone will not sustain life for any great length of time.

A Balanced Ration

A balanced ration is a feed or combination of feeds containing protein, carbohydrates and fat in such proportions and amounts as are necessary to furnish nourishment which will produce a healthy growth and production to the greatest desirable degree.

An Unbalanced Ration

An unbalanced or one-sided ration is one containing too much or too little of one or the other of the compounds necessary to promote a maximum growth and production.

Examples

A ration containing one part protein and four parts or less of carbohydrates would be called a narrow or unbalanced ration, and one containing one part protein and seven or more parts of carbohydrates would be a wide ration. A well balanced ration contains one part protein to five or six and one half parts of carbohydrates as the requirements demand.

If the animal is young and a rapid growth is desired then the ration should be about one to five, and when fat is desired, more carbohydrates should be given and the ratio increased to one to six or possibly one to six and one-half, for the reason that carbohydrates form the fat, and are the source of energy.

The Nutrients in Feeds

The following table furnished by the Minnesota Agricultural College, gives the nutritive value of some of the principal feeds.

	Protein	Carbohydrates	Fat
CONCENTRATES			
Corn	.079	.667	.043
Barley	.087	.656	.016
Oats	.092	.473	.042
Wheat	.102	.692	.017
Rye	.099	.676	.011
Millet	.089	.450	.032
Kaffir Corn	.078	.571	.029
Sorghum	.070	.521	.031
Shorts	.122	.500	.038
Bran	.129	.401	.034
Peas	.168	.518	.007
Corn Oil Meal	.202	.445	.088
Gluten Feed	.233	.507	.027
Oil Meal	.293	.327	.070
Gluten Meal	.322	.422	.025
Cotton Seed Meal	.372	.169	.122
ROUGHAGE—GREEN			
Fodder Corn	.010	.116	.004
Sorghum	.006	.122	.004
Oats	.026	.180	.010
Timothy	.012	.191	.006
Red Top	.021	.212	.006
Clover	.020	.148	.007
Alsike	.027	.121	.006
Alfalfa	.039	.127	.005
Cow Pea	.018	.187	.002
Soy Bean	.031	.110	.005
Barley	.019	.102	.004
SILAGE			
Corn	.009	.113	.007
Sorghum	.006	.140	.002
Cow Pea	.015	.006	.009
Clover	.020	.135	.010
Soy Bean	.027	.087	.013
Alfalfa	.030	.085	.019
STRAW			
Wheat	.004	.363	.004
Oats	.012	.380	.008
Barley	.007	.412	.006

ROUGHAGE—CURED

	Protein	Carbohydrates	Fat
Fodder Corn	.025	.346	.012
Stover	.017	.328	.007
Sorghum	.024	.321	.016
Timothy	.028	.434	.014
Prairie Hay	.029	.415	.012
Red Top	.048	.469	.010
Oat Hay	.043	.464	.015
Millet	.032	.485	.010
Marsh Hay	.024	.299	.009
Soy Bean	.109	.401	.015
Cow Pea	.107	.382	.012
Clover	.068	.358	.017
Alsike	.084	.425	.015
Alfalfa	.110	.396	.012

MISCELLANEOUS

Potato	.009	.163	.001
Sugar Beet	.011	.103	.001
Mangel	.011	.054	.001
Turnip	.010	.072	.002
Rutabaga	.010	.081	.002
Cabbage	.015	.008	.003
Pumpkin	.010	.058	.003
Rape	.015	.081	.002
Beet Pulp	.006	.073	.000

How to Determine a Balanced Ration

By referring to the foregoing tables, it is not difficult to determine the amount of each essential element in feeds given and in what quantities they should be proportioned. To illustrate: corn is called a carbohydrate, because the quantity of carbohydrates and fat exceeds the amount of protein to an extent beyond a balanced ration. To determine the amount of carbohydrates including the fat in 100 pounds of a given feed, multiply the digestible fat in 100 pounds by 2.25 and add the product to the digestible carbohydrates. By referring to the foregoing tables, it will be seen that one pound of corn contains .079 protein, .667 carbohydrates and .043 fats. Therefore, 100 pounds of corn contains 7.9 pounds of protein, 66.7 pounds of carbohydrates and 4.3 pounds of fat. Multiply the fat by 2.25 and add to the carbohydrates, we have the total amount of carbohydrates, 4.3x2.25 equals 9.67 plus 66.7 or 76.37 pounds of carbohydrates. To get the ratio, divide 76.37 by the protein, 7.9, and we have 1 to 9.7 or decidedly an unbalanced ration containing too much of the elements that go to make fat, and not enough of protein to promote growth, hence, we must balance the ration by adding a nitrogenous feed containing protein.

It is shown by the tables that wheat, oats, bran, peas, gluten feed, oil meal and cotton seed meal are all rich in protein, and if mixed with corn ration, will equalize the feed.

Of roughages, corn fodder, sorghum, timothy hay, prairie hay, millet and silage are carbohydrates. Alfalfa, cow peas, soy beans, and clover on the other hand are rich in protein.

Having a knowledge of the nutritive content of the various feeds, it is easy to figure out a very desirable ration knowing that a good ration contains one part of protein to five, six or six and one-half parts of carbohydrates. It must be remembered that carbohydrates alone, or nitrogenous feeds alone, are poor rations.

The results of good and bad rations will be given in discussing the various departments of stock-feeding.

WATER

PURE water is a very essential factor in animal growth and health. Dirty troughs, mud-holes and stagnant streams tend to disorganize the digestive system amd encourage diseases. Hog cholera is often transmitted to healthy hogs by drinking water from a contaminated stream. Henry says:

"Animals can live much longer without solid food than without water and an insufficiency of water in the body causes serious disturbances. The processes of mastication, digestion, absorption and assimilation are hindered, the intestines are not properly flushed, waste matter remains too long therein, the blood thickens and the body temperature is increased. Through these complications, death may result. Animals partially deprived of water for a long period lose their appetite for solid food and vomiting and diarrhea may occur. The latter also often takes place when water is again supplied."

Under normal conditions, animals consume a fairly uniform quantity of water for each pound of dry matter eaten. Kellner places the amount at four to six pounds for milch cows, four to five pounds for oxen, two to three pounds for horses and sheep, and for swine seven to eight pounds, which seems excessive. Possibly due to their laxative nature, feeds rich in crude protein, bran, linseed meal, peas, etc., cause a greater demand for water than starchy feeds. Kellner found that for each 100 pounds of water drank and in the food, the stabled ox passed 46.3 pounds in the solid excrement, 29.2 in the urine and 24.5 in the breath and perspiration. Water is an important regulator of the temperature of the animal body. A large amount of heat is absorbed in converting water into the vapor given off by the lungs and skin, and when sweat evaporates it carries much heat from the body.

The free drinking of water does not diminish the gains of animals nor increase the breaking down of protein in the body, though flushing the intestines with much water may at first cause a more complete removal of the nitrogenous waste therefrom. With animals which continue to drink freely, the nitrogenous waste soon becomes normal again. Scientists now agree that farm animals should have all the water they will drink, for they do not take it in excess unless they are forced to live on watery foods or are given salt irregularly. The excess of water taken into the body is discharged through the urine.

Water taken into the body must be raised to the temperature of the body. Warrington points out that during winter sheep in the turnip fields of England consume about twenty pounds of the roots daily, containing over eighteen pounds of water, or about fifteen pounds more than is needed. To raise fifteen pounds of water from near the freezing point to the body temperature requires the heat evolved in the body by burning nutrients found in the turnips, equivalent to three ounces of glucose, or about eleven per cent of their total food value. In addition, the equivalent of more than two ounces of glucose must be burned for each pound of water vapor given off from the lungs and skin. Warming cold water taken into the body does not necessarily mean that more food must be burned, for animals evolve a large amount of heat in the work of digesting food and converting the digested matter into the body products or work. Due to this, many animals have an excess of body heat. Comfortably housed and well-fed steers and dairy cows burn more food than is needed to keep their bodies warm, and such excess may go to warm the water they drink, so that no food is directly burned for that purpose.

Armsby points out that in winter farm animals, watered but once daily, drink freely. The sudden demand for heat caused by taking into the body this large quantity of cold water may exceed the available supply. The result is that some of the food nutrients or body tissues are burned to meet it. Animals unduly exposed to cold and those sparingly fed or with scant coats may be directly helped by watering frequently or by warming their drinking water. In cold regions in order to induce animals, especially cows, to drink freely in winter, it is usually best to warm the water, which should be comfortably accessible.

AIR

PURE air is a vital requirement for animals. A close, restricted, unventilated barn impairs digestion, restricts growth and production, and is the chief cause of tuberculosis, both in hogs and cattle.

Henry says: "The first and most vital requirement of animals is air."

The amount of air breathed by farm animals, as given by King, is placed in the first division of the table below. The second division shows the quantity of fresh air that must pour into a room where animals are confined in order to provide substantially pure air, or that which does not contain over 3.3 per cent of air that has been previously breathed.

AIR BREATHED BY ANIMALS AND AIR REQUIRED FOR GOOD VENTILATION

Animal	Air Breathed			Ventilation Requirement per Animal	
	Hourly Cu. Ft.	Per 24 Hours		Hourly Cu. Ft.	Per 24 Hours Cu. Ft.
		Cu. Ft.	Lbs.		
Horse	142	3,401	272	4,296	103,104
Cow	117	2,804	224	3,542	85,008
Pig	46	1,103	89	1,392	33,408
Sheep	30	726	58	917	22,008

The table shows that the horse breathes hourly 142 cubic feet of air and daily about 3,400 cubic feet, which weighs about 272 pounds. To provide the horse in confinement with air not more than 3.3 per cent of which has been previously breathed, there must hourly pass into the room not less than 4,296 cubic feet, or over 103,000 cubic feet each 24 hours.

The cow gives off about 19 therms of heat each 24 hours, or enough to raise 79,603 cubic feet of dry air from 0 degrees F. to 50 degrees F. The proper ventilation for the cow requires that about 85,000 cubic feet of air be brought into the stable each 24 hours. This is only a little more air than the natural heat from her body will raise from 0 degrees F. to 50 degrees F., which is a desirable winter temperature for cow stables in cold climates.

The King system of ventilation should be installed in every stock barn. This system not only furnishes fresh air for the stock, but the natural heat of the animals in the barn during extreme cold weather will keep the temperature moderately warm if the circulation of air is perfect.

DAIRYING

DAIRYING is a feature in Better Farming the importance of which the farmer cannot afford to ignore. History does not record an instance, if properly conducted, where dairying has not proven successful from every viewpoint.

1. The dairy cow maintains in a great measure the fertility of the soil.

Pure Bred Guernsey Calves on the Deere Modern Method Farm, Moline, Illinois

2. She makes an income for the farmer, at least three hundred days each year in the production of butter-fat.

3. Skim milk has a feeding value almost equal to whole milk.

4. Her offsprings has a value ranging from ten to one hundred per cent of the cow.

Success in the dairying like other branches of farming depends entirely upon the foundation of the herd, and the thoroughness and skill devoted to the work by the farmer.

If the business is conducted in a careless manner, if the cow is not manifestly a milk producer and properly cared for and rightly fed, or if the breed is not adapted to climatic and other conditions, dairying will, like tilling the soil in a haphazard way, be unprofitable, but if all of the essential features are strictly observed the farmer will be rewarded by having a very attractive net balance at the end of the year.

Testing a Cow

The first essential is to select cows of a breed that are manifestly milk producers and then select from them only those that prove, after a year's trial, to be profitable performers. While a large per cent of pure-bred dairy cows are profitable, grades, if carefully selected, are excellent producers of milk and butter-fat. A pure-bred sire possessing an ancestry of good milkers will soon bring the herd to a high standard and, for the average farmer, this is the quickest and most economical way to secure a profitable herd.

Every dairyman should have a Babcock tester in order that he may know how much butter-fat his cows are producing and note the results obtained from various feeds. Too often a few poor producers will consume the profits made by the balance of a fairly good herd.

In trying out a cow, a record of the amount, the kind of food and its value should be kept, as well as a daily record of milk and butter-fat. It costs from ten to twelve cents a day to feed a cow, or from $35.00 to $42.00 per year. A cow that will not give 3,000 pounds of milk in one year is not regarded as very profitable and should be replaced by a more promising one. A cow giving 4,000 pounds of milk in one year pays for her keeping and compensates the farmer for his labor, interest on the investment, etc., but a good cow, properly fed, will produce 6,000 pounds of milk and is worth to the farmer approximately $140.00 gross if milk is worth 20 cents per gallon.

Prof. Fraser, chief of Dairy Husbandry of the University of Illinois in Circular No. 134 gives some very interesting data on the keep and profit of several herds which compare favorably with the ordinary dairy. His experiments should prompt all dairyimen to test their cows. In summing up he makes the following statement:

Cow Barn on a Deere Modern Method Farm, Moline Illinois . . Sunlight Enters All Parts . . It Is Equipped with a Milking Apparatus, Sewer System and Perfect Ventilation

"The returns from cows, when expressed in dollars and cents, stand out much more vividly than they do when expressed in pounds of milk and butter-fat. Therefore, if every dairyman would keep a yearly record of the amount of milk and butter-fat produced by his individual cows, and from this calculate the profit or loss on the individuals, he would be astonished at the wide variation in earning capacity of the different cows in his own herd, and the results would be of untold value to him. When the herds themselves are given like consideration, a notable contrast in the variation in earning capacity of the herds is brought out."

The cows in one herd lacked $7.48 each of paying for their feed and care, while each cow in another herd made a profit of $42.77, making a difference in income of over $50 per cow between the two herds. The best cow in a good herd brought in $69.70 profit, while the poorest cow in the poor herd was kept a loss of $27.52, making a difference in the earning power of the two cows of nearly $100 annually."

Selecting a Herd

The herd should be choosen strictly from a business standpoint, or in other words, the farmer should select a breed of cows adapted to the line of dairying he expects to engage in. One breed is especially adapted to butter, the milk containing a high per cent of butter-fat and having the natural color of butter. Another is desirable for the quantity of milk, but contains less butter-fat, while another breed is for general purposes, that is, both milk and beef. As a safeguard against contaminating the herd, every cow bought should be tested for tuberculosis and the entire herd should be tested at least once each year.

Care of the Cow and Dairy Buildings

While breeding and feeding are essential features, care of the dairy cow is of no less importance. The dairy barn should be roomy, well lighted and thoroughly ventilated. Good health is maintained by furnishing the right kind of food, pure water and an abundance of pure air. If the dairy cow is compelled to breathe dead air, she will sooner or later contract tuberculosis.

A system of ventilation constructed on scientific principles is inexpensive and a safeguard against disease. Sunlight is a germ destroyer and a great purifier, hence, the cow barn should be so constructed that sunlight can enter all parts of the barn some time during the day. The barn should be kept clean and gypsum or phosphate rock sprinkled in the stalls and manure gutter after the droppings have been removed. An abundance of pure water should be accessible at all times.

Lord Balam of Pine Meadow No. 18326 Grandson of Lord Mar.

Unless the weather is extremely cold, cows do much better in an exercising shed during the night than if confined in stanchions. Cows should not be exposed to cold stormy weather at any time.

Cows should be curried and the udder thoroughly cleansed before milking. The milker should be in good health, wear clean garments and have clean hands in order to insure sanitary milk.

Milk should not be kept in cans or pails in the stables, but be removed to a detached milk house as soon as it is taken from the cow. The floor in both milk house and cow barn should be made of cement and all walls and equipment given a coat of paint often enough to prevent the accumulation of disease germs. When steam is accessible, it is advisable to sterilize stalls, feed boxes, etc., occasionally.

Contagious Abortion in Cows—How to Prevent

This disease is due to a specific micro-organism. The cow becomes contaminated from afflicted cows or bulls, voided calves, afterbirths and discharges. The germs persist for months unless the affected cows are removed and the barn and surroundings made perfectly sanitary. By using steam, hot water, disinfecting fluid and white-washing the interior of the barn, the germs can be destroyed.

When a cow is threatened with abortion, she should be isolated and if she is restless, given from one-half to one ounce of laudanum or one-half ounce of fluid extract of canabis indica in a little water. Also give about one ounce of the fluid extract of black haw and continue the black haw giving one-half ounce once or twice daily until the cow is well.

To prevent other cows in the barn from contracting the disease where one has aborted, spray the external genitals of each pregnant cow with a one per cent of coal tar disinfectant and disinfect the floor and gutters by using coal tar solution or a solution of copper sulphate, one ounce to the gallon of hot water.

RATIONS FOR DAIRY COWS

WHILE the ration should contain the essential elements of milk, no fixed formula can be prescribed to meet the requirements of all cows. The dairyman can, by trials, usually select a diet suited to the individual. The needs of different animals vary from time to time. A balanced ration for a large cow giving a large quantity of milk would not be suited to a small one giving a less quantity, and a cow which is inclined to fatten easily should have less carbohydrates than a lean one. Hence, the dairyman should study his cows and cut and fit to suit. No better general feeding guides can be given than those furnished by our experimental stations and practical dairymen who have been successful.

We will present in an abridged form those that have given the best results and compare them with rations selected without reference to the nutrient value of the feeds or the requirements of the individual cow.

Good and Poor Rations

The New Jersey Experimental Station made the following test between a good ration and a poor one.

SUMMARY OF TEST

Good Ration	Dry Matter Lbs.	Protein Lbs.	Digestible Fat Lbs.	Carbo-hydrates Lbs.	Nutritive Ratio
30 lbs. silage	7.69	.37	.21	4.48	
5 lbs. hay (timothy)	4.22	.17	.06	2.23	
4 lbs. wheat bran	3.53	.54	.13	1.80	
4 lbs. dried brewers' grains	3.65	.67	.22	1.36	
2 lbs. linseed meal	1.82	.50	.14	.69	
Total	20.91	2.34	.76	10.56	1 : 5.3
Poor Ration					
12 lbs. cornstalks	10.78	.41	.11	6.50	
8 lbs. hay (timothy)	6.75	.27	.10	3.57	
4 lbs. corn meal	3.42	.32	.12	2.63	
Total	20.95	1.00	.33	12.70	1 : 13.5

Result of the Test

Four cows were included in the test which continued for two months. The milk from each cow was weighed daily and the per cent of butterfat determined by analysis. The yield of milk and fat is given in the following table.

SUMMARY OF TEST

	Good Ration				Poor Ration			
	Milk Lbs.	Fat Per Cent	Fat Lbs.	Butter Lbs.	Milk Lbs.	Fat Per Cent	Fat Lbs.	Butter Lbs.
Cow No. 1	949.9	4.72	44.84	52.31	613.6	4.02	24.68	28.79
Cow No. 2	538.5	3.55	19.00	22.28	435.6	3.45	15.01	17.51
Cow No. 3	500.4	4.48	22.39	26.12	402.5	4.61	18.56	21.65
Cow No. 4	712.9	3.65	25.98	30.31	562.5	4.01	22.58	26.35
Total and Average	2701.7	4.16	112.32	131.04	2014.2	4.01	80.84	94.32

"This summary shows that 687.5 pounds or 34.1 per cent more milk, and 31.47 pounds, or 38.9 per cent more fat were produced from the good rations than from the poor rations, an actual gain in production of over one-third. The cost of the food used to produce 100 pounds of milk and one pound of butter was practically the same for the two rations, viz., 70.2 cents and 14.5 cents, respectively for the good ration, and 70.3 cents and 15 cents for the poor ration, yet 34.1 per cent more milk and 38.9 per cent more butter were produced from the good ration than from the poor ration with practically the same amount of labor and capital. The results, therefore, indicate that twenty cows well fed, yet with no attempt at forcing, would produce as much milk as thirty cows equally as good if fed an abundance of corn stalks and timothy hay and four pounds of corn meal per day. If, then, there is any profit in producing milk from a ration made up largely of roughage of a carbonaceous character on the basis of this experiment, the profit might be increased one-third by feeding a ration containing a larger amount of concentrated feed and properly balanced in respect to food compounds. It has been claimed that, other things being equal, a small herd well fed will prove more profitable than a large herd poorly fed and the facts brought out by this study emphasize the correctness of this claim. They point to the importance of good feeding in the economical production of milk and butter."

In addition to all the food the cow will eat, she should be provided with as much pure water as she will drink. During the winter the water should be slightly warmed.

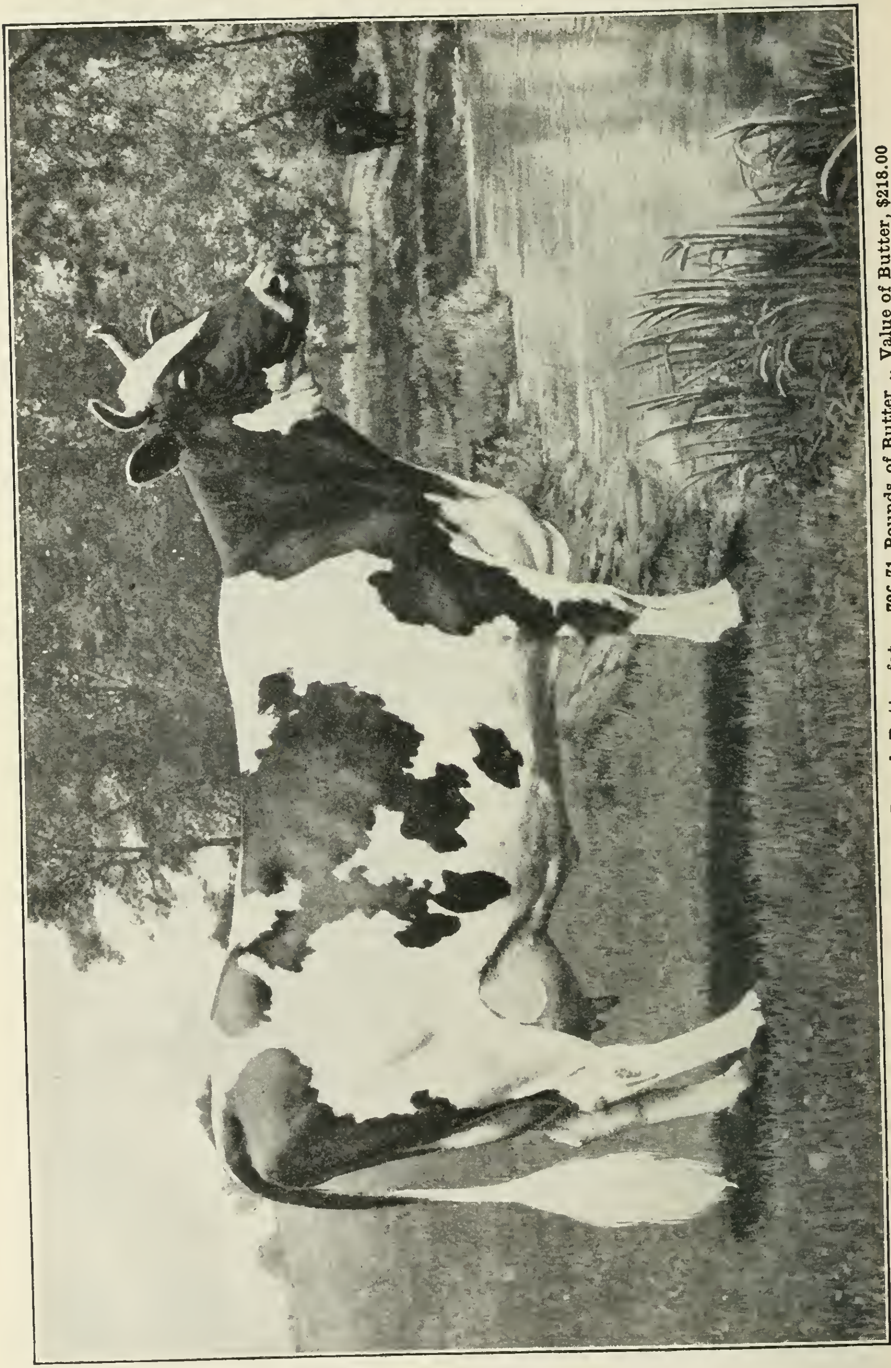
A cow requires from three-quarters to one ounce of salt each day. It is a good plan to keep in some convenient place in the cow lot a few large lumps of rock salt.

Ear Corn Compared with Corn-and-Cob Meal

Lane of the New Jersey Station compared broken ear corn with an equal weight of corn-and-cob meal with the results shown in the table:

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Lot 1— Ear corn, 6 lbs.; corn stover, 10 lbs.; wheat bran, 6 lbs.; hay, 9.4 lbs.	20.2	0.89
Lot 2— Corn-and-cob meal, 6 lbs.; corn stover, 10 lbs.; wheat bran, 6 lbs.; hay, 9.4 lbs.	22.1	0.93

The table shows the returns from the corn-and-cob meal exceed those from ear corn by 9.4 per cent for milk flow and 4.5 per cent in the yield of fat. These returns in favor of grinding corn are not materially different from those secured with fattening steers and swine.



Glencoe's Bopeep .. Year's Record, 622.61 Pounds Butter-fat .. 726.71 Pounds of Butter .. Value of Butter, $218.00

Corn and Mixed Grains

At the Maryland Station Patterson fed cows on corn meal as the sole concentrate during the entire lactation period, while others given a mixture of corn meal, gluten feed and wheat bran in such quantity as to form with the roughage, chiefly dry fodder and silage corn, a balanced ration. The next year the rations were reversed so that each cow was on both sides of the trial. The average yearly returns were as follows:

YIELD PER COW

	Milk, Lbs.	Butter, Lbs.
When corn meal only was fed	3,150	152
When mixed grains were fed	4,195	221

It is shown that the returns were about 45 per cent greater when feeding a balanced ration of mixed grains than with corn meal as the exclusive concentrate. Only when the roughage is rich in crude protein should corn constitute the sole concentrate in the ration of the dairy cow, and even then more variety would be better.

Ground Oats and Bran

Woll of the Wisconsin Station compared ground oats with wheat bran in a feeding trial with four cows lasting 47 days with the results shown in the table.

GROUND OATS COMPARED WITH WHEAT BRAN

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Lot 1— Ground oats, 10 lbs.; clover hay, 6 lbs.; corn meal, 2 lbs. corn stover, without limit	23.3	1.03
Lot 2— Wheat bran, 10 lbs.; clover hay, 6 lbs.; corn meal, 2 lbs.; corn stover, without limit	20.8	0.93

The table shows a return of about 11 per cent more milk and fat from ground oats than from wheat bran. The high feeding value of oats for the dairy cow is well illustrated in this trial.

Kaffir Meal

In a trial with eighteen cows for seven weeks, Cottrell and Skinner of the Kansas Station found that eight pounds of Kaffir meal and twenty pounds of alfalfa hay made the cheapest dairy ration for Kansas conditions. When fed with prairie, timothy, or sorghum hay or corn fodder, Kaffir tends to dry up the cows, and if fed abundantly to fatten them.

Gluten Feed Compared with Wheat Bran and Corn Meal

Cooke of the Vermont Station fed two cows the following rations alternately for periods of eighteen days each to compare gluten feed with the same weight of a mixture of corn meal and wheat bran.

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Ration 1— Gluten feed, 4 lbs.; wheat bran, 2 lbs.; cut hay, 8 lbs.; corn meal, 2 lbs.; corn silage, without limit	21.5	1.08
Ration 2— Wheat bran, 4 lbs.; cut hay, 8 lbs.; corn meal, 4 lbs.; corn silage, without limit	18.7	0.93

The table shows a gain of 15 per cent in milk and 16 per cent in fat through substituting gluten feed for an equal weight of corn meal and bran equal parts.

COTTON-SEED MEAL COMPARED WITH VARIOUS FEEDS

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
(South Carolina Station)		
Lot 1— Cotton-seed meal, 5.1 lbs.; corn silage, 34.8 lbs.	16.4	0.71
Lot 2— Wheat bran, 3.4 lbs.; cotton-seed meal, 3.4 lbs.; corn silage, 32.1 lbs.	15.9	0.68
(New Jersey Station)		
Lot 1— Cotton-seed meal, 4.5 lbs.; corn silage, 36 lbs.; corn stalks, 6 lbs.	22.7	0.96
Lot 2— Wheat bran, 5 lbs.; corn silage, 36 lbs.; dried brewers' grains, 5 lbs.; corn stalks, 6 lbs.	23.9	0.95

Dried Brewers' Grains Compared with Wheat Bran

At the Massachusetts Station, Lindsay compared dry brewers' grains with wheat bran for cows. Seven cows, divided into two lots, were fed in two alternate periods covering four weeks each, the ration and daily returns being as follows:

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Lot 1— Dried brewers' grains, 4.3 lbs.; corn silage, 26.3 lbs.; gluten feed, 3.0 lbs.; blue-grass hay, 12.1 lbs.	21.4	1.1
Lot 2— Wheat bran, 4.4 lbs.; corn silage, 26.2 lbs.; gluten feed, 3.0 lbs.; blue-grass hay, 12.6 lbs.	20.8	1.1

The results show dried brewers' grains somewhat superior to wheat bran for milk production.

Hills of the Vermont Station found dried brewers' grains and wheat bran equal in feeding value to a mixture of cotton seed meal, linseed meal and wheat bran. Hayward and Weld of the Pennsylvania Station found dried brewers' grains equal to buckwheat middlings.

CORN SILAGE COMPARED WITH CORN FODDER

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Lot 1— Corn silage, 44.0 lbs.; wheat bran, 4.6 lbs.; dried brewers' grains, 3.4 lbs.; corn meal, 1.1 lbs.; linseed meal, 1.1 lbs.	23.7	0.90
Lot 2— Corn fodder. 14.3 lbs.; concentrates as above	21.0	0.90

The table shows that the silage fed cows averaged 2.7 pounds or 12.8 per cent more milk daily than those on dry fodder corn, a convincing example of the merits of corn silage.

Corn Silage Compared with Sugar Beets

Haecker of the Nebraska Station compared corn silage and sugar beets with two lots of five cows, each fed for a period of five weeks with the results shown below. The concentrates consisted of equal parts of oats, corn and wheat bran.

Average Ration	Average Daily Yield per Cow	
	Milk, Lbs.	Fat, Lbs.
Lot 1— Corn silage, 30 lbs.; alfalfa hay, 10 lbs.; concentrates, 6 to 10 lbs.	17.4	0.84
Lot 2— Sugar beets, 30 lbs.; alfalfa hay, 10 lbs.; concentrates, 6 to 10 lbs.	16.1	0.78

It is shown that where thirty pounds of corn silage was fed against an equal weight of sugar beets, the small difference in yield of milk and fat was in favor of the silage.

SOILAGE VS. PASTURE

From Wisconsin Station

"SOILAGE means supplying forage such as grass, clover, alfalfa, green corn, rye, oats, etc., fresh from the fields to animals confined in a yard, shed or stable.

"Twenty cows kept in stalls, but allowed to exercise in an open yard, were kept on the green crops from 17 acres of land when 50 acres had previously been required to sustain them. Three cows were kept during the summer on an excellent blue-grass pasture. During the same period three other cows were maintained in a stable and yard by soilage. The pastured cows consumed the grass from 3.7 acres while the soilage cows had the forage from 1.5 acres." The yield of forage was as follows:

	Pounds
Green Clover, three cuttings	18,792
Green Fodder Corn	23,658
Green Oats	2,385
	44,835
Waste from the above	1,655
Total green forage eaten from 1.5 acres	43,180

The product was as follows:

	From 3.7 Acres Pasture	From 1.5 Acres Soiling Crop	Return per Acre	
			Pasture	Soilage
Milk	6,583 lbs.	7,173 lbs.	1,780 lbs.	4,782 lbs.
Butter-fat	303 lbs.	294 lbs.	82 lbs.	196 lbs.

This shows that one acre of soilage equals 2½ acres of good blue-grass pasture.

Grinding Grain for Cows

The average grain left whole when fed to cows, as given by the Michigan Station, is as follows:

	Per Cent
Corn	22.8
Oats	12.1
Corn and Oats	26.5

The foregoing would indicate that it is profitable to grind grain for cows, unless they are followed by pigs. The gain made by pigs following cows, fed on whole grain practically absorbs all loss. It has been repeatedly demonstrated that is does not pay to grind or cook corn for pigs. While there is a slight increase, they require more pounds of feed to make a given amount of gain.

Corn Silage vs. Corn Fodder

The results of the Vermont Station experiments are as follows:

	Pounds
24,858 lbs. of green fodder corn when dried and fed with a uniform daily ration of hay and grain, produced, of milk	7,888
24,858 lbs. of green fodder corn when converted into silage and fed with the same daily ration of hay and grain, produced, of milk	8,525

The experiment shows 837 pounds of milk, or 11 per cent in favor of silage.

At the Wisconsin Station the results were as follows:

"From 29,800 pounds of green fodder 24,440 pounds of silage was obtained. It was fed with 1,648 pounds of hay and 2,884 pounds of grain producing 7,496 pounds of milk containing 340.4 pounds of butter-fat. From 29,800 pounds of green fodder were obtained 7,330 pounds of field-cured fodder corn, which fed with 1,567 pounds of hay and 2,743 pounds of grain, produced 7,119 pounds of milk containing 318.2 pounds of fat, or 377 pounds of milk and 7 per cent more of butter-fat in favor of the silage."

A Well-Balanced Ration

The Illinois Station gives the following for a cow weighing 1200 pounds giving 30 pounds of milk daily:

20 pounds of clover hay
8 pounds of ground corn
6 pounds of wheat bran

This ration contains one pound of protein to 6.4 pounds of carbohydrates and fat.

W. H. Martin, herdsman at the Deere Dairy Farm recommends the following mixtures for dairy cows.

Mixture No. 1—Four parts bran, two parts oats, two parts corn, one part cotton-seed meal.

Mixture No. 2—100 pounds corn, 200 pounds oats, 300 pounds bran, 200 pounds oil meal, 200 pounds cotton-seed meal.

Mixture No. 3—250 pounds oats, 200 pounds corn and cob meal, 200 pounds bran, 150 pounds gluten, 175 pounds cotton-seed meal, 100 pounds oil meal.

Mixture No. 4—150 pounds corn grains, 300 pounds oats, 200 pounds bran, 250 pounds gluten, 200 pounds cotton-seed meal.

Mixture No. 1 is especially adapted to cows before calving. The daily ration of the others should depend upon the amount of milk given and the size of the cow. Usually one pound of the mixture for every three or four pounds of milk is sufficient.

To the above rations should be added from twenty to thirty pounds of corn silage, ten to twenty pounds of clover or alfalfa hay and from eight to ten pounds of beets or other roots.

A good ration for the average herd is:

18 to 20 pounds of clover, alfalfa or pea hay
35 to 38 pounds of corn silage
2 to 3 pounds of corn meal
2 to 3 pounds of ground oats
2 pounds of linseed meal

Various Rations for Dairy Cows

(By Henry)

A Poor Ration—Timothy hay, 20 pounds; ground corn, 4 pounds; dried brewers' grains, 7 pounds.
A Fair Ration—Clover, 22 pounds; ground corn, 8 pounds.
An Ideal Ration—Corn silage, 40 pounds; clover hay, 15 pounds; cotton-seed meal, 1 pound; ground corn, 3 pounds.

To the above rations should be added all the roughages the cow will eat.

Roughages, Class One—Poor in digestible crude protein, poor in digestible carbohydrates, high in fiber: Wheat straw, barley straw, marsh hay, salt marsh hay, cotton-seed hulls, corn stover, oat straw, rye hay.

Roughages, Class Two—Fair in digestible crude protein, fair in digestible carbohydrates, considerable fiber: Timothy hay, redtop hay, Bermuda hay, Johnson-grass hay, sorghum fodder, Kaffir fodder, milo fodder, corn fodder, corn silage, roots.

Roughages, Class Three—Rich in digestible crude protein, fair in digestible carbohydrates, considerable fiber: Alfalfa hay, red clover hay, cow pea hay, vetch hay, soy bean hay, velvet bean hay, beggar-weed hay.

Concentrates, Class Four—Fair in digestible crude protein, rich in digestible carbohydrates, little fiber: Ground corn, corn-and-cob meal, hominy feed, oats, barley meal, emmer meal, rye meal, buckwheat meal, buckwheat bran, rice meal, Kaffir, milo, dried beet pulp.

Concentrates, Class Five—Rich in digestible crude protein, fair in digestible carbohydrates, some fiber: Low-grade flour, wheat bran, wheat middlings, rye bran, rye middlings.

Concentrates, Class Six—Highest in digestible crude protein, fair in digestible carbohydrates, little fiber: Gluten meal, gluten feed, buckwheat middlings, cow pea meal, soy bean meal, linseed meal, field pea meal, cotton-seed meal, soy bean cake meal, dried brewers' grains, dried distillers' grains.

A Safe Guide

When there is an ample supply of suitable roughages, the following is a safe rule:

Give to each cow as many pounds of concentrates daily as she yields pounds of butter-fat weekly, or one pound of concentrates daily for every three or four pounds of milk yielded daily.

If rich silage is given, the amount of concentrates should be less.

FEEDING CALVES

A CALF should be carefully cared for and judiciously fed during the first few weeks of its life. If affected with scours, indigestion or any ailment, it becomes stunted and its subsequent development will be retarded.

Many dairymen deem it advisable to feed pure-bred calves whole milk for several weeks, and some permit the calf to run with its mother, believing that the calf is less liable to be afflicted with bowel and stomach troubles and will make a greater gain. As a rule, it is not profitable, owing to the value of butter-fat, to feed calves whole milk after the first ten days or two weeks.

If the milk contains as much as four and one-half or five per cent of butter-fat, a delicate stomach may reject it or it may weaken a strong stomach. In that event, warm water or thin milk should be added.

If the farmer does not have a market for his butter-fat, but does have an extensive range, it is profitable to raise animals for beef, permitting the calves to run with the dams.

As soon as possible the calf should be taught to eat shelled corn, oats, bran, etc.; otherwise, at weaning time it is apt to become stunted while learning to eat grains.

When to Wean the Dairy Calf

As a general proposition, it is a good plan to separate the calf from its mother very soon after it is born. If the calf is permitted to be with its mother a few days, it is more difficult to teach it to drink, and the attachment formed between the two causes both to fret after separation more than they otherwise would. The calf should, however, always get the first milk or colostrum, which is designed by nature for cleansing the bowels and stimulating normal digestion.

Feeding the Calf

Give the calf two or three pounds of whole milk containing from three to three and one-half per cent of butter-fat three times daily for a period of two weeks, thereafter dilute the whole milk by adding from 20 to 25 per cent of skim milk each week until all the milk given is skim. In addition to the milk, a small quantity of grains should be given. Skim milk is rich in protein, but contains very little of the carbohydrates; hence, as skim milk is added, grains containing carbohydrates should be supplied. Corn meal or shelled corn is probably the best substitute for butter-fat. The young calf's stomach is very small and will not hold a great amount of milk at first. Too often over-feeding is responsible for many of the calf's afflictions. Milk should be given sweet and warm. Each calf should be fed separately from a pail, and the pail kept perfectly clean. Scours and other stomach and bowel troubles are usually caused from unsanitary pails or troughs.

Otis of the Wisconsin Station makes the following concise statement in regard to feeding calves:

"Skim milk contains more protein and carbohydrates than whole milk. In selecting a grain to take the place of the fat that has been removed, it is neither necessary nor advisable to get one rich in protein, as the skim milk furnishes this nutrient. While calves may do well on high-priced concentrates, they are unnecessarily expensive and give no better results than the cheaper carbonaceous grains such as corn, oats, barley, Kaffir or sorghum."

Calves will sometimes learn to eat the grain more readily if a little bran forms a part of the ration for a short time. A number of farm grains have been used successfully in feeding calves. The following list may serve as a guide to the calf feeder in making selections or combinations to suit his conditions:

1. Corn meal gradually changed in four to six weeks to shelled corn with or without bran.
2. Whole oats and bran.
3. Whole oats or corn chop, the latter being gradually replaced by shelled corn in four to six weeks.
4. Ground barley with bran or shelled corn.
5. Shelled corn and ground Kaffir or sorghum.
6. Whole oats, ground barley and bran.
7. A mixture of 20 pounds of oat meal, 20 pounds of oil meal, 10 pounds of blood meal and 5 pounds of bone meal, changed to corn, oats and bran when calves are three months old.
8. A mixture of 6 pounds whole oats, 3 pounds bran, 1 pound of corn meal and 1 pound of linseed meal.

The calf may be taught to eat grain by rubbing a little on its mouth when it is through drinking milk. There is little danger of calves getting too fat on any of these grains while being fed skim milk. Should any of the dairy calves show a tendency to fatten, a little bran or oil meal can be added to the ration and the corn reduced or removed. After weaning from milk, greater care will be needed in selecting grains containing the right amount of protein and mineral matter for the proper development of bone and muscle.

There is also little or no danger of the calf fed skim milk eating too much grain. The young calf makes better gains for grain consumed than the older calf, which is an additional reason for giving it all it will eat. Limiting the grain ration causes a loss in gain and is seldom to be recommended. The calf is possessed of a good set of grinder teeth and when from four to six weeks of age, is able to do most of his own grinding. A number of feeders have obtained excellent results with whole oats. Experiments indicate that calves do better and are less subject to scours when fed shelled corn instead of corn chop. Grains that are small and hard, like sorghum and Kaffir, give better results ground.

When possible, it is best to feed a mixture of two or three grains than one, but a large variety does not seem to be of any special merit. A number of calf meals may be purchased on the market. While these undoubtedly possess some merit, they are usually high-priced, and, as a rule, possess no particular merits over a good combination of farm-grown grains. It is not advisable to mix grain with the milk. The calf needs to properly masticate it and not gulp it down before the starchy matter of the feed is acted upon by the saliva. This precaution will frequently avoid scours.

Calves will eat roughages at about the same time they begin to eat grain, viz., two or three weeks of age, and will consume about the same quantity of each at first. As the calf grows older, the proportion of roughage to grain increases, and, by the time the calf is six months of age, it will have consumed about three times as much roughage as grain. The quality of the hay should be of the best, always clean and bright. It can be placed in a rack in one corner of the calf pen. Any left uneaten should be removed at the next feeding and a new supply added.

The Kansas Station reports the following:

How Fed	Before Weaning				210 Days in Feed Lot, After Weaning	
	No. of Calves	Length of Time (Days)	Average Daily Gain (Lbs.)	Cost for 100 Lbs., Gain	Average Daily Gain (Lbs.)	Concentrates Per 100 Lbs., Gain
Skim Milk	10	154	1.5	$2.26	2.1	439
Whole Milk	10	154	1.9	7.06	1.9	470
Running w'h Dam	22	140	1.8	4.41	2.0	475

The above fully illustrates the great value of skim milk for calves. It must be remembered that skim milk is very rich in protein and to secure the best results, carbohydrates in the form of corn, grains, corn meal or Kaffir corn must be given to make a balanced ration. In the above test, those fed skim milk and whole milk were given, in addition, equal parts of corn meal and Kaffir meal with alfalfa hay. After weaning, all were placed in the feed lot and given the same ration.

After a calf is two months old, it should be given water to drink three or four times during the day. If the calf is puny and does not eat well, it should be given from one teaspoonful to one tablespoonful dried blood or blood meal in the skim milk each day. Blood meal is a splendid tonic as well as a good remedy in cases of scours.

Martin Recommends the Following Rations for Calves

Calves until they are two weeks old should be given whole milk and one third of a pound of grain and all the hay and grass they will eat. After a period of two weeks, twenty-five per cent of skim milk should be added each week until all the milk is skim. The amount of grain should be increased from one-third of a pound to two pounds according to the age of the calf.

In Martin's test with skim milk and whole milk, he found that after a calf was five weeks old it made a greater gain on skim milk than on whole milk, when the proper amount and kinds of concentrates were added.

Pens

The calf quarters should be kept clean. A damp dirty unventilated pen is one of the main causes of disease. The calf should receive sunlight and air and plenty of clean bedding. The bedding should not be permitted to become damp and filthy. During the summer a well shaded pasture should be provided.

Scours

When the calf has scours, it should be isolated. This trouble, which depletes and stunts the calf, is caused from dirty pens, dirty pails and troughs, sour milk, old milk, cold milk and over-feeding. This serious trouble can be prevented if the dairyman will observe cleanliness, give sweet milk at the right temperature and not feed too much at a time. It is better to feed often, especially during the first few weeks of the calf's life. Scalded milk will sometimes give relief and a spoonful of blood meal will often check the trouble in its early stages. Castor oil given in doses of from two to six tablespoonfuls well shaken in the milk is a good remedy. This should be followed with one or two teaspoonfuls of a mixture of one part of salol and two parts of subnitrate of bismuth given at intervals of four to six hours according to the severity of the case.

White Scours

This is an infectious disease contracted through the freshly broken navel cord. It usually occurs within a day or two after the calf is born and runs a rapid course. If one calf becomes infected, others are liable to contract the disease if kept in the same stable. The stall should be kept clean and thoroughly disinfected. As a protection against this disease, it is well to dress the cord very much in the same manner as the doctor dresses the navel cord of the new-born babe. A mild solution of carbolic acid or creolin should be applied before and after the dressing.

SWINE

Feed and Care

SWINE-RAISING is a feature of farming that deserves careful attention. The hog is a great factory. It rapidly converts many products of the soil into human food which usually command a very attractive price the world over. By converting corn and other grains into pork, their value is increased above the market value of the grains, provided the factory is properly managed. If the scientific side of feeding and proper care is ignored and the theory is adopted that corn alone is the hog's natural feed and a balanced ration is disregarded, the farmer will secure no more for his pork than the market value of the corn and other grains. While, on the other hand, if he adopts systems that have demonstrated that the value of a bushel of corn, when properly mixed with other feeds, can be greatly increased, he will find hog-raising the most profitable feature of farmimg.

Too often the value of a good pasture, pure water and an abundance of shade during the summer months is not appreciated. Young pigs should be turned into a mixed pasture of clover, alfalfa, bluegrass, rape, or soy beans as early in the spring as possible. If such pastures are not available, turn them on winter rye which usually makes an early growth. If the pigs are given a good early pasture, which is continued through the summer months, they will make a very rapid growth with but little corn and after they have attained a weight of 160 or 175 pounds, they should be shut up and finished on corn.

The farmer must keep in mind the fact that the pig requires protein during its early growth, and without it, it will not gain very rapidly. He must also remember that after a reasonable growth has been attained it should be given a carbohydrate in order to make it fat. Protein is secured from clover, alfalfa, cow peas, soy beans and rape, as well as in other pastures mentioned. Carbohydrates are contained in corn.

Pigs should not be permitted to become stunted during their early growth, for such a condition is reflected during the entire life of the hog.

Pigs and hogs should not be shut up in a dirty pen and given corn and swill and be denied exercise and a good pasture. In order to be healthy and make a rapid growth, they require a balanced ration, fresh air, exercise and an abundance of pure water. Running streams and mud wallows are not conducive to good health. The wallows should be made of cement and washed out every few days. The feeding places should also be of cement.

By using these precautions, the farmer will go a long way toward preventing cholera and other diseases.

In order to keep the skin healthy and the pig free from vermin, it should occasionally be dipped. A dipping tank can be constructed of cement at little cost, and the pigs can be run through the tank from time to time, without much trouble.

While no fixed rules regarding feed can be given to meet all classes of pigs and conditions, we will present the results of experiments which have been successfully tried by swine-raisers and experimental stations.

Jerusalem Artichokes

Mr. A. C. Williams of Vinton, Iowa, a very prominent and successful breeder of Poland Chinas, says:

"The keep of my hogs in warm weather consists of blue grass, clover and Jerusalem artichokes, sometimes called Brazilian artichokes. Forty head of hogs and their pigs may be kept without other food on an acre of artichokes from the time the frost is out of the ground until the first of June and from September or October until the ground is again frozen.

"To grow them, the ground should be rich, plowed eight or ten inches deep, the tubers cut the same as seed potatoes and planted from early spring to June 10th, ten to fifteen inches apart, in rows that are three feet apart, planting six bushels of seed to the acre.

"They can also be planted in the fall, from October 15th to November 15th, but the tubers should not be cut and the ground should be thoroughly rolled after planting.

"If planted in spring, plenty of rain in July and August will make them large enough to turn hogs on in September; otherwise, not until a month later. If in foul ground, they may, when three or four inches high, be given a thorough working with cultivators, and when the hogs have been removed to allow a new crop of tubers to grow, the ground should be made smooth by harrowing, that the tops may be cut with a mower as food for cattle and horses.

"Enough seed will remain in the ground for another crop, but they can easily be eradicated by mowing off the tops and plowing the ground deeply in July and the early part of August.

The Brazilian artichoke is red and does not spread or scatter like the wild, white variety and produces more hog feed to the acre than any crop I am acquainted with. The hogs will harvest the crop themselves.

"Hogs taken from the artichoke pastures to clover and blue grass will not root up the sod, as they are free from intestinal worms, constipation, indigestion and fever, caused by feeding corn in winter."

A Good Plan—Let the Hogs Do the Harvesting

Have four lots as follows:

Lot No. 1 is sown to rye early in the fall and seeded to clover early in the spring.

Lot No. 2 is sown to alfalfa during the summer or early fall.

Lot No. 3 is planted to sweet corn and cow peas in the spring.

Lot No. 4 is planted to field corn.

In the spring turn the pigs into the rye lot. They will eat down the rye and tramp the clover seed into the ground. After they have been in the rye for one month, turn them into the alfalfa lot. When the rye is nearly ripe, turn them back into the rye field. After the rye is eaten down, turn them into the sweet corn and cow peas, leaving the gates open into the rye and alfalfa lots. Between the young clover, alfalfa, cow peas and corn, the pigs will be ready for market when the corn is gone. The corn in Lot No. 4 is husked and fed to the brood sows during the winter. By adopting this plan, the hogs do most of the harvesting and the farmer secures from $40.00 to $50.00 per acre from his land.

Rape

Rape is a very valuable pasture for pigs of all ages. It makes a rapid rank growth in rich ground, reaching a height of a foot or more in six or eight weeks. Pigs can be turned in at any time after it is six or eight inches high. Pigs on a rape pasture should be given a little corn or other grain.

Pigs make a greater gain on rape than on clover and the amount of concentrates required per one hundred pounds gain is less. In speaking of the importance of legumes, rape and roots, Henry says:

"If this country is to make any further great advancement in pork production, such progress must come in no small measure through the wider and more intelligent use of legumes, rape and roots. Because the hog shows supreme fondness for corn and because that grain is widely and easily grown, we have come to think of corn and the hog as the beginning and end of pork production. It is true we provide meagerly of other feeds, but grudgingly and under protest, as it were, regarding anything other than corn as something to be given in small amount rather than liberally. Let us now change the viewpoint and hold that it is not only best, but also more economical to grow the pig largely on the legumes, rape and roots, and use a heavy allowance of corn for fattening only. The feeder who will conduct his operations on this basis will find his pork output greatly increased and his income correspondingly advanced. Instead of measuring the possible pork output by the quantity of corn available, one should figure on what is possible from all the available corn plus the gains that the pigs can make from the freest use of all such crops as alfalfa, clover, Canada peas, soy beans, cow peas, peanuts, rape and roots that the farm will economically grow. By the wisest and largest use of these crops throughout the land, the amount of pork now produced in the United States can easily be doubled without any corresponding increase in the total cost of production. The large and general use of the legumes, rape and roots by those who raise swine means larger litters of pigs, a reduction in the present heavy death-rate of the young and the more rapid growth of sturdy, vigorous young hogs that will finally fatten more quickly and on less corn than under the still too common system of well-nigh continuous corn feeding from birth to slaughter."

Growing legumes and roots will so improve the soil that all of the feed from this source which is fed to the pig is produced at small cost. Fields as well as pigs will be benefited by this rational expansion which should rapidly come in our system of pork production through combining the feeding of legumes and roots with the proper use of corn and the other cereal grains.

Peanuts

Peanuts are regarded in the South as a very desirable feed for pigs. They require no more attention than corn and the production of nuts is very large. The pigs are turned in the field when the beans are matured.

At the Alabama Station, Gray, Duggar and Ridgeway fed three lots of 61-pound pigs for 60 days upon the rations shown in the table following to determine the value of peanuts in supplementing corn for fattening pigs.

PEANUTS AS A SUPPLEMENT TO CORN

Average Ration	Average Daily Gain, Lbs.	Feed for 100 Lbs. Gain	
		Concentrates, Lbs.	Peanut Pasture, Acres
Lot 1— Corn, 3.8 pounds	0.7	560	----
Lot 2— Corn, 1.6 pounds; Foraging peanut field	0.9	177	0.12
Lot 3— Corn, 1.1 pounds; Cotton-seed meal, 0.5 pounds; Foraging peanut field	1.0	158	0.08

The table shows that pigs fed 3.8 pounds corn gained only 0.7 pounds daily, while those getting 1.6 pounds of corn daily and foraging in the peanut field, gained 0.9 pounds. Lot 3, fed two parts corn and one part cotton-seed meal while in the peanut field made slightly larger gains than Lot 2 on corn and peanuts. It was found that one acre of good peanuts was equal to about 3,200 pounds of corn in feeding value.

The Arkansas Station reports the following:

One acre of peanuts gave 1,252 pounds gain. One acre of corn gave 436 pounds gain.

Peanuts, being rich in protein, should be supplemented with corn to secure hard, sweet pork. The digestible nutrients in 100 pounds of peanut kernels are: crude protein, 25.1 pounds; carbohydrates, 13.7 pounds, and fat, 35.6 pounds.

Skim Milk

Skim milk, being rich in protein and ash, is valuable as a muscle and bone builder, but to secure the best results, it should be mixed with corn or other starchy grains in the right proportion to make a balanced ration. A good plan is to mix a little corn meal with the milk.

Beach fed 25-pound pigs on skim milk alone; also in combination with grain, during an 86-day trial with the following results:

FEEDING SEPARATOR SKIM MILK ALONE AND IN COMBINATION WITH GRAIN

Average Ration	Average Daily Gain, Lbs.	Feed for 100 Lbs. Gain	
		Skim Milk Lbs.	Grain, Lbs.
Lot 1— Skim milk, 19.7 lbs.	0.72	2,739	-----
Lot 2— Skim milk, 17.2 lbs. Grain, 2.2 lbs.	1.28	1,341	168
Lot 3— Skim milk, 12.9 lbs. Grain, 3.2 lbs.	1.38	935	233
Lot 4— Grain, 2.1 lbs.	0.47	-----	445

This trial shows a loss from feeding even young pigs entirely on skim milk, for when so fed, they required over 2,700 pounds of milk for 100 pounds of gain. By feeding meal with the milk, far more rapid and economical gains were made. Skim milk, rich in protein and mineral matter, should always be combined with starchy carbohydrates such as corn, barley, Kaffir, milo, etc., in which case it becomes one of the most useful of all available feeds for the pig.

SKIM MILK RATIONS FOR PIGS
By Goessman

Weight of Pigs, Lbs.	Food	Nutritive Ratio
20 to 80	2 ounces corn meal to each quart skim milk.	1 to 3
80 to 125	4 ounces corn meal to each quart skim milk.	1 to 4
125 to 190	6 ounces corn meal to each quart skim milk.	1 to 4.5

Each animal is given as much of the mixture as he will eat.

Henry found that the use of these two feeds, in the proportions of one pound of corn meal to three pounds of skim milk, resulted in the production of a pound of pork on a smaller number of pounds of digestible nutrients than grains alone or corn meal and skim milk in any other proportions.

Extensive experiments convinced Henry that 462 pounds of skim milk effected a saving of 100 pounds of corn meal.

Corn, Soy-Bean Pasture, Tankage and Cotton-Seed Meal

The Alabama Station in Bulletin No. 154 gives some very interesting results from the above mentioned feeds. For comparison the following prices are used.

Corn, per bushel	$ .70
Tankage, per ton	40.00
Cotton-seed Meal, per ton	30.00
Soy-Bean Pasture, per acre	8.00

The summary of the results are as follows:

Prices realized from each bushel of corn when fed in connection with soy-bean pasture, with tankage, with cotton-seed meal, and when fed alone.

AVERAGE OF THREE YEARS

No. Lot	Ration	Selling Price of Corn when Hogs Sell at:			
		5 Cents	6 Cents	7 Cents	8 Cents
1	Corn, ¼ ration, soy-bean pasture	$2.68	$3.55	$4.33	$5.15
2	Corn, ½ ration, soy-bean pasture	1.37	1.77	2.18	2.58
3	Corn, ¾ ration, soy-bean pasture	1.29	1.61	1.93	2.25
4	Corn alone	.46	.55	.64	.74
5	Corn, 9-10 tankage, 1-10	.78	.96	1.15	1.34
6	Corn, 9-10; cotton-seed meal, 1-10	.67	.82	.97	1.12

The following table from the same bulletin is also very interesting.

SOY BEAN PASTURES VS. CORN ALONE AND THE MOST PROFITABLE AMOUNT OF CORN TO USE WITH THE PASTURE

Average of Three Years Work

Lot No.	Ration	Average Daily Gains, Lbs.	Feed to Make 100 Lbs. of Pork, Lbs.	Cost of Grain to Make 100 Lbs. of Pork	Grain Plus Pasture Cost to Make 100 Lbs. of Pork	Value One Acre in terms of Corn, Bushels
1	Corn, ¼ ration Soy-bean pasture	1.102	68 .218 Acr.	$0.85	$2.59	44
2	Corn, ½ ration Soy-bean pasture	1.006	138 .204 Acr.	1.73	3.36	41
3	Corn, ¾ ration Soy-bean pasture	1.329	175 .123 Acr.	2.19	3.17	63
4	Corn alone	.375	609	7.61	7.61	

Following taken from Henry:

"Field Feeding Corn. Gaumnitz, Wilson, and Bassett of the Minnesota Station turned one lot of pigs into ripe standing corn and fed another lot ear corn in a yard, with the results shown in the following table. Rape sown broadcast in the corn field before the last cultivation furnished succulent feed to the foraging lot, and both lots received an allowance of wheat shorts. The amount of corn eaten in the field was carefully estimated.

FIELD FEEDING OF CORN COMPARED WITH FEEDING CORN IN YARD

How Fed	Number of Pigs Fed	Length of Trial Days	Average Daily Gain, Lbs.	Ear Corn and Shorts for 100 Lbs Gain, Lbs.
First Trial—				
Lot 1, foraging corn	26	49	1.3	835
Lot 2, fed ear corn	13	49	1.0	1,042
Second Trial—				
Lot 1, foraging corn	32	61	1.4	635
Lot 2, fed ear corn	8	61	1.1	677

Corn-and-Cob Meal

The studies of the stations on the merits of corn-and-cob meal for swine feeding have shown widely discordant results. Those of Kennedy and Robbins of the Iowa Station, which are by far the most detailed, complete, and satisfactory, are condensed in the following table:

CORN-AND-COB MEAL COMPARED WITH WHOLE CORN AND CORN MEAL FOR PIGS

Kind of Corn Fed	Average Weight at Beginning, Lbs.	Average Daily Gain, Lbs.	Corn for 100 Lbs. Gain, Lbs.	Lbs. Gain Per Bushel of Corn
Dry ear corn	148	0.74	456	12.3
Soaked shelled corn	134	0.63	513	10.9
Dry corn meal	128	0.61	595	9.4
Soaked corn meal	145	0.72	555	10.1
Dry corn-and-cob meal	118	0.51	604	9.3
Soaked corn-and-cob meal	123	0.56	583	9.6

Gluten Meal

At the Cornell Station, Clinton compared gluten meal and skim milk with corn meal and skim milk, feeding two lots, each of eight pigs averaging 70 lbs., for 50 days with the results shown below:

GLUTEN MEAL COMPARED WITH CORN MEAL

Average Ration	Average Daily Gain, Lbs.	Average Total Gain, Lbs.	Feed for 100 Lbs. Gain	
			Meal, Lbs.	Milk, Lbs.
Lot 1— Gluten meal, 2.4 lbs. Skim milk, 6.4 lbs.	0.9	46	255	684
Lot 2— Corn meal, 2.7 lbs. Skim milk, 7.3 lbs.	1.3	65	206	569

Wheat Shorts

In a 60-day trial at the New Hampshire Station, Shaw compared wheat shorts with corn meal as a feed for 47-lb. pigs, obtaining the results shown below:

LOW-GRADE WHEAT SHORTS COMPARED WITH CORN

Average Ration	Average Daily Gain, Lbs.	Feed for 100 Lbs. Gain	
		Concentrates, Lbs.	Skim Milk, Lbs.
Lot 1— Wheat shorts, 2.2 lbs.	0.3	787	-----
Lot 2— Corn meal, 3.0 lbs.	0.5	591	-----
Lot 3— Wheat shorts, 2.1 lbs. Skim milk, 8.3 lbs.	0.5	412	1,647
Lot 4— Corn meal, 3.2 lbs. Skim milk, 13.0 lbs.	1.3	255	1,019

In this trial the wheat shorts proved unsatisfactory for young pigs, whether fed alone or with skim milk. They were doubtless ground over bran with mill dust and sweepings added, judging by the results. Such feed has little value compared with cost and should be avoided by the pig feeder.

Oats

At the Wisconsin Station Henry fed whole and ground oats with corn meal to 115-lb. pigs for 60 days with the following results:

WHOLE OATS COMPARED WITH GROUND OATS

Feed	Average Ration, Lbs.	Average Daily Gain Lbs.	Feed for 100 Lbs. Gain, Lbs.
Whole Oats—			
Lot 1, $\frac{2}{3}$ oats, $\frac{1}{3}$ corn meal	3.8	0.68	564
Lot 2, $\frac{1}{3}$ oats, $\frac{2}{3}$ corn meal	4.0	0.82	492
Ground Oats—			
Lot 1, $\frac{2}{3}$ oats, $\frac{1}{3}$ corn meal	4.4	1.03	429
Lot 2, $\frac{1}{3}$ oats, $\frac{2}{3}$ corn meal	5.1	1.27	402

We observe that the pigs getting whole oats ate less feed and gave poorer returns than those fed ground oats. The best returns were with a ration of one-third ground oats and two-thirds ground corn. In both trials the feed requirements for 100 lbs. of gain were very low where ground oats were used, showing the high value of ground oats when combined with corn.

Sugar Beets

At the Utah Station Clark feed sugar beets, wet beet pulp, and beet molasses in combination with wheat shorts to 4 lots of 130-lb. pigs for 48 days with the results shown below:

SUGAR BEETS, BEET PULP AND BEET MOLASSES FED TO PIGS

Average Ration	Daily Gain, Lbs.	Feed for 100 Lbs. Gain			
		Shorts, Lbs.	Beet Pulp, Lbs.	Sugar Beets, Lbs.	Molasses Lbs.
Lot 1— Shorts, 7.6 lbs.	1.7	444	---	---	---
Lot 2— Shorts, 3.2 lbs. Sugar beets, 8.3 lbs.	1.2	268	---	697	---
Lot 3— Shorts, 3.3 lbs. Beet pulp, 12.3 lbs.	1.2	275	1,030	---	---
Lot 4— Shorts, 3.0 lbs. Beet pulp, 9.4 lbs. Beet molasses, 4.4 lbs.	1.6	186	600	---	281

Feeding Potatoes

In two trials at the Wisconsin Station, potatoes were cooked in an open kettle, using as little water as possible, and corn meal added to form a thick mush which was eaten by pigs with great relish. Corn meal wet with water was fed to a second lot for comparison. The results were as follows:

440 lbs. of corn meal, fed alone, produced 100 lbs. of gain. 262 lbs. of corn meal with 786 lbs. of potatoes, weighed before cooking, produced 100 lbs. of gain.

From this we learn that 786 lbs. of potatoes when fed to pigs after being cooked, effected a saving of 178 lbs. of corn meal, 442 lbs. of potatoes taking the place of 100 lbs. of corn meal.

At the Copenhagen Station Fjord found 400 lbs. of cooked potatoes equal to 100 lbs. of mixed grain for swine. Since corn has a somewhat higher feeding value than the grains used by Fjord, it is fair to hold that 4.5 bu. (of 60 lbs. each) of potatoes after cooking are equal to one bushel (56 lbs.) of corn in pig feeding. Grisdale of the Ottawa Experimental Farm reports that raw potatoes alone will scarcely maintain life in pigs, but if given in small quantities with grain they help to keep them in health when other succulent food is lacking.

TO obtain the best results from feeds in this department, skill and judgment are required, not only in feeding, but in care and selection of breeds. While opinions differ regarding the care that should be given cattle on full feed, there should be but one opinion regarding the question of protection against bad storms and severely cold weather.

While the natural heat of the body is sufficient to maintain a normal temperature without drawing upon reserve fat during ordinary weather, it is very certain that during extremely cold spells an extra amount of fuel is required to maintain the heat of the body and that it is taken from the reserve store of accumulated fat. At the same time, an abundance of fresh air and a reasonable amount of exercise is necessary to maintain a healthy digestion. It is just as reasonable to suppose that a house unprotected during zero weather would require no more fuel to maintain a comfortable temperature than one protected, as to suppose that an animal would maintain its normal temperature when exposed to zero weather or colder on the same amount of fuel as it would in comfortable quarters.

Open Shed vs. Confinement

Waters, of the Missouri Station, housed a bunch of dehorned fattening steers in comfortable, well-bedded quarters during the winter. They were turned out for water at nine o'clock each morning, remaining in the yard until four o'clock in the afternoon, except during stormy weather, when they were out only long enough to drink. Another similar bunch was fed in an open shed located in a small lot. The average returns for four winters were:

	In Barn, Pounds	In Open Shed Pounds
Daily gain per steer	1.7	1.9
Gain per bushel of corn	4.9	5.2
Digestible matter eaten per pound of gain	11.3	10.3

It is seen that the steers running in an open shed made greater gains than those confined in a close barn. This is due to the fact that in the open shed they were in a great measure protected from the cold and at the same time given a reasonable amount of exercise, while in the closed barn they did not receive a sufficient amount of fresh air nor enough exercise to maintain active digestion.

Box-Fed and Stall-Fed

At the Ontario Station it was found that box-fed steers made larger and cheaper gains than steers tied in stalls.

The above demonstrates that even a limited amount of exercise is beneficial.

Balanced Rations

Beef cattle require, in order to secure the best results, a balanced ration. During the growing stage, they should receive feed rich in protein or what is known as a narrow ration. During the latter end of the feeding period, when an accumulation of fat is desired, the ration should be widened, or, in other words, should contain a greater amount of carbohydrates.

The following table furnished by Winters is strictly in keeping with thousands of other trials of like character showing the difference between a well-balanced and an unbalanced ration. In this trial, there were four steers in each bunch. In each trial the same amount of corn was given to the different lots and all the hay they would eat.

	Pounds
4 steers fed 104 days corn and timothy hay, gain	260
4 steers fed 104 days corn and cow pea hay, gain	624
4 steers fed 80 days corn and timothy hay, gain	318
4 steers fed 80 days corn and clover hay, gain	640
4 steers fed 80 days corn and millet hay, gain	119
4 steers fed 105 days corn and timothy hay, gain	789
4 steers fed 105 days corn and clover hay, gain	1135
4 steers fed 105 days corn and cow pea hay, gain	1134

Feeding Corn in Various Forms to Steers

Mumford of the Illinois Station fed four lots of choice feeders, averaging about 1,000 pounds each for 186 days. Lots 3 and 4 contained ten steers each, and the other lots fifteen steers each. Pigs following the steers worked over the droppings. Each lot was given clover hay for roughage, a limited allowance of gluten meal being fed in the first half and of oil meal in the second half of the trial. As the table shows, Lot 1 was fed ear corn, Lot 2 corn-and-cob meal, Lot 3 shelled corn, Lot 4 corn meal, Lot 5 ear corn and shock corn, this lot being fed no gluten meal.

Lot 2, fed corn-and-cob meal, made neither larger nor more economical gains than Lot 1, fed ear corn, while the pigs following the steers getting ear corn made decidedly better gains than those following the steers fed corn-and-cob meal.

Lot 3, getting shelled corn, made the poorest gains, due to the fact, Mumford tells us, that these steers did not masticate their corn so thoroughly as the others. While about the same amount of concentrates was required for 100 pounds gain as with the preceding lots, it must be remembered that the ear corn and the corn-and-cob meal rations contained over 17 per cent cob. Thus, shelled corn proved inferior to ear corn or corn-and-cob meal in beef production.

Average Ration	Average Daily Gain, Lbs.	Average Gain per head, Lbs.	Feed for 100 Lbs. Gain		Gain of Pigs per 100 Lbs. Corn Fed to Steers, Lbs.
			Concentrates, Lbs.	Roughages, Lbs.	
Lot 1— Ear corn, 20.1 lbs. Gluten or oil meal, 2.9 lbs. Clover hay, 8.0 lbs.	2.3	434	986	344	1.7
Lot 2— Corn-and-cob meal 20 lbs. Gluten or oil meal, 2.9 lbs. Clover hay, 8.1 lbs.	2.3	432	993	350	0.5
Lot 3— Shelled corn, 16.6 lbs. Gluten or oil meal, 3.0 lbs. Clover hay, 9.0 lbs.	2.0	370	984	454	3.6
Lot 4— Corn meal, 16.6 lbs. Gluten or oil meal, 2.9 lbs. Clover hay, 8.7 lbs.	2.4	443	822	370	0.7
Lot 5— Ear corn, 13.5 lbs. Oil meal, 1.4 lbs. Shock corn, 14.7 lbs. Clover hay, 7.2 lbs.	2.1	388	*991	782	1.8

*Including ear corn in the shock corn.

The steers in Lot 4, fed corn meal, made the largest gains, and required 164 pounds less concentrates for 100 pounds gain than those fed shelled corn. Considering the low gains of the pigs following the corn-meal-fed steers, corn meal was no more efficient than shelled corn for combined beef and pork production. Ear corn proved the most economical form of corn for combined gains of steers and hogs.

Good Rations

The following combinations are very desirable. The amount of the various feeds can be changed to suit conditions. The farmer must remember that some steers are larger and have a greater capacity than others and some steers take on fat more readily than others, hence he should add to or take from the ration, carbohydrates and protein as may seem advisable.

Ration No. 1—	Pounds
Clover or alfalfa hay	6
Corn silage	18
Corn meal or kaffir corn meal	12 to 15
Bran	2 to 3

	Pounds
Ration No. 2—	
Alfalfa or clover hay	8 to 10
Corn meal	10
Barley, either whole or ground	3
Ground oats	5

	Pounds
Ration No. 3—	
Mixed hays	7
Silage	25
Oats	10
Cotton-seed meal	1

	Pounds
Ration No. 4—	
Cow pea or soy bean hay	15
Corn silage	25
Oats or barley	5

	Pounds
Ration No. 5—	
Clover hay	10
Gluten or oil meal	3
Corn meal	16

	Pounds
Ration No. 6—	
Clover, alfalfa or cow pea hay	10
Corn-and-cob meal	20
Gluten or oil meal	2

Sugar-Beet Pulp

Carlyle and Griffith of the Colorado Station divided a bunch of forty-eight 956-lb. steers of mixed breeding and below average in quality into four lots of 12 each, giving alfalfa hay of poor quality to all without limit. Sugar-beet pulp was fed without limit to two lots twice a day. Coarse corn meal was fed for concentrates to lots 1 and 2, the allowance starting with two pounds per steer daily and being gradually increased during the 100-day trial.

VALUE OF WET BEET PULP IN STEER FEEDING

Average Ration	Average Daily Gain, Lbs.	Average Gain per head, Lbs.	Feed for 100 Lbs. Gain		
			Corn, Lbs.	Hay, Lbs.	Pulp, Lbs.
Lot 1— Beet pulp, 93.4 lbs. Alfalfa hay, 20.0 lbs. Corn, 6.6 lbs.	2.6	263	251	759	3,545
Lot 2— Alfalfa hay, 31.3 lbs. Corn, 6.6 lbs.	1.8	176	376	1,778	
Lot 3— Beet pulp, 97.3 lbs. Alfalfa hay, 21.9 lbs.	1.8	184		1,189	5,283
Lot 4— Alfalfa hay, 41.5 lbs.	1.5	147	---	2,829	-----

The table shows that each steer in lot 1 consumed over 93 lbs. of beet pulp daily in addition to 20 lbs. of alfalfa hay and 6.6 lbs. corn meal. On this ration they made the excellent daily gain of 2.6 lbs. each, gaining 263 lbs. in 100 days. With alfalfa hay, beet pulp, and no grain, the steers of lot 3 gained 1.8 lbs. against 1.5 lbs. daily for lot 4 on alfalfa hay alone. These investigators report that throughout the trial the pulp-fed steers were more uniformly thrifty than those getting no pulp. They estimate that for two-year-old fattening steers 9 lbs. of wet sugar-beet pulp proved equal to 2.8 lbs. of alfalfa hay or 1 lb. of ground corn.

Dried-Beet Pulp

Shaw and Norton of the Michigan Station found as a result of three winter trials that dried beet pulp tended to growth with cattle rather than to fattening, and conclude that in the earlier part of the feeding period dried pulp can be fed advantageously in large quantities because of its cheapness and ability to produce rapid gains. During the finishing period, however, it should be largely replaced by corn meal. A 1000-lb. steer will not consume over 10 lb. of dried beet pulp daily.

Salt and pure water should be accessible to fattening cattle at all times. It is estimated that a steer requires not less than 10 gallons water per day and 1½ ounces of salt. Hogs running with cattle should have a separate drinking place.

FEEDING SHEEP AND LAMBS

Lambs

INASMUCH as the quantity and quality of milk vary greatly in different breeds of sheep, in feeding a lamb before it is weaned the amount of milk and butter-fat produced by the mother should be taken into consideration. Careful experiments made by the Wisconsin Station give the following amount of milk and per cent of butter-fat from the different breeds.

Breed	Average Daily Milk Yield, Pounds	Fat, Per Cent
Oxford	3.1	7.7
Southdown	1.9	8.4
Dorset	4.3	7.2
Shropshire	2.5	5.9
Merino	2.3	6.0
Range	2.7	7.2

Grain Feeding Lambs Before Weaning

At the Wisconsin Station Craig fed various grains to unweaned high-grade Shropshire lambs for periods averaging ten weeks. The lambs were induced to eat grain as early as possible and were given all they could consume in a trough accessible at all times through a "creep," which shut out the dams. A summary of four trials is here shown.

FEEDING VARIOUS GRAINS TO LAMBS BEFORE WEANING

Grain Fed	Average Daily Grain Consumption, Lbs.	Average Weight at Beginning, Lbs.	Average Daily Gain, Lbs.	Average Total Gain, Lbs.	Grain Fed for 100 Lbs. Gain, Lbs.
Corn meal	0.4	39	0.51	35.8	74
Whole oats	0.4	44	0.53	37.0	78
Wheat bran	0.3	43	0.48	33.6	71
Cracked peas	0.4	37	0.53	37.0	81

Corn meal gave good returns in these trials, especially when cost is considered. This feed is one of the best for unweaned lambs designed for the butcher, since it puts on much fat. For unweaned lambs which are to go into the breeding flock, at least one-half of the concentrates should be such as were fed to the other lots in these trials. Oats and peas are rich in crude protein and one or both can be grown on almost any farm in America. Where not available, bran can take their place. The large daily gains made by these unweaned lambs and the small amount of grain required in addition to the dam's milk for a given gain forcefully illustrates the principal that young animals give the best returns for feed consumed.

FEEDING SHORN AND UNSHORN LAMBS CONFINED IN A BARN, MICHIGAN STATION

	Average Ration		Average Weight at Beginning, Lbs.	Average Daily Gain, Lbs.	Average Total Gain, Lbs.	Feed for 100 Lbs. Gain	
	Grain, Lbs.	Hay, Lbs.				Grain, Lbs.	Hay, Lbs.
Unshorn	1.3	1.3	85	0.25	23.0	506	510
Shorn	1.4	1.5	84	0.18	16.1	786	830

Fattening Sheep of Different Ages

At the Montana Station, Shaw compared the fattening qualities of average western range lambs, one and two-year-old wethers, and aged ewes. Each lot of about 50 was fed whole barley and clover hay for 88 days with the following results:

FATTENING RANGE SHEEP OF DIFFERENT AGES

Age When Fed	Average Ration		Average Weight at Beginning, Lbs.	Average Daily Gain, Lbs.	Average Total Gain, Lbs.	Feed for 100 Lbs. Gain	
	Barley, Lbs.	Clover, Lbs.				Barley, Lbs.	Clover Hay, Lbs.
Lambs	0.7	2.1	63	0.27	23.7	253	763
One-year-old wethers	0.7	3.8	95	0.27	23.5	256	1413
Two year-old wethers	0.7	4.1	116	0.28	24.3	248	1469
Aged ewes	0.7	2.3	92	0.18	15.6	387	1320

It will be observed that all lots, except the aged ewes, made practically the same daily and total gains. The lambs, however, consumed but little over half the hay eaten by the others. About the same amount of grain was required by all but the aged ewes. Other trials at the same station showed that lambs make more rapid and economical gains than do yearling wethers. Owing to their tendency to grow, lambs require a longer period to fatten than do mature wethers, and their rations should contain more fat-producing material.

Exposure vs. Confinement

Next to feed, the feeding place and the method of confinement are of importance in fattening sheep. At the Minnesota Station Shaw fed four lots, each of eight lambs averaging 78 lbs. for 117 days under various conditions as to confinement. Lot 1 was kept out of doors continuously in a yard sheltered from the wind by a low building at one side. Lot 2 was confined in a yard with an open shed for shelter. Lot 3 was kept in a compartment of the barn having one large window facing the east for ventilation. All lots were fed the same ration with the following results:

EFFECT OF VARIOUS METHODS OF CONFINEMENT ON FATTENING LAMBS

Where Fed	Average Daily Gain, Lbs.	Feed for 100 Lbs. Gain		
		Wheat Screenings, Lbs.	Oil Meal, Lbs.	Hay, Lbs.
Lot 1— Out of doors	0.28	804	90	316
Lot 2— In yard with shed	0.32	668	74	251
Lot 3— In stable	0.28	722	80	282

It will be seen that lot 2, kept in a yard with an open shed, made the largest and the most economical gain, while lot 1, kept out of doors, made as good gains as those confined in the barn, but required slightly more feed for 100 lbs. of gain.

Salt

In a feeding experiment in France in which three lots of sheep were fed the same rations of hay, straw, potatoes and beans, those receiving 0.5 ounces of salt per head daily gained 4.5 lbs. per head more than those fed no salt, and 1.25 lbs. more than those fed 0.75 ounces of salt per head daily. This indicates that sheep can be given too much as well as too little salt. The fleeces of the salt-fed sheep were better and heavier than those fed no salt.

Corn Silage vs. Roots

At the Michigan Station Mumford compared corn silage with roots for fattening lambs. In the first trial, lasting 84 days, sugar beets and corn silage were fed, and in the second, lasting 119 days, rutabagas and corn silage. The concentrates consisted of two parts of oats and one part of bran in the first trial, and equal parts of oats and bran in the second.

CORN SILAGE COMPARED WITH ROOTS

Average Ration	Average Daily Gain, Lbs.	Feed for 100 Lbs. Gain		
		Grain, Lbs.	Hay, Lbs.	Roots or Silage, Lbs.
First Trial				
Lot 1— Sugar beets, 4.7 lbs. Hay, 1.0 lbs. Grain, 1.0 lbs.	0.43	233	233	1,101
Lot 2— Silage, 4.5 lbs. Hay, 0.8 lbs. Grain, 1.0 lbs.	0.36	282	225	1,266
Second Trial				
Lot 1— Rutabagas, 5.6 lbs. Hay, 1.6 lbs. Grain, 1.0 lbs.	0.25	398	413	2,277
Lot 2— Silage, 3.4 lbs. Hay, 0.8 lbs. Grain, 1.0 lbs.	0.25	400	337	1,383

In the first trial sugar beets gave somewhat better results than corn silage, while in the second rutabagas did not quite equal corn silage.

Alfalfa Hay vs. Prairie Hay

At the Nebraska Station Burnett fed 52-lb. lambs alfalfa hay in opposition to prairie hay, giving them in addition all the shelled corn they could eat. The results of the trial which lasted 98 days are as follows:

Average Ration	Average Daily Gain, Lbs.	Average Total Gain, Lbs.	Feed for 100 Lbs. Gain	
			Corn, Lbs.	Hay, Lbs.
Lot 1— Alfalfa hay, 1.4 lbs. Shelled corn, 1.0 lbs.	0.33	31.9	306	411
Lot 2— Prairie hay, 0.9 lbs. Shelled corn, 0.9 lbs.	0.20	19.8	429	424

As shown above, the lambs in lot 1, fed alfalfa hay, ate less hay and grain, made heavier gains, and yet consumed 123 lbs. less corn for each 100 lbs. of gain. They were more thrifty, had better appetites, and so were able to convert more feed into mutton.

HORSES

Feeds for Horses

Oats. While several varieties of grains are used for horse feeds, nothing seems to take the place of oats. Oats are not only palatable, but the nutrients they contain are in such proportion that they form almost a perfect balanced ration. Often it is advisable, if a horse's teeth are poor, or they are over-worked, to grind the oats. New and musty oats should never be given. The quantity to give a work horse is about one pound or quart of oats to each one hundred pounds of weight. If the horse is working hard, it should receive a little more, and if idle, a little less.

Corn. Next to oats, corn is the most desirable grain for the horse. It is a good plan to mix the two feeds and not change abruptly from one to the other. New corn is apt to produce indigestion and oftentimes colic. It is much safer to feed ear corn than shelled corn, for the reason that the corn on the cob is better preserved and the horse is more apt to thoroughly masticate the grains. Corn being a carbohydrate, tends to add fat, especially if the animal is idle.

Barley is also a splendid feed for horses, but it requires more of this grain than oats to give the same results. Ground barley gives better results than whole grains.

Wheat. Wheat either alone or mixed with barley, oats or corn, gives good results. It is not advisable to feed too much wheat alone.

Rye. If rye is given, it should be mixed in proportion of one part of rye to four parts of oats.

Kaffir Corn and Milo Maize are also good, but owing to the small size and hardness of the grains, they should be ground.

Cow Peas are fed very generally in the South, and when mixed with corn or other grains, have been found very satisfactory.

Dried Brewers' Grains have been found very satisfactory when fed with hay, wheat bran, shelled corn or oats.

Cotton-Seed Meal, when mixed with other feeds, is very satisfactory. Usually about one to one and one-half pounds of the cotton-seed meal is fed daily.

Millet Hay, if fed in large quantities, is apt to affect the horse's kidneys.

Thickly-Grown Corn Fodder and Corn Stover, when properly cured, are among the best of roughages for the horse.

Clover and Alfalfa Hay, when not musty and dusty, are splendid feeds for colts on account of the protein they contain.

The Amount of Grain to Give a colt or horse depends upon the age. For instance, after weaning until the colt is one year of age, a fair allowance is from two to three pounds. When one to two years of age, four to five pounds, and when two to three years of age, it should have from seven to eight pounds. Henry Woodruff recommends that a colt at weaning time be given an unlimited allowance of hay and two pounds of oats. When one year old, it should have four pounds of oats and hay, and when two years old, it should have six pounds of oats, or, if the colt is in training, increase to eight pounds. For a colt in training, when three years old, he recommends from eight to twelve pounds of oats, and hay unlimited allowance. Splan recommends for trotting horses a fair amount of hay and from ten to fifteen pounds of oats.

Stutgart recommends for farm horses doing medium work, ten pounds of oats, ten pounds of hay and three pounds of straw. Farm or dray horses doing heavy work should have from four to seven pounds of corn, five or six pounds of oats, one-half pound of bran, three or four pounds of corn meal and twelve or fifteen pounds of hay. Army horses that are called upon to do hard and continued work, do best when given oats, hay and straw.

POULTRY

IS poultry raising worth while? Unhesitatingly we say, "Yes." The poultry production amounts annually in the United States to more than $750,000,000, a greater sum than the value of our entire wheat crop. Success, however, will not result if haphazard methods are pursued.

Good judgment and a knowledge of the requirements of poultry are necessary to successfully raise and make them profitable. Mixed breeds,

Flock of Columbian Wyandottes .. Fine for Both Eggs and Meat

unscientific feeding and poor care always result unprofitably. In this short treatise we will deal only with chickens, as they are generally of greater importance to the farmers than ducks, geese, turkeys, etc., although the same rules governing breeding and feeding are applicable to all fowls.

First. The poultry raiser should have a fair knowledge of the mechanism of the fowl.

Second. He should understand the value of the different breeds.

Third. He should know the kind of food required to produce meat and the kind necessary to produce eggs.

Fourth. He must know how to care for the birds at all seasons of the year, if they are to yield a profitable return.

In raising chickens, it must be remembered that experience is a wise teacher, and the writer suggests that a small beginning coupled with a fair amount of knowledge and a reasonable amount of common sense developed from progressive experiments and trials is more apt to result in a profitable business than an elaborate beginning without first having encountered many of the stumbling blocks met with by the novice and not uncommon to the experienced fancier.

Breeds

The first thing to consider is breeds. They may be classified as Egg Producers, Meat Breeds, General-Purpose Breeds and Fancy Fowls.

Egg-Producing Breeds are usually small in size, poor sitters and not very considerate of their chicks. The best varieties are, Leghorns, Minorcas and Black Spanish. These breeds mature very young, it not being uncommon for them to begin laying when five or six months old. For meat, they are not desirable, as they fatten slowly and do not attain a great weight. On account of their restless disposition and unreliability as sitters, it is best to hatch their eggs in an incubator or under another breed of hens.

Meat Breeds. These fowls are large and sluggish. They are heavy eaters, but will not skirmish for food as other varieties do. They are poor layers and persistent sitters. The best varieties of this breed are Brahmas, Cochins and Langshans. Some of these varieties when compelled to forage and have the proper diet, are said to be good layers.

General-Purpose Breeds. These breeds are recommended as the most desirable from every standpoint for the average farmer. They are of good size and active rustlers. They mature early, are good layers, good sitters and splendid mothers. If forced early and given the right diet, they make early broilers. A few of the best breeds are Plymouth Rocks, Wyandottes, Rhode Island Reds, Javas and Orpingtons.

Plymouth Rocks. Of all the varieties of the Plymouth Rocks, the Barred variety is a great favorite with the farmer. They seem to possess all of the requirements of a delightful barnyard fowl. The other varieties—Buff and White—are also splendid chickens to raise both for eggs and meat.

Wyandottes. While Wyandottes are not, as a rule, quite as large as the Plymouth Rocks, they make excellent broilers and roasters, their meat being exceptionally sweet, juicy and tender. They are also splendid layers and are good to their young.

Rhode Island Reds. The Rhode Island Red is a splendid general-purpose chicken. It is of medium size, matures early and is very hearty. There are two varieties of this breed, namely the Single Comb and the Rose Comb.

Typical Brown Leghorn Hen .. Leghorns Are Excellent Layers

Javas. The Java is a splendid general-purpose fowl. In size it is about the same as the Plymouth Rock. Both varieties, Black and Mottled, are beautiful birds and possess the splendid qualities of the other breeds mentioned.

Orpingtons are fast gaining favor as general-purpose fowls. They are of good size, splendid layers and very easy to keep in prime condition. Of the ten distinct varieties of Orpingtons, only three or four are bred extensively in the United States.

Light Brahmas .. Typical Meat Fowls

Ornamental Breeds are not, from an economical standpoint, desirable fowls for the farmer to raise. Bantams, Sultanas, Crested Polish, Hamburgs, Houdans and Exhibition Games are a few of the breeds of ornamental fowls. While these breeds delight the eye, they are not regarded as popular from a producing standpoint.

In selecting chickens, it is never advisable to mix breeds, nor is it best to mix varieties of the same breed. In-bred fowls are very inferior to pure-bred ones, and it is safe to say that a large per cent of the disappointments in the production of eggs and chickens is due to in-breeding. In-bred chickens are under-sized, poor layers, and, if the in-breeding continues for a number of years, as is the case on most farms, the chickens are hardly worth their feed. The writer advises the selection of one or two breeds, preferably two, and that they be kept entirely separate during the breeding season. If one breed is egg-producing and the other a general-purpose fowl, the eggs of the former can be hatched under general-purpose hens and the young chickens are certain to be well cared for.

Feeding

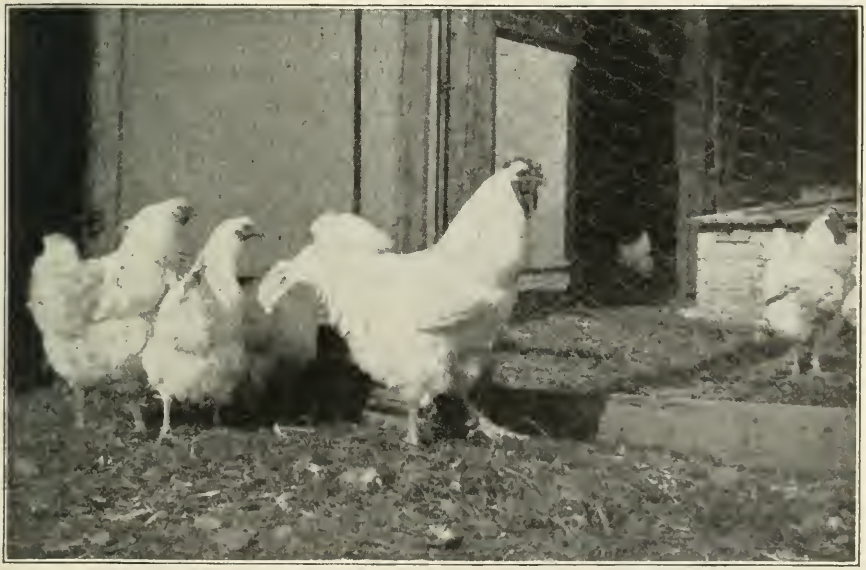
The importance of feeding is a problem that requires scientific knowledge of the fowl's requirements, whether the aim is to produce meat or eggs, and coupled with that, common sense is indispensable. Fowls require a food composed of three constituents or substances, namely, mineral matter, nitrogenous matter and carbonaceous matter, and they must be proportioned so that the most economical results will be obtained. By carefully studying the habits of the chicken, the farmer will be able to know its requirements at all seasons of the year. Every one knows that the hen does the best laying in the spring and early summer. This is because she instinctively selects the proper diet, From the soil she secures mineral matter, especially lime, necessary to produce shells. She picks up small pieces of rock which are an aid to digestion. She secures seed that produces the heat and energy, or, in other words, the carbonaceous materials. She picks green vegetation, which is rich in protein, and she also secures insects which supply the meat element necessary to maintain health and strong-producing qualities.

Inasmuch as eggs command the highest price during the winter months, the hens can be made very profitable if they are furnished practically the same diet that they secure when foraging in the spring. Green vegetation can be secured by growing oats, barley or rye in boxes in the furnace room, or by saving cabbages, turnips, rutabagas or any roots of the same nature, and giving them a small quantity each day. Meat can be supplied by furnishing bones from the meat shop or meat scraps which are usually to be secured at a small cost. Ground bones are very beneficial given in small quantities and ground oyster shells are indispensable. A few bushels of sand or fine gravel should be put in some convenient place for the chickens during the winter months.

Feeding Chicks

The first week of the chick's life is a critical period. It should be given nothing to eat the first day for the reason that nature provides a store of nutrients within the chick which is intended for its use during the first 20 or 24 hours after it is hatched.

Probably the best diet for the young chick during the first few days is infertile eggs boiled hard, ground or finely chopped, shells included,



White Plymouth Rocks .. Excellent Meat and Egg Producers and mixed with rolled oats. After the fourth or fifth day it can be given in addition, stale bread crumbs, cracked wheat, oatmeal (granulated), broken rice and a small quantity of millet seed. Cornmeal should not be given during the first week, but after that time corn-meal bread or corn meal, rolled oats, wheat bran, cracked wheat and screenings can be given in combination.

Charcoal and sand should be kept on the floor from the beginning. Skim milk or even sweet milk is desirable for a drink. Fresh water is absolutely essential, and should be supplied often. The chick should be fed often, but not too much at one time. As a general rule there is more danger in over-feeding than in not feeding enough during the first two weeks. Meat scraps should be supplied unless insects are plentiful. Young chicks should be permitted to run where green grasses or clover can be had. If grasses cannot be secured, they should be given lettuce, onion tops or green roots. Little chicks should not be exposed to a broiling sun, neither should they be chilled or become wet during their early life.

To Fatten Chickens

To fatten rapidly, chickens should be confined, perferably in a crate, for three or four weeks before they are to be sent to the market. Carbohydrates are necessary to produce fat, hence, corn should constitute the main part of the diet. A good ration is,

Finely-ground corn meal	2 parts.
Middlings	1 part.
Meat scraps	1 part.

Buckwheat and hulled oats are also good to mix with the corn.

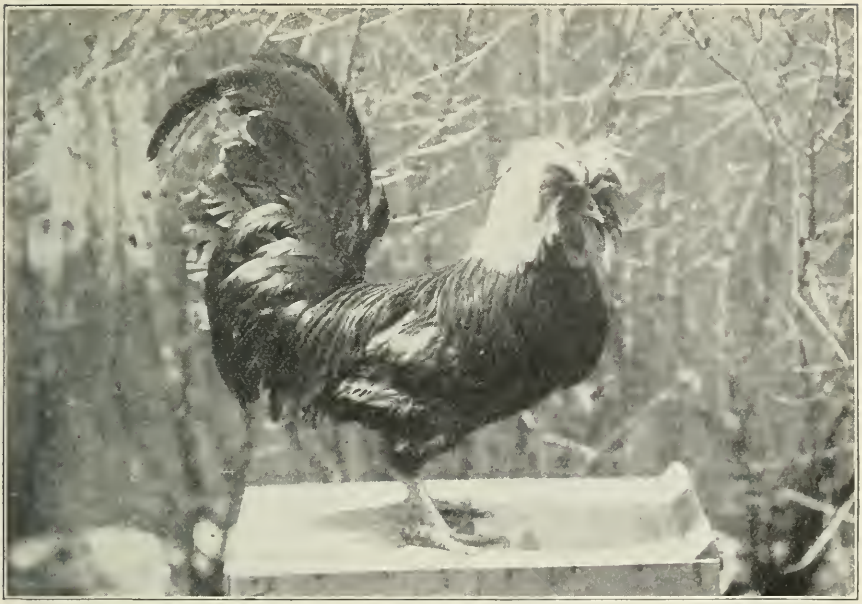
Food not eaten promptly should be removed from the pen. Plenty of fresh water should be supplied, and if possible, milk given. Green feed should be given three or four times weekly and grits furnished occasionally.

Feed for Laying Hens

Hens do not lay well if too fat, hence, corn should not be the major portion of their diet. Exercise being important, whole or cracked grain should be sprinkled on a thick layer of litter, compelling the hens to scratch in order to secure the feed.

A dry mash of wheat bran two parts, and one part each of corn-meal middlings, brewers grains, linseed meal and beef scraps, make an excellent diet, and an abundance should be kept in a feeding trough at all times. Another splendid diet for laying hens is,

Millet seed	1 part.
Wheat bran	4 parts.
Meat or meat meal	4 parts.
Wheat, cracked or whole	3 parts.
Corn meal	4 parts.
Corn, whole or cracked	2 parts.



White Crested Black Polish Cockerel .. An Ornamental Fowl

Sharp sand and ground oyster shells should be given and cabbage and roots added if grasses are not accessible.

Hens should be given fresh water at least twice each day. A dust heap is splendid to keep the skin healthy and free from vermin. It is also very advantageous, especially during the winter, to occasionally dust the hens with insect powder. Pullets thrive better and begin laying earlier if separated from the cockerels.

If the farmer will fill a few barrels with turnips or rutabagas in the fall and place them in the cellar where it is warm enough to cause them to grow, they take the place of grasses and clover. If the winter diet conforms closely to the spring food and the hen is compelled to scratch, it will be found that she will lay as free during the winter as she does in the early spring. Ground fresh bones are of material assistance to the laying hens during the winter time.

The writer is inclined to think, from experience, that dry mashes are preferable to wet ones, and that raw grains give better results than cooked. I realize, however, that opinions differ widely on this question.

The Pennsylvania Experiment Station has made some exhaustive experiments in feeding and managing poultry, and without going into details we take the liberty to give their conclusion which conforms very closely to results obtained by many experiment stations and prominent raisers of poultry.

Conclusions

1. Large breeds in general eat more than small ones during the growing period.

2. Early hatched chickens grow faster than late hatched ones. April first seems to be a desirable time for hatching in the northern and middle states.

3. The amount of feed required to produce a pound of gain increases as the chicks approach maturity.

4. Between the ages of 6 and 13 weeks, they require from 4 to $4\frac{3}{4}$ pounds of feed to produce a pound of gain. Between the age of 13 and 26 weeks they require $4\frac{3}{4}$ to $5\frac{3}{4}$ pounds of feed to produce a pound of gain.

5. Chicks forced when young do not make so rapid a growth as they approach maturity as those fed moderate rations.

6. Chicks weighing less than one pound seem to grow faster on a wet mash; those weighing a pound and a half or more do best on dry feed.

7. The loss among chicks on wet mash is greater than among those on dry feed, even when weighing less than one pound each.

8. Eggs set about April first seem to produce the highest per cent of chicks.

Early pullets should begin to lay not later than November first and continue through the winter.

If yearling hens lay well during the summer, they are not apt to do so well in the winter.

Hens are not regarded profitable after they are $2\frac{1}{2}$ years of age.

The Hen House

The hen house, whether it is a continuous house or a colony, should be built on high, dry ground if possible. A sandy loam is more preferable than a heavy clay, for the reason that it is not apt to remain cold and damp. The house should if possible front the south in order to be warm during the winter time, and it should be so constructed that the rays of the sun will at some time during the day strike all parts of the interior. The chicken house should be well ventilated.

If the ground is dry, a dirt floor is sufficient. A cement floor is more preferable than any other kind for the reason that it can at all times be kept clean and free from vermin. Board floors are not desirable.

The foundation should be made of concrete and deep, in order to keep out rats.

The inside of the house should be made of well-matched boards or plastered in order that it can be kept free from vermin.

The nests should be detachable so that they can be taken out occasionally and sunned and cleaned. Each chicken should be given three or four feet of floor space. Not more than fifty chickens should be kept in a colony. If the house is continuous, the outside pens should be constructed so that the chickens can be rotated and the grasses or vegetation on one or more of the plots given an opportunity to grow.

Rye, rape, alfalfa and clover make the best summer pasture.

Diseases

So many specific remedies are given for diseases and so many failures reported that the writer will not attempt to deal with them except to say that diseases can to a great extent be prevented by cleanliness, the right kind of diet and pure water.

Vermin kill young chicks and destroy the usefulness of the hens. This condition can be obviated by keeping the house and nests sprayed and occasionally painted. Do not neglect to keep a bath of dust where the chickens can get to it. Ducks and geese bathe in water, but chickens and turkeys bathe in dust. Do not use lard to kill lice on the heads and under the wings of young chickens, but use olive oil.

Do not feed young chicks too much corn meal. During the first week they should have none.

Do not permit young chicks to become chilled.

Furnish shade for young chicks during the heat of the day.

Do not store eggs intended for hatching in a cold, damp place, or where it is too hot.

Never permit a hen to sit on an old nest.

THE FARM GARDEN

EVERY farmer should allot a desirable plot of ground for a garden. Nothing on the farm will give the farmer, his family and his city friends more satisfaction than a garden well stocked with a large variety of vegetables and berries.

We will not attempt to go into the matter of conducting a garden, believing that the information given in most seed catalogs is a sufficient guide to the farmer. We will, however, mention a few of the essential things necessary to make a garden productive.

The garden, for convenience, should be located near the house. If conditions will permit, a plot should be selected which has a gentle slope to the south. A garden needs the sun early and late; hence, the location should not be where it will be shaded. A windbreak, however, either of trees, hedge or a tight fence, is desirable as a protection on the north line.

An ideal garden soil is a rich, sandy loam, but we fully realize that such a soil is not always available. If the soil is not of the right character and is not fertile, make it so. If the soil is inclined to be tight and soggy, it should be drained by placing drain tile.

Drain tile are very essential. They serve three purposes, namely, to remove superfluous water, admit air to the soil and increase the temperature of the soil early in the spring.

The gardener should use every device and means to make his garden soil warm. Thorough tillage assists, and the application of well-rotted barnyard manure is of great value in making the ground warm and, in absorbing water, and drain tile will make it several degrees warmer than undrained ground.

The ground should be plowed and tilled deep and a subsoil plow used. The object in plowing deep and using the subsoil plow is to make a deep seed-bed and destroy a hard-pan or a compact plow sole. A deep seed-bed gives room for the plant roots, furnishes more plant food and acts as a surface reservoir to absorb a heavy rain and hold it until it percolates into the deeper subsoils. It is practically useless to attempt to have a profitable garden if a hard-pan exists or the upper subsoil layer is very compact.

If the soil is not of the right character, it can be improved by adding such soils and substances as may be necessary. For instance, if the ground is clay, well-rotted manure, peat, muck and leaf mould will improve it. The muck and leaf mould will prevent baking and puddling. If it is sandy, add loam, muck and manure. If the soil is apparently too rich in organic matter, a condition which tends to stimulate an abnormal growth of tops, then add clay or sand. Garden soil should contain an abundance of lime.

If the soil is deficient in plant food, and it is not convenient to obtain sufficient quantities of well-rotted manure, it is advisable to add commercial fertilizers, either in the form of a complete commercial fertilizer or some of the amendments. The farmer should remember, however, that commercial fertilizers are of little use unless the soil contains an abundance of humus. A desirable commercial fertilizer should contain about seven per cent of ammonia, ten per cent of phosphoric acid and eight or ten per cent of potash. Wood ashes make a splendid fertilizer, besides improving the physical condition of the soil. Poultry manure excels all other manures for the garden.

Rotation or changing location of the various products each year is important. It is not profitable to plant the same vegetables on the same plot year after year.

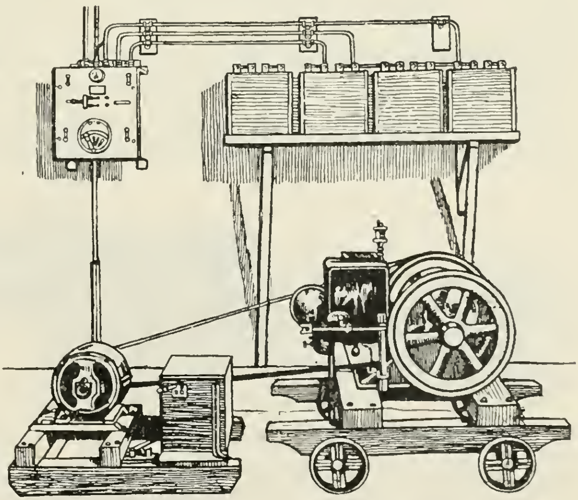
In order to have fresh vegetables from early spring until winter, early medium and late varieties should be planted. By using cold frames, fresh vegetables can be grown nearly all winter. As soon as a piece of ground is cleared of vegetables in the fall, it should be covered with well-rotted manure. If it cannot be obtained, cover with coarse manure or straw and disc in thoroughly before plowing in the spring.

HOW CAN THE FARM BE MADE MORE ATTRACTIVE?

THE farm is profitable and attractive just in proportion to its equipment and the scientific methods employed in its management. If the farm is not equipped with modern implements that lessen the time and cost of labor and lighten the burdens, it is not profitable, nor is farming a desirable occupation. To the credit of the farmer, who appreciates the fact that farming is a profession and has a realization of his responsibilities to future generations, he is keeping pace with inventions and improvements both in implements and methods. He promptly discarded the grain cradle when the hand rake reaper appeared, and in turn purchased the self rake, the Marsh harvester and finally the modern self binder, realizing that to ignore them meant falling by the wayside in the march to keep pace with his more progressive neighbor. Today, the up-to-date farm is equipped with a sulky plow (many with a tractor and gangs). The time and cost of making and storing hay is reduced three hundred per cent through the efficacy of the mower, loader, stacker and baler. The modern grain drill is indispensable and many other tools and appliances costing thousands of dollars are regarded as indispensable. The elevated water tank at the barn, the gasoline engine to grind feed and shell corn save time and labor.

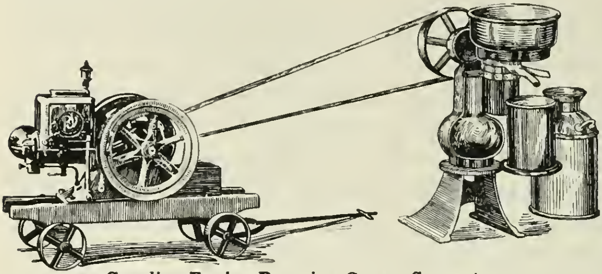
But, how about the home, the housewife and the children? Is the equipment of the farm home in keeping with the farm? Does the housewife enjoy the modern conveniences that are found in the city home?

Unfortuntely too many do not. With her the day's work is never done. Drudgery confronts her from early morning till late at night. Pumping and carrying water, running the washing machine, churn and cream separator are for her to do as well as many other burdens which could be lessened by using modern appliances. When she visits her city friends and enjoys the



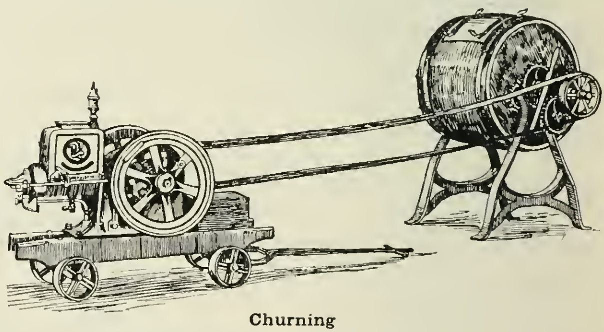
"R & V Triumph" Charging Lighting Plant

ever-flowing faucet, the kitchen drain, the bath room and its auxiliaries and contrasts the electric lights with her oily lamps and many other things that might be mentioned, the farm home is repulsive, and she longs to leave what can be made the most delightful abode on earth, the old farm.

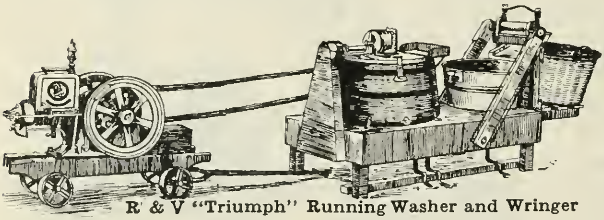

Gasoline Engine Running Cream Separator

With modern devices at a very moderate cost, the farm home can be made as convenient and attractive as the city palace, and when that is done the rural dweller is delighted to invite his city friends to his country home.

The gasoline engine has become a very economical and popular power. With it water is pumped from the well or cistern and forced to the tank both at the barn and in the garret of the house. A pressure tank in the basement can be adopted instead of the reservoir in the garret if deemed advisable. A small gasoline engine will churn the butter, skim the milk, wash the clothes and even the dishes.


Churning

A medium-sized engine will, besides running the various devices mentioned, generate electricity at the same time which can be stored in a storage battery and used to light both house and barn.


R & V "Triumph" Running Washer and Wringer

A bath room and lavatory can be installed at a small cost. By installing a septic tank the sewage and drainage rom bath room and kitchen can be safely and economically disposed of. All of these conveniences are available and the cost is only a small per cent of the the cost of the up-to-date implements used on the farm.

Heating

A furnace of sufficient capacity to heat an ordinary house and heat water for the kitchen, bathroom and lavatory is no more expensive to maintain than the ordinary hard-coal burners. Furnaces are on the market which are not only economical, but are equipped with an automatic device which regulates the heat.

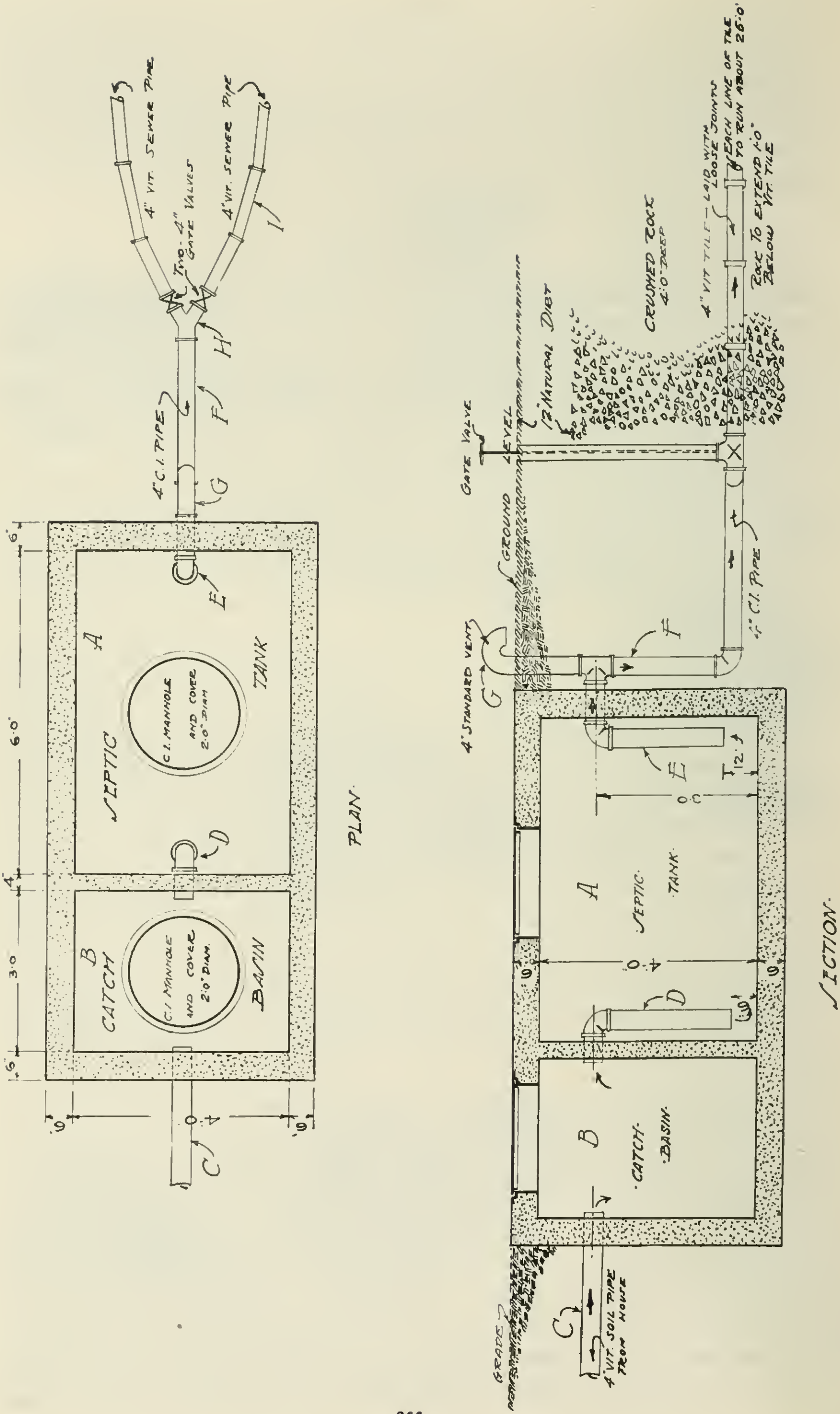
Septic Tank

While the sewage may in some instances be emptied in a stream or ravine, it is a dangerous thing to do, for the reason that the stream will be contaminated, and unless the flow is great, odors will arise, therefore it is necessary that some other means of disposing of sewage be provided. Nothing has as yet been devised as a sewage disposal for the farm home equal to the septic tank.

A septic tank is a receptacle for the purification and disposal of sewage. This system of sewage disposal is especially adapted to villages and farm dwellings where no regular sewage system exists. The process by which sewage is liquefied, made odorless and harmless, is accomplished by a specific bacteria or micro-organism known as anaerobiosis.

The apparatus consists of a receiving chamber (b), a process chamber (a), an inlet pipe (c), discharge pipes(e and f), and a vent pipe (g). The tanks should be made of concrete and practically air-tight, having a man-hole in the top. The walls and top should be from four to to five inches in thickness, and the top reinforced. The tank can be located at any reasonable distance from the dwelling house. It will be necessary to locate it so that there will be a slight fall between the house and the tank. The pipe (c) leading from the house to the tank should be of iron in order to prevent the possiblity of leaks. Sewer pipe can be used if the joints are properly cemented. This pipe should also have a trap at the point where it leaves the house. The receiving chamber should be of concrete, made air tight and provided with a man-hole in order that sludge can be pumped out in case of accumulation.

The sewage passes from the receiving chamber (b) to the main tank (a) through pipe (d). The object in having pipe (d) curved downwards and extend to within one foot on the bottom of the main tank is to prevent any disturbance of the scum which forms on top of the sewage in tank (a). That scum or crust must not be broken, for the reason that if it is, bacterial action and liquefaction stop until the crust again forms. The effluent or liquefied sewage leaves the tank through siphon pipe (e). This pipe starts, as is shown in the illustration, about one foot from the bottom of the tank and discharges into the tile drain which carries the harmless liquid away.


4" VIT. SEWER PIPE
TWO-4" GATE VALVES
4" VIT. SEWER PIPE
4" C.I. PIPE
SEPTIC TANK
C.I. MANHOLE AND COVER 2'0" DIAM
CATCH BASIN
C.I. MANHOLE AND COVER 2'0" DIAM.
6'0"
3'0"
4'0"
PLAN
GATE VALVE
GROUND LEVEL
12" NATURAL DIRT
CRUSHED ROCK 4'0" DEEP
4" VIT TILE — LAID WITH LOOSE JOINTS EACH LINE OF TILE TO RUN ABOUT 25'0"
ROCK TO EXTEND 1'0" BELOW VIT. TILE
4" STANDARD VENT
4" C.I. PIPE
GRADE
4" VIT. SOIL PIPE FROM HOUSE
SECTION

The outlet pipe must be provided with a vent (g) to prevent the tank from being emptied by the siphon (e and f).

The drain should be ordinary soft porous drain tile laid end to end with loose open joints. The ditch in which the tile are laid should be about four feet deep. Before the tile are laid, one foot of loose gravel should be placed in the ditch and one foot of loose gravel on top of the tile, and the ditch then filled with dirt. If this line of tile is four or five rods long, it will never become clogged unless the soil is a very compact clay. If the soil is of such a nature, two lines should be laid from the "V"-shaped junction, having, as shown at H, gate valves so that the flow can be alternated every two weeks, giving each line time to dry out.

Size

For a family of ten or twelve people, a tank six feet long, four feet wide and four feet deep, holding 718 gallons, will be large enough. Such a tank should take care of a sink, laundry, bath and toilet room, and the overflow from a cistern. The receiving chamber should be about four feet by two or three feet, and as deep as the main tank. After the tank has been in operation a year or two, if any great amount of sludge has accumulated on the bottom, it should be pumped out. If the tank is properly constructed, the accumulation is very little, even after it has been in operation several years.

Caution

Care must be taken not to empty into the intake pipe potato peelings and other coarse substances that will not pass through a trap freely.

Chloride of lime interferes with the bacterial action; hence, it should not be used to any great extent in the sink.

Bacteria do not materially change grease. If it enters the tank system in great quantities, it eventually clogs it. It is often necessary to have a grease trap below the sink.

To prevent gases from escaping, the manhole covers should be made tight by using cement or asphalt.

A system of this kind will not freeze in winter, as the gases arising from the sewage in the tank generate enough heat to counteract cold and prevent freezing.

The secret, if secret it may be called, of the whole system is the dark air-tight tank, the submerged inlet and submerged outlet. The bacteria will do their work if not disturbed, but if the scum is molested, the bacterial action does not take place.

GOOD ROADS

GOOD roads are not a fad, they are a necessity. They are to the farmer what railroads are to the commercial world, and the paved streets and electric roads are to the busy, hustling throngs in the city.

The farmer is a busy man. He is beginning to appreciate that his occupation is a business and that time and labor represent money. He appreciates the fact that the time is past when he can afford to hire labor or spend his own time at the prevailing prices to haul products of his farm to market over poor roads. He recognizes the fact that his farm is his business house and demands his attention, if it is to prosper, and that he cannot spend hours going over roads with a plodding horse when, with an automobile or a tractor on good roads, he can make the same trip in one-tenth of the time. Gasoline and oil are rapidly displacing horses, both on the farm and roads, and the sooner the farmer realizes the economical benefits of rapid transportation, the sooner will he be abreast with the improvements which characterize other lines of business.

While the conveniences of good roads are of great importance, the financial benefits are surprising. To be sure, it costs money to build a permanently good road, but the farmer, the city dweller and the taxpayers in general cannot make an investment which will give better returns.

In the United States we have about 2,250,000 miles of roads, and not more than eight per cent have been permanently improved. The cost per ton per mile to haul farm products over the roads varies greatly in different sections, but the average cost is not less than 23 cents. The average haul that the farmer makes to town is nine miles, or approximately $2.07 for each ton hauled. In foreign countries, and in our own country, where roads have been improved, it costs 8 cents per ton per mile, or $1.35 per ton less than over poor dirt roads. It is estimated that the farmers of the United States haul to and from their farms 300,000,000 tons annually, or, in other words, the farmer pays toll to poor roads each year, amounting to the enormous sum of $377,500,000 which could be saved were the grades improved and the road-bed made of macadam, concrete or some other durable substance.

We will not attempt to recommend any special make of roads to meet all conditions, believing that the Good Roads Experts in the states, who are familiar with local conditions, are better able to advise the taxpayers.

In some sections, a well made dirt road is nearly equal to a macadam. In building a dirt road, the first important thing to consider is drainage. The road should be drained on either side by means of good sized tile or deep ditches having a free outlet. The surface should be rounded and kept so, otherwise the water will not run off rapidly Ruts and worn paths will soon make a muddy road, but with a little filling at the right time and the use of a King Drag, the road can be kept in good condition at small cost.

S. E. Bradt, Chairman of the Good Roads Committee of the Illinois Bankers Association has for a number of years made a very careful study of hard roads. In a recent letter to the writer he states,

"Our macadam roads have been very uniformly ten feet wide and nine or ten inches thick after they were rolled. We put on about eleven or twelve inches of material. They cost from three to four thousand dollars per mile depending upon the length of haul and whether they are built of stone furnished by the State at a cost of 62½ cents per yard or stone that we purchased at a cost of about $1.00 per yard. This cost includes grading."

"The concrete road which we built last fall cost about $7,500 exclusive of the preliminary grading. The state furnished the mixer and superintendent and two men to operate the mixer. The road is 12 feet wide and 6½ inches thick. It was built in October when labor was scarce and we were obliged to pay for 10 hours work and only able to work an average of 8½ hours. There was also considerable rain which caused delay, making the work quite expensive. We could easily have saved at least $500 in labor and material had we been working under favorable conditions. On each side of the road is a macadam shoulder 2 feet wide and 6 inches thick."

Following are the details of the cost:

2274 barrels cement	$2274.00
Sand and gravel	1671.00
Expansion joints	160.00
Grading	440.00
Labor	2216.00
Watchman	125.00
Coal, lumber, oil and waste	152.00
Car-fare for the laborers	50.00
Cost of macadam shoulders	500.00
	$7588.00

In the above is included the cost of the labor furnished by the state.

Concrete roads have been built in Michigan complete for $10,000 per mile. Rock-macadam roads in Missouri, Ohio, Michigan and Wisconsin have cost from $3000 to $4000 per mile. Gravel roads in Michigan and Iowa, where local gravel is near by, have cost from $1000 to $2000 per mile. The cost, however, of a permanent road will depend entirely upon the character of the material used, its accessibility and the necessary amount of grading to be done.

While the horse will undoubtedly continue to be the main motive power in the farmer's field for many years to come, the touring car, the runabout, the auto-truck and tractor will supplant the horse on the roads very generally in the near future. The march of progress will neither stop nor stay, nor will the American people turn back in the onward movement to sustain their supremacy. Goods roads are as necessary to the safe and profitable utilization of these new methods of transportation as the well ballasted railroad bed is to the locomotive, hence we are simply confronted with the problem of constructing country roads to meet the requirements of the times, and we cannot evade our responsibility without being guilty of placing stumbling blocks in the path of progress.

Quantity of Seed to Sow per Acre

Alfalfa (broadcast)	20 to 25 pounds
Alfalfa (drilled)	15 to 20 pounds
Artichoke, Jerusalem	6 to 8 bushels
Barley	8 to 10 pecks
Bean, field (small varieties)	2 to 3 pecks
Bean, field (large varieties)	5 to 6 pecks
Beet	4 to 6 pounds
Blue grass	25 pounds, pure
Brome grass (alone for pasture)	15 to 20 pounds
Brome grass (alone for hay)	12 to 15 pounds
Brome grass (in mixture)	2 to 5 pounds
Broom corn	3 pecks
Buckwheat	3 to 5 pecks
Bur-clover	12 pounds
Carrots (for stock)	4 to 6 pounds
Chick-pea	30 to 50 pounds
Clover, alsike (alone for forage)	8 to 15 pounds
Clover, alsike (on wheat or rye in spring)	4 to 6 pounds
Clover, Egyptian or berseem	½ to 1 bushel
Clover, Japan (Lespedeza)	12 pounds
Clover, Mammoth	12 to 15 pounds
Clover, red (on small grain in spring)	8 to 14 pounds
Clover, sweet (melilotus)	2 pecks
Clover, white	10 to 12 pounds
Corn	6 quarts to 1 bushel
Corn (for silage)	9 to 11 quarts
Cotton	1 to 3 bushels
Cow pea	1 to 1½ bushels
Cow pea (in drill with corn)	½ to 1 bushel
Cow pea (for seed)	3 pecks
Crimson clover	12 to 15 pounds
Field pea (small varieties)	2½ bushels
Field pea (large varieties)	3 to 3½ bushels
Flax (for seed)	2 to 3 pecks
Flax (for fiber)	1½ to 2 bushels
Hemp (broadcast)	3½ to 4 pecks
Hungarian grass (hay)	2 pecks
Johnson-grass	1 to 1½ bushels
Kafir (drills)	3 to 6 pounds
Kafir (for fodder)	10 to 12 pounds
Kale	2 to 4 pounds
Lespedeza	12 pounds
Lupine	1½ to 2 bushels
Mangels	5 to 8 pounds
Millet, barnyard (drills)	1 to 2 pecks
Millet, foxtails (drills)	2 to 3 pecks
Millet, German (seed)	1 peck
Millet, Pearl (for soiling)	4 pounds
Millet, Pearl (for hay)	8 to 10 pounds
Milo	5 pounds
Oat-grass, tall	30 pounds
Oats	2 to 3 bushels
Oats and peas	Oats 2 bushels, Peas ½ bushel
Orchard grass	12 to 15 pounds Pure
Parsnips	4 to 8 pounds
Popcorn	3 pounds
Potato, Irish, average	10 to 14 bushels
Potato, cut to one or two eyes	6 to 9 bushels
Potato, recommended by many for best yields	15 to 20 bushels
Rape (in drills)	2 to 4 pounds
Rape (broadcast)	4 to 8 pounds
Red top, recleaned	12 to 15 pounds
Rice	1 to 3 bushels
Rutabaga	3 to 5 pounds
Rye	3 to 4 pecks
Rye (forage)	3 to 4 bushels
Rye grass	2 to 3 bushels
Sorghum (forage broadcast)	1½ to 2 bushels
Sorghum (for seed or syrup)	2 to 5 pounds
Sorghum, saccharine (for silage or soiling, drills)	6 pounds to ½ bushel
Sorghum and peas	3 to 4 pecks each
Soy bean (drills)	2 to 3 pecks
Soy bean, (broadcast)	1 to 1½ bushels
Sugar beets	15 to 20 pounds
Sugar cane	4 tons of cane
Sunflower	10 to 15 pounds
Sweet clover	2 to 4 pecks
Timothy	15 to 25 pounds
Timothy and clover	Timothy 10 lbs. Clover 4 lbs.
Turnip, (broadcast)	2 to 4 pounds
Turnip (drills)	1 pound
Velvet bean	1 to 4 pecks
Vetch, hairy (drilled)	1 bushel, 1 bushel small grain
Vetch, hairy (broadcast)	1½ bushels, 1 bushel small grain
Wheat	6 to 9 pecks

Number of Pounds to the Bushel (Legal Weight) in Different States.

States	Buckwheat	Corn on the Cob	Shelled Corn	Corn Meal	Onions	Sweet Potatoes	Potatoes	Turnips	Peas	Beans	Barley	Wheat	Oats	Rye	Dried Apples	Flax Seed	Clover Seed	Blue Grass Seed	Timothy Seed
Arkansas	52	70	--	50	57	50	60	--	46	60	48	60	32	56	24	56	60	14	45
California	40	--	52	--	--	--	--	--	--	--	50	60	32	54	--	--	--	--	--
Connecticut	48	--	56	50	50	--	60	50	60	60	48	60	32	56	--	--	--	--	--
Georgia	52	70	56	48	57	56	60	55	60	60	47	60	32	56	24	56	60	14	45
Illinois	52	70	56	48	57	55	60	55	--	60	48	60	32	56	24	56	60	14	45
Indiana	50	68	56	50	48	--	60	--	--	60	48	60	--	56	25	--	60	14	45
Iowa	52	70	56	--	57	46	60	--	--	60	48	60	32	56	24	56	60	14	45
Kansas	50	70	56	50	57	50	60	55	--	60	48	60	32	56	24	54	60	14	45
Kentucky	55	70	55	50	57	55	60	60	60	60	47	60	32	56	24	56	60	14	45
Maine	48	--	56	50	52	--	60	50	60	64	48	60	30	50	--	--	--	--	--
Massachusetts	48	--	56	50	52	56	60	--	--	--	48	60	32	56	--	--	--	--	--
Michigan	48	70	56	50	54	56	60	58	60	60	48	60	32	56	22	56	60	14	45
Minnesota	42	--	56	--	--	--	60	--	--	--	48	60	32	56	28	--	60	--	--
Missouri	52	--	56	--	57	--	60	--	--	60	48	60	32	56	24	56	60	14	45
Nebraska	52	70	56	50	57	50	60	55	60	60	48	60	32	56	24	56	60	14	45
New Hampshire	--	--	56	--	--	60	--	60	60	--	--	60	32	56	--	--	--	--	--
New Jersey	50	--	56	--	57	54	60	--	60	60	48	60	30	56	25	55	64	--	--
New York	48	--	56	--	--	--	60	--	60	62	48	60	32	56	--	55	60	--	44
North Carolina	50	--	54	46	--	--	--	--	50	--	48	60	30	56	22	--	64	--	--
Ohio	50	70	60	--	50	50	60	--	60	60	48	60	32	56	24	56	60	--	45
Oklahoma	42	70	56	50	52	46	60	60	60	60	48	60	32	56	24	56	60	14	42
Pennsylvania	48	--	56	--	--	--	56	--	--	--	47	60	32	56	--	--	62	--	--
Rhode Island	--	--	56	50	50	--	60	--	--	--	48	60	32	56	--	--	--	--	--
South Carolina	56	70	56	50	57	50	60	--	60	60	48	60	33	56	26	44	60	14	--
Tennessee	50	72	56	50	56	50	60	--	60	60	48	60	32	56	26	56	--	14	45
Texas	42	--	56	--	57	55	60	55	60	60	48	60	32	56	28	56	60	14	45
Vermont	46	--	52	--	52	--	60	60	60	60	48	60	32	56	--	--	60	--	45
Virginia	52	70	56	50	57	56	60	55	60	60	48	60	32	56	28	56	60	14	45
Wisconsin	50	70	56	--	50	--	60	42	--	60	48	60	32	56	28	56	60	--	45

Capacity of Corn Cribs

(Height 10 Feet.)

Width \ Lth.	½	1	12	14	16	18	20	22	24	28	32	36	48	64
6	13	27	320	373	427	480	533	587	640	747	853	960	1280	1707
6¼	13	28	333	389	444	500	556	611	667	778	889	1000	1333	1777
6½	14	29	347	404	462	520	578	636	693	809	924	1040	1387	1849
6¾	15	30	360	420	480	540	600	660	720	840	960	1080	1440	1920
7	16	31	373	436	498	560	622	684	747	871	996	1120	1493	1991
7¼	16	32	387	451	516	580	644	709	773	902	1031	1160	1547	2062
7½	17	33	400	467	533	600	667	733	800	933	1067	1200	1600	2133
7¾	17	34	413	482	551	620	689	758	827	964	1102	1240	1653	2204
8	18	36	427	498	569	640	711	782	853	996	1138	1280	1707	2276
8½	19	38	453	529	604	680	756	831	907	1058	1209	1360	1813	2418
9	20	40	480	560	640	720	800	880	960	1120	1280	1440	1920	2560
10	22	44	533	622	711	800	889	978	1067	1244	1422	1600	2133	2844

The length is found in top line, the width in left-hand column—the height being taken at 10 ft. Thus a crib 25 ft. long, 7½ ft. wide and 10 ft. high, will hold 800 bushels of ear corn, reckoning 2¼ cubic feet to hold a bushel. If not 10 ft. high, multiply by the given height and cut off the right-hand figure. If above crib were only 7 ft. high it would hold 800 x 7 equals 560 (0 bu., etc.). The same space will hold 1 4-5 times as much grain as ear corn. Thus a crib that holds 800 bushels of ear corn, will hold 800 x 1 4-5 equals 1440 bushels of grain.

INTERESTING INFORMATION

POPULATION OF THE UNITED STATES

1850	23,191,876
1910	91,972,266

LAND AREA OF UNITED STATES IN ACRES

1850	1,884,375,680
1910	1,903,289,600

LAND IN FARMS, ACRES IN THE UNITED STATES

1850	293,560,614
1910	878,798,325

IMPROVED LANDS IN FARMS, ACRES IN THE UNITED STATES

1850	113,032,614
1910	478,451,750

ACRES OF IMPROVED FARM LAND IN THE STATES

Alabama	9,693,581
Arkansas	8,076,254
Arizona	350,173
Connecticut	988,252
Colorado	4,302,101
California	11,389,894
District of Columbia	5,133
Delaware	713,538
Florida	1,805,408
Georgia	12,298,017
Indiana	16,931,252
Illinois	28,048,323
Iowa	29,491,199
Idaho	2,778,740
Kansas	29,904,067
Louisiana	5,276,016
Maine	2,360,657
Massachusetts	1,164,501
Michigan	12,832,078
Minnesota	19,643,533
Missouri	24,581,186
Maryland	3,354,767
Mississippi	9,008,310
Montana	3,640,309
New Hampshire	929,185
New York	14,844,039
New Jersey	1,803,336
North Carolina	8,813,056
New Mexico	1,467,191
Nevada	752,117
North Dakota	20,455,092
Nebraska	24,382,577
Ohio	19,227,969
Oklahoma	17,551,337
Oregon	4,274,803
Pennsylvania	12,673,519
Rhode Island	178,344
South Dakota	15,827,208
South Carolina	6,097,999
Texas	27,360,666
Tennessee	10,890,448
Utah	1,368,211
Vermont	1,633,955
Virginia	9,870,058
Wisconsin	11,907,606
West Virginia	6,521,757
Wyoming	1,256,160
Washington	6,373,311

AVERAGE ACREAGE PER FARM IN THE UNITED STATES

1910	138.1

AVERAGE IMPROVED ACRES PER FARM IN THE UNITED STATES

1910	75.2

TOTAL VALUE OF FARM PROPERTY IN THE UNITED STATES

1850	$ 3,967,343,580.00
1910	40,991,449,000.00

AVERAGE VALUE OF ALL FARM PROPERTY PER FARM IN THE UNITED STATES

1850	$2,738.00
1910	6,444.00

VALUE OF ALL FARM PRODUCTS IN 1912 IN THE UNITED STATES

1912	$9,532,000,000.00

THE SIZE OF THE SEAS

	Miles Long
Mediterranean	2,000
Caribbean	1,800
Red	1,400
Black	932
Baltic	600

AREA OF OCEANS IN SQUARE MILES

Pacific	70,000,000
Atlantic	35,000,000
Indian	23,000,000
Southern	7,000,000
Arctic	4,000,000

SIZE OF THE GREAT LAKES

	Miles Long	Miles Wide
Superior	380	120
Michigan	330	60
Ontario	170	40
Champlain	123	12
Erie	270	50
Huron	250	90
Winnipeg	240	40
Athabaska	200	20

BOOK-KEEPING ON THE FARM

WHILE farmers are very generally adopting scientific methods in tilling the soil, managing their crops and feeding stock, they are still slow to recognize the benefits to be derived from keeping a systematic set of books.

Farming is a diversified business of considerable magnitude. The farmer pays out a large sum of money through many channels during the year and his income is from various sources. As a good business man he should know the cost of productions and maintenance, not only of his operations as a whole, but of each specific operation. He should know the cost of producing a bushel of grain, corn, potatoes or any other product of the soil. He should know the cost of feeding cattle and hogs and the net earnings of his dairy. If he keeps a record of these things he will know which feature to improve and encourage and which to eliminate.

The farmer, like the merchant, should make a complete inventory of all of his possessions at least once a year, placing on each item a fair cash value. With each succeeding inventory he should add to it, if his property has increased, and he should also make a reasonable reduction for depreciation, especially of the perishable property.

Many farmers hesitate, believing that book-keeping is intricate and hard to master and that it will require too much time. This, however, is not the case. A modified system is very simple and to make daily records will require but a few moments of the farmer's time. If the farmer can interest his boys or girls in book-keeping, they will take delight in keeping the records and reporting from time to time just what each department of the farm is doing.

Only three inexpensive books are required, namely, a day-book, journal and ledger. Farmers who have adopted systematic book-keeping unhesitatingly state that it is indispensable to them and should be to any farmer who wants to know the details of his business.

A practical and simple system which will serve as a splendid guide to those who are inexperienced in book-keeping can be secured by sending ten cents to the Soil Culture Department of Deere & Company.

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ILLUSTRATIONS

SOIL CULTURE

AND MODERN FARM METHODS

ISSUED BY SOIL CULTURE DEPARTMENT
OF DEERE & COMPANY
MANUFACTURERS OF HIGH GRADE
AGRICULTURAL IMPLEMENTS
MOLINE · ILLINOIS