

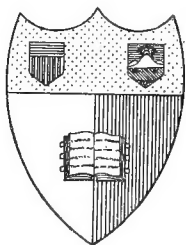
Clovers
and
How to Grow Them

Thomas Shaw

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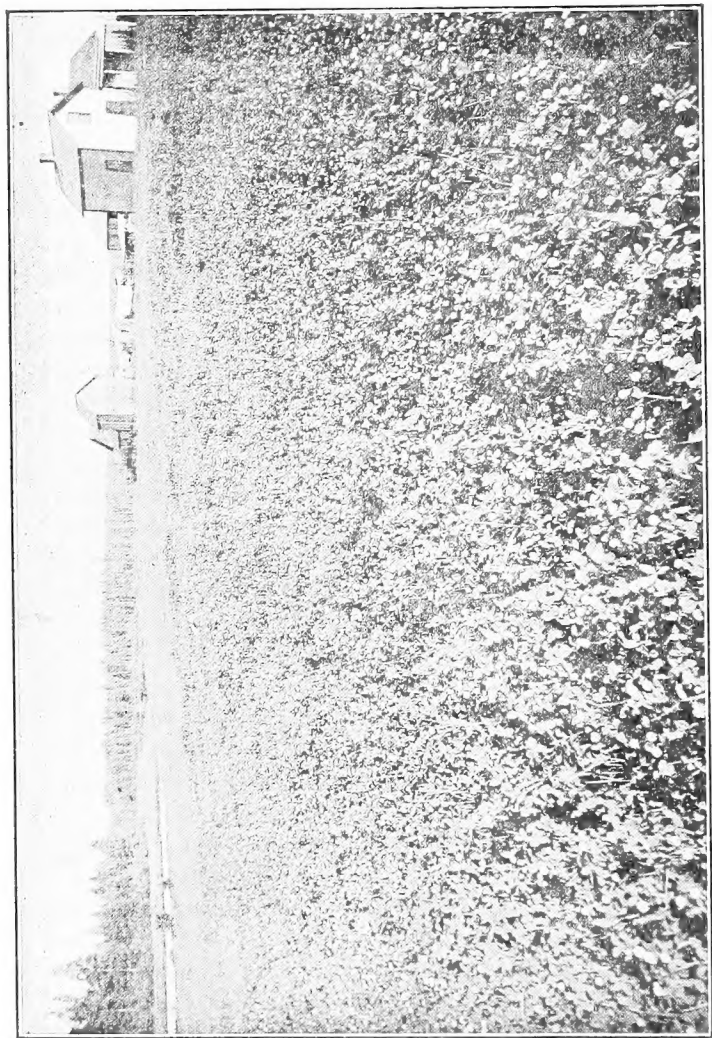


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Alfalfa Clover in Northern Wisconsin

CLOWERS

AND

HOW TO GROW THEM

BY

THOMAS SHAW

Author of "Forage Crops Other than Grasses,"
"The Study of Breeds," "Soiling Crops and
the Silo," "Animal Breeding," "Grasses
and How to Grow Them," etc.



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TO ALL PERSONS
WHO ARE OR MAY BE INTERESTED
IN THE
GROWING OF CLOVERS
THIS WORK IS MOST RESPECTFULLY DEDICATED
BY THE AUTHOR

St. Anthony Park, Minn.
1906

ACKNOWLEDGMENTS

In preparing this work, the chief sources of information beyond the author's experience and observation have been the bulletins issued by the various experiment stations in the United States and discussions in the Agricultural Press.

For the illustrations the author is indebted to Professor A. M. Soule of the experiment station of Tennessee, Professor H. H. Hume of the experiment station of Louisiana and Mr. W. T. Shaw of the experiment station of Oregon.

THE AUTHOR'S PREFACE

Some books have been written on Clover in the United States, and as far as they go they serve a good purpose. Many references and discussions have also appeared in various bulletins and reports issued by the experiment stations. These have proved helpful not only in the States in which they have been issued, but also in other States where the conditions are similar. But no book or bulletin has yet appeared which discusses the growth of clovers as applicable to all parts of the United States and Canada. Nor has any been issued which takes up the subject in orderly and consecutive sequence. It is evident, therefore, that there is not only room for a book which will cover the ground with at least measureable fulness, but also in concise and orderly succession, but there is great need for it. It has been the aim of the author to write such a book.

Only those varieties of clover are discussed at length which are possessed of economic value. The treatment of the subjects is virtually the same as was adopted in writing the book on "Grasses and How to Grow Them." Some references are made to the history, characteristics and distribution of each variety. These are followed by discussions with ref-

erence to soil adaptation; place in the rotation; preparing the soil; sowing; pasturing; harvesting for hay; securing seed; and renewing the stand.

The book is intended, in some measure at least, to meet the needs of the students of agriculture, with reference to the plants discussed and also of all who are concerned in the tilling of the soil.

St. Anthony Park, Minn.
1906

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CHAPTER I

INTRODUCTORY

In this book all the varieties of clover will be discussed that have hitherto been found of any considerable value to the agriculture of America. Varieties that are of but little value to the farmer will be discussed briefly, if discussed at all. The discussions will be conducted from the standpoint of the practical agriculturist rather than from that of the botanist. It is proposed to point out the varieties of clover worthy of cultivation, where and how they ought to be cultivated, and for what uses.

Definition of Clover.—According to Johnson's Encyclopædia, clover or trefoil is a plant of the genus *Trifolium* and the family *Leguminosæ*. The Standard Dictionary defines it as any one of several species of plants of the genus *Trifolium* of the bean family *Leguminosæ*. Viewed from the standpoint of the American farmer it may be defined in the collective sense as a family of plants leguminous in character, which are unexcelled in furnishing forage and fodder to domestic animals, and unequaled in the renovating influences which they exert upon land. The term *Trefoil* is given because the leaves are divided into three leaflets. It is also applied to plants not included in the genus, but belonging to the same order.

The true clovers have their flowers collected into roundish or oblong heads and in some instances into cone-shaped spikes. The flowers are small and of several colors in the different varieties, as crimson, scarlet, pink, blue, yellow and white, according to the variety, and some are variously tinted. The stems are herbaceous and not twining. The seeds are inclosed in pods or seed sacks, each of which contains one, two and sometimes, but not often, three or four seeds. The plants have tap roots, and in some varieties these go far down into the sub-soil. The roots are also in some varieties considerably branched.

Varieties. —At least twenty varieties, native or naturalized, are found in Great Britain; more than twelve varieties belong to the United States. The more valuable varieties found in this country have been introduced from Europe, unless it be the small white clover (*Trifolium repens*). Viewed from the standpoint of the agriculturist the varieties that are most generally useful include medium red clover (*Trifolium pratense*), alfalfa (*Medicago sativa*), alsike (*Trifolium hybridum*), mammoth (*Trifolium magnum*), crimson (*Trifolium incarnatum*) and small white (*Trifolium repens*). The varieties which flourish only in the South include the Japan (*Lespedeza striata*) and the burr clover (*Medicago denticulata*). Sweet clover (*Melilotus alba*), sometimes called Bokhara, which will grow equally well North and South, is worthy of attention because of its power to grow under hard conditions, in order to provide honey for bees and to renovate soils.

Other varieties may render some service to agriculture, but their value will not compare with that of the varieties named.

The most valuable of the varieties named in providing pasture, include the medium red, the mammoth, the alsike and the small white. The most valuable in providing hay are the medium red, alfalfa and alsike. The most valuable, viewed from the standpoint only of soil renovation, are the medium red, mammoth, alsike, crimson, Japan and sweet. The most valuable in producing honey accessible to tame bees, are the small white, alsike and sweet.

Distinguishing Characteristics.—Clovers differ from one another in duration, habit of growth, persistence in growth, their power to endure low or warm temperatures, and ability to maintain a hold upon the soil. Of the varieties named, alfalfa, the small white and alsike varieties are perennial. That most intensely so is the first variety named. The medium red and mammoth varieties are biennial, but sometimes they assume the perennial quality. Sweet clover is biennial. The crimson, Japan and burr varieties are annual.

Some varieties, as alfalfa, crimson and sweet clover, are upright in their habit of growth. Others, as the small white and the burr, are recumbent. Others again, as the medium red, alsike and mammoth, are spreading and upright. The alfalfa and medium red varieties grow most persistently through the whole season. The sweet, small white and alsike varieties can best endure cold, and the sweet, Japan

and burr varieties can best endure heat. The small white, Japan, burr and sweet clovers stand highest in ability to maintain a hold upon the soil.

The minor points of difference are such as relate to the shape and color of the leaves, the tints of shade that characterize the leaflets, the shape and size of the heads and the distinguishing shades of color in the blossoms.

The characteristics which they possess in common are the high protein content found in them, the marked palatability of the pasture and hay, unless in the sweet and burr varieties, the power which they have to enrich and otherwise improve soils, and the honey which they furnish.

Plan of Discussion.—Chapter I., that is, the present chapter, as already indicated, is introductory, and outlines the nature, scope and plan of the work. Chapter II. deals with the general principles and facts which relate to the growing of clovers. A close study of these will, in the judgment of the author, prove helpful to those who engage in growing any of the varieties of clover discussed in the book. Chapters III. to XI. inclusive treat of individual varieties, a chapter being devoted to each variety. It has been the aim of the author to discuss them in the order of the relative importance which they bear to the whole country and to devote space to them accordingly.

The following varieties are discussed and in the order named: Medium Red clover, Alfalfa, Alsike, Mammoth, Crimson, Small White, Japan, Burr and Sweet. All of these varieties will be found worthy

of more or less attention on the part of the husbandmen in the various parts of this continent.

Chapter XII. is devoted to a brief discussion of miscellaneous varieties which have as yet been but little grown in this country, or of varieties of but local interest. The former are Sainfoin (*Onobrychis sativa*), Egyptian clover (*Trifolium Alexandria-num*), yellow clover (*Medicago lupulina*), Sand Lucerne (*Medicago media*), and a newly introduced variety of Japanese clover (*Lespedeza bicolor*). These may prove more or less valuable to the agriculture of the United States when they have been duly tested, a work which as yet has been done only in the most limited way. The latter include Florida clover (*Desmodium tortuosum*), more frequently called Beggar Weed, Buffalo clover (*Trifolium reflexum*), and Seaside clover (*Trifolium invulneratum*). These may be worthy of some attention in limited areas where the conditions are favorable, but it is not likely that they will ever be very generally grown. They are dwelt upon rather to show their small economic importance and with a view to prevent needless experimentation with plants possessed of so little real merit.

CHAPTER II

SOME GENERAL PRINCIPLES WHICH APPLY TO THE GROWING OF CLOVERS

In growing clovers, as in growing other crops of the same species, which embrace several varieties, certain features of management will apply more or less to all of these in common. It will be the aim to point out the chief of these in the present chapter.

Adaptation in Clovers.—Adaptation in the varieties of clover considered will be more fully given when discussing these individually, but enough will be said here to facilitate comparisons. Clover in one or the other of its varieties can be grown in almost all parts of the United States and Canada. Speaking in a general way, the medium and mammoth varieties can be grown at their best between parallels 37° and 49° north latitude. Alfalfa has special adaptation for mountain valleys of the entire West, but it will also grow in good form in parts of all, or nearly all, the other States. Alsike clover grows in about the same areas as the common and mammoth varieties, but it may also be grown further North, owing to its greater hardihood. Crimson clover has highest adaptation to the States east of the Alleghany Mountains and west of the Cascades, but will also grow in the more Central States south, in which moisture is abundant. Small white clover will grow

in any part of the United States or Canada in which moisture is sufficiently present. Japan and burr clover grow best south of parallel 37° and east of longitude 98° . Sweet clover will grow in all the States and provinces of the United States and Canada, but has highest adaptation for the Central and Southern States.

With reference to adaptation to soils, medium and mammoth clover grow best on upland clay loam soils, such as have sustained a growth of hardwood timber, and on the volcanic ash soils of the Western mountain valley. Alfalfa flourishes best on those mountain valley soils when irrigated, or when these are so underlaid with water as to furnish the plants with moisture. Alsike clover has much the same adaptation to soils as the medium and mammoth varieties, but will grow better than these on low-lying soils well stored with humus. Crimson clover has highest adaptation for sandy loam soils into which the roots can penetrate easily. Small, white clover has adaptation for soils very similar to that of alsike clover. Japan clover and burr clover will grow on almost any kind of soil, but on good soils the growth will, of course, be much more vigorous than on poor soils. Sweet clover seems to grow about equally well on sandy loams and clay loams, but it has also much power to grow in stiff clays and even in infertile sands.

Place in the Rotation.—All the varieties of clover discussed in this volume may be grown in certain rotations. Their adaptation for this use, however, differs much. This increases as the natu-

ral period of the life of the plant lessens and *vice versa*. Consequently, the medium red variety, the mammoth, the crimson, the Japan and the burr varieties stand high in such adaptation. The alsike, living longer, is lower in its adaptation, and alfalfa, because of its long life, stands lowest in this respect. The small, white variety is almost invariably grown or found growing spontaneously along with grasses, hence no definite place has been or can be assigned to it in the rotation. Sweet clover being regarded by many as a weed has not had any place assigned to it in a regular rotation, although in certain localities it may yet be grown for purposes of soil renovation. (See page 306.)

All these crops are leguminous without any exception. This fact is of great significance where crops can be rotated. They have power to gather nitrogen from the air and store it in the soil in tubercles which form on their roots, in all soils in which they produce a vigorous growth. This fact indicates where they should come in the rotation. They should be grown with a view to gather food for other crops made to follow them, which have not the same power. They should, therefore, be made to precede such crops as the small cereals, corn, the sorghums, the millets and cotton. But since these clover plants have the power to bring nitrogen from the air, it must not be supposed that they will grow with sufficient vigor in soils destitute of this element. They must be able to appropriate enough from the seed soil to give them a good start before they can draw nitrogen from the air, hence, though they may

be made to follow almost any kind of crop, it may sometimes be necessary to apply some nitrogenous fertilizer before they will make a vigorous growth.

The clovers, unless in the case of some of the smaller varieties, are more commonly sown to provide hay than pasture in the first crops obtained from them. The value of the hay is increased or lessened in proportion as weeds are present. To insure cleanliness in the hay crop, therefore, the system which aims to sow clover seed on land to which clean cultivation has been given while growing on them a cultivated crop, as corn or field roots, meets with much favor. The mechanical condition of the soil immediately after growing these crops also favors the vigorous growth of the young clover plants, more especially when they are sown upon the surface of the land after some form of surface cultivation, rather than upon a surface made by plowing the land after cultivation has been given to it, but to this there may be some exceptions.

Clover in some of its varieties is frequently grown from year to year in orchards and for the two-fold purpose of gathering food for the trees and providing for them a cover crop in winter. The medium red and crimson varieties are preferred for such a use. The latter is the more suitable of the two, since it does not draw on soil moisture needed by the trees, owing to the season at which it is grown. Enough of the seed of these crops may be allowed to mature to re-seed the land from year to year, and thus keep it producing. The clover plants

not only gather nitrogen for the fruit trees, but in their decay they increase the power of the soil to retain moisture for the benefit of the trees.

Some varieties of clover may be grown as catch crops, that is, as crops which are grown in addition to some other crop produced the same season. When thus grown, it is usually for purposes of soil improvement rather than to furnish food. The varieties best adapted for this purpose in the Northern States and Canada are the medium red and the crimson, the latter being much more circumscribed in the area where it will grow successfully than the former. When medium red clover is thus grown, it is commonly sown along with one of the small cereal grains, and is buried in the autumn or in the following spring. (See page 75.) The extent of the advantage is dependent chiefly on the amount of the growth made, and this in turn is influenced by the character of the soil, the season and the nurse crop. In certain areas favorable to the growth of clover some good farmers sow clover along with all the small cereal grains which they grow. Crimson clover is usually sown in the late summer after some crop has been reaped and it is plowed under the following spring. (See page 250.)

In the Southern States Japan clover and burr clover will serve the purpose of catch crops better than the other varieties. The former will follow a winter crop (see page 284), and the latter a summer crop. (See page 294.)

Although alfalfa is not usually looked upon as a rotation crop in the Rocky Mountain valleys, it

may be made such a crop. In these it grows so vigorously as to fill the soil with its roots in one or two seasons, hence it may be made to rotate profitably with other crops. (See page 135.) In such instances, however, medium red clover would probably answer the purpose quite as well, and possibly better, since the labor of burying it with the plow would be less difficult.

While some varieties of clover may be grown in various rotations and with profit, one of the best of these, where the conditions are favorable, is a three years' rotation. The first year some small cereal grain is grown and clover is sown along with it or, at least, on the same land. The next year the clover is grown for hay or pasture. The third year a crop of corn, potatoes or vegetables is grown, and the following year small cereal grain and clover. The clover may thus be made to furnish nitrogen indefinitely for the other crops, but in some instances it may be necessary to add phosphoric acid and potash.

Preparing the Soil.—Clovers are usually sown with a nurse crop. The exceptions are crimson clover, and in many instances alfalfa. When thus grown, the preparation of soil for the nurse crop will usually suffice for the clovers also. But there may be instances in which it would be proper to give more attention to cleaning and pulverizing the soil to properly fit it for receiving the clover seed. The leading essentials in a seed-bed for clover are fineness, cleanness, moistness and firmness. Ordinarily black loam soils, sandy loam soils, sandy soils, humus

soils and the volcanic ash soils of the West are made sufficiently fine without great labor. Clay soils may call for the free use of the harrow and roller used in some sort of alternation before they are sufficiently pulverized. Excessive fineness in pulverization of these soils is also to be guarded against in rainy climates, lest they run together, but this condition is present far less frequently than the opposite.

Cleanness can usually be secured when clovers follow cultivated crops by the labor given to these when the land is not plowed in preparing it for the clovers. In other instances the longer the land is plowed before putting in the seed and the more frequently the surface is stirred during the growing part of the season, the cleaner will the seed-bed be.

In the spring the land is usually sufficiently moist for receiving the seed. In the autumn moisture is frequently deficient. Stirring the surface of the soil occasionally with the harrow will materially increase the moisture content in the soil near the surface, even in the absence of rain. As crimson clover is usually sown in the late summer and alfalfa is frequently sown in the autumn, it may sometimes be necessary to give much attention to securing sufficient moisture to insure germination in the seed.

When clovers are sown in the spring on land which is also growing a winter crop, no preparation is necessary in preparing the land for receiving the seed. On some soils the ground becomes sufficiently honeycombed through the agency of water and frost to put it in a fine condition for receiving the seed.

When this condition is not present, the seed will usually grow if sown amid the grain and covered with the harrow.

When clovers are sown on sod land for the purpose of renewing pastures, disking them will prepare them for receiving the seed. The extent of the disking will depend on such conditions as the toughness of the sod and the nature of the soil. Usually disking once when the frost is out a little way from the surface, and then disking across at an angle will suffice, and in some instances disking one way only will be sufficient. On newly cleared lands the clovers will usually grow without any stirring of the land before sowing, or any harrowing after sowing. Clovers that are grown chiefly for pasture, as the small white, the Japan and the burr, will usually obtain a hold upon the soil if scattered upon the surface which is not soon to be cultivated.

Fertilizers.—On certain soils low in fertility and much deficient in humus, it may be necessary to apply fertilizers in some form before clovers will grow vigorously. Such are sandy soils that have been much worn by cropping, and also stiff clays in which the humus has become practically exhausted. In such instances green crops that can be grown on such lands, as rye, for instance, plowed under when the ear begins to shoot, will be found helpful. If this can be followed on the sandy soil with some crop to be fed off upon the land, as corn, for instance, and the clover is sown, successful growth is likely to follow. On clays in the condition named it may not be necessary to grow a second crop before sow-

ing clover, since in these soils the lack is more one of humus than of plant food. The application of farmyard manure will answer the same purpose, if it can be spared for such a use.

Other soils are so acid that clovers will not grow on them until the acidity is corrected, notwithstanding that plant food may be present in sufficient quantities. Such are soils, in some instances at least, that have been newly drained, also soils that grow such plants as sorrels. This condition will be improved if not entirely corrected by the application of lime. On such soils this is most cheaply applied in the air-slaked form, such as is used in plastering and in quantities to effect the end sought. These will vary, and can only be ascertained positively by experiment.

Usually it is not necessary to apply much farmyard manure in order to induce growth in nearly all varieties of clover, and after free growth is obtained, it is not usually necessary to supply any subsequently for the specific purpose named. In some soils, however, alfalfa is an exception. It may be necessary to enrich these with a liberal dressing of farmyard manure to insure a sufficiently strong growth in the plants when they are young. Having passed the first winter, further dressings are not absolutely essential, though they may prove helpful.

Farmyard manure applied on the surface will always stimulate the growth of clovers, but it is not common to apply manure thus, as the need for it is greater in growing the other crops of the farm. When thus applied, it should be in a form somewhat

reduced, otherwise the coarse parts may rake up in the hay. It is better applied in the autumn or early winter than in the spring, as then more of the plant food in it has reached the roots of the clover plants, and they have also received benefit from the protection which it has furnished them in winter.

In a great majority of instances, soils are sufficiently well supplied with the more essential elements of fertility to grow reasonably good crops of clover, hence it has not usually been found necessary to apply commercial fertilizers to stimulate growth, as in the growing of grasses. In some instances, however, these are not sufficiently available, especially is this true of potash. Gypsum or land plaster has been often used to correct this condition, and frequently with excellent results. It also aids in fixing volatile and escaping carbonates of ammonia, and conveys them to the roots of the clover plants. It is applied in the ground form by sowing it over the land, and more commonly just when the clover is beginning to grow. The application of 50 to 200 pounds per acre has in many instances greatly increased the growth, whether as pasture, hay or seed. The following indications almost certainly point to the need of dressings of land plaster: 1. When the plants assume a bluish-green tint, rather than a pea-green, while they are growing. 2. When the plants fail to yield as they once did. 3. When young plants die after they have begun to grow in the presence of sufficient moisture. 4. When good crops can only be grown at long intervals, as, say, 5 to 8 years. It has also been noticed that on some soils where

gypsum has long been used in growing clover the response to applications of the plaster is a waning one, due doubtless to the too rapid depletion of the potash in the soil.

Potassic fertilizers give the best results when applied to clovers, but dressings of phosphoric acid may also be helpful. Applications of muriate or sulphate of potash or kainit may prove profitable, but on many soils they are not necessary in growing clover. Wood ashes are also excellent. They furnish potash finely divided and soluble, especially when applied in the unleached form. When applied unleached at the rate of 50 bushels per acre and leached at the rate of 200 bushels, the results are usually very marked in stimulating growth in clover.

Seasons for Sowing.—Clovers are more commonly sown in the springtime in the Northern States and Canada than at any other season and they are usually sown early in the spring, rather than late. On land producing a winter crop, as rye or wheat, they can be sown in a majority of instances as soon as the snow has melted. That condition of soil known as honeycombed furnishes a peculiarly opportune time for sowing these seeds, as it provides a covering for them while the land is moist, and thus puts them in a position to germinate as soon as growth begins. Such a condition, caused by alternate freezing and thawing, does not occur on sandy soils. Where it does not so occur, sowing ought to be deferred until the surface of the ground has become dry enough to admit of covering with a harrow. As in sowing the seeds of certain grasses good

results usually follow sowing just after a light fall of snow, which, as it melts, carries the seed down into the little openings in the soil. But there are areas, especially in the American and Canadian northwest, where in some seasons the young clover plants would be injured from sowing the seed quite early. This, however, does not occur very frequently. When sown on spring crops, as spring wheat, barley and oats, the seed cannot, of course, be sown until these crops are sown. The earlier that these crops are sown the more likely are the clovers sown to make a stand, as they have more time to become rooted before the dry weather of summer begins. In a moist season the seed could be safely sown any time from spring until mid-summer, but since the weather cannot be forecast, it is considered more or less hazardous to sow clovers in these northern areas at any other season than that of early spring. If sown later, the seed will more certainly make a stand without a nurse crop, since it will get more moisture. If sown later than August, the young plants are much more liable to perish in the winter.

In the States which lie between parallels 40° and 35° north, and between the Atlantic and the 100th meridian west, clover seeds may be sown in one form or another from early spring until the early autumn without incurring much hazard from winter killing in the young plants, but here also early spring sowing will prove the most satisfactory. The hazard from sowing in the summer comes chiefly from want of sufficient moisture to germinate the seed.

In the Southern States the seed is sown in the early spring or in the autumn. If sown late, the heat of summer is much against the plants. Seeds sown in the early autumn as soon as the rains come will make a good stand before the winter, but there are some soils in the South in which alternate freezing and thawing in winter, much more frequent than in the North, would injure and in some instances destroy the plants.

In the Western valleys where irrigation is practiced, clover seeds may be sown at any time that may be desired, from the early spring until the early autumn. The ability to apply water when it is needed insures proper germination in the seed and vigor in the young plants.

Methods of Sowing.—Clover seed may be sown by hand, by hand machines, and by the grain drill, with or without a grass-seed sowing attachment. These respective methods of sowing will be discussed briefly here, but since they are practically the same as the methods to be followed in sowing grass seeds, and since they are discussed more fully in the book "Grasses and How to Grow Them" by the author, readers who wish to pursue the subject further are referred to the book just named.

✓ When clovers are sown by hand, usually but one hand is used. Enough seed is lifted between the thumb and two forefingers of the right hand to suffice for scattering by one swing of the same. On the return trip across the field the seed should be made to overlap somewhat the seed sown when going in the opposite direction. In other words, the seed

is sown in strips or bands, as it were, each strip being finished in one round. Some sowers, more expert at their work, sow with both hands and complete the strip each time they walk over the field. When the ground is plowed in lands of moderate width the furrows will serve to enable the sower to sow in straight lines. Where the sowing is done on land sown to grain by the drill, the drill marks may be made to effect the same result. When sown on light snows, the foot-marks will serve as guides. In the absence of marks it will be necessary to use stakes to guide the sower. Four stakes are used, two of which are set at each end of the field, and these are moved as each cast is made. At each round made over the field, from 12 feet to 15 feet may be sown by the sower who sows only with one hand. The sower with two hands will accomplish twice as much.

A comparatively still time should be chosen for sowing the seed by hand, more especially when grass seeds, which are usually lighter, are sown at the same time. In hand sowing much care is necessary in scattering the seed, so that each cast of the seed will spread evenly as it falls, leaving no bare spaces between the cast from the hand or between the strips sown at one time. Hand sowing, especially in the Western States, is in a sense a lost art, owing to the extent to which machine sowing is practised; nevertheless, it is an accomplishment which every farmer should possess, since it will oftentimes be found very convenient when sowing small quantities of seed, and in sowing seeds in mixtures which cannot be so well sown by machines.

Hand machines are of various kinds. Those most in favor for ordinary sowing consist of a seeder wheeled over the ground on a frame resembling that of a wheelbarrow. It sows about 12 feet in width at each cast of the seed. It enables the sower to sow the seed while considerable wind is blowing and to sow it quite evenly, but it is not adapted to the sowing of all kinds of grass and clover mixtures, which it may be desirable to sow together, since they do not always feed out evenly, owing to a difference in size, in weight, in shape and in the character of the covering.

When clover seed is sown with the grain drill, it is sometimes sown separately from grain; that is, without a nurse crop, and is deposited in the soil by the same tubes. But it is only some makes of drills that will do this. Clover seed, and especially alfalfa, may be thus sown with much advantage on certain of the Western and Southern soils, especially on those that are light and open in character, and when the seed is to be put in without a nurse crop. Eastern soils are usually too heavy to admit of depositing the seed thus deeply, but to this there are some exceptions.

When sown with a nurse crop, the seed is in some instances mixed with the grain before it is sown. In some instances it is mixed before it is brought to the field. At other times it is added when the grain has been put in the seed-box of the drill. This method of sowing is adapted to certain soils of the Western prairies and to very open soils in some other localities, but under average conditions

it buries seeds too deeply. There is the further objection that they all grow in the line of the grain plants and are more shaded than they would be otherwise. Nevertheless, under some conditions this method of sowing the plants is usually satisfactory.

One of the most satisfactory methods of sowing clover seeds along with a nurse crop is to sow the clover with a "seeder attachment;" that is, an attachment for sowing small seeds, which will deposit the same before or behind the grain tubes as may be desired. The seed is thus sown at the same time as the grain, and in the process is scattered evenly over the surface of the ground. These seeder attachments, however, will not sow all kinds of clover and grass mixtures any more than will hand-sowing machines do the same.

Depth to Bury the Seed.—The depth to bury the seed varies with the conditions of soil, climate and season. Clover seeds, like those of grasses, are buried most deeply in the light soils of the prairie so light that they sink, so as to make walking over them unusually tiresome when working on newly plowed land, and in other instances so light as to lift with the wind. On such soils the seeds may be buried to the depth of 2 to 3 inches. On loam soils, a covering of 1 inch or less would be ample, and on stiff clays the covering may even be lighter under normal conditions.

Clover seeds are buried more deeply in dry than in moist climates, and also more deeply in dry portions of the year than when moisture is sufficient.

While it may be proper in some instances to scatter the seeds on the surface without any covering other than is furnished by rain or frost, it will be very necessary at other seasons to provide a covering to insure a stand of the seed.

When clover seed is sown on ground honeycombed with frost, no covering is necessary. When sown on winter grain in the spring, the ground not being so honeycombed, covering with the harrow is usually advantageous. When sown on spring crops and early in the season, it may not be necessary to cover the seed, except by using the roller, even though the seed should fall behind the grain tubes while the grain crop is being sown, or should be sown subsequently by hand. In other instances the harrow should be used, and sometimes both the roller and the harrow. Under conditions such as appertain to New England and the adjacent States to Ontario and the provinces east and to the land west of the Cascade Mountains, clover and also grass seeds do not require so much of a covering as when sown on the prairie soils of the central portion of the continent.

Sowing Alone or in Combinations.—Whether clover seed should be sown alone or in combination with the seeds of other grasses will depend upon the object sought in sowing it. When sown to produce seed, it is usually sown without admixture, but not in every instance; when sown to produce hay, it is nearly always sown in mixtures, but to this there are some exceptions; when sown to produce pasture, it is almost invariably sown with something

else; and when sown to enrich the land, it is, in all, or nearly all, instances, sown without admixture.

When sown primarily to produce seed, there are no good reasons why timothy and probably some other grasses may not be sown with medium red and mammoth clover, when pasture is wanted from the land in the season or seasons immediately following the production of seed.

The presence of these grasses may not seriously retard the growth of the clover plants until after they have produced seed, and subsequently they will grow more assertively and produce pasture as the clover fails. Moreover, should they mature any seed at the same time that the clover seeds mature, they may usually be separated in the winnowing process, owing to a difference in the size of the seeds. But timothy should not be sown with alsike clover that is being grown for seed, since the seeds of these are so nearly alike in size that they cannot be separated.

When hay is wanted, the practice is very common of sowing timothy along with the medium red, mammoth and alsike varieties of clover. Timothy grows well with each of these; supports them to some extent when likely to lodge; matures at the same time as the mammoth and alsike clovers; comes on more assertively as the clovers begin to fail, thus prolonging the period of cropping or pasturing; and feeds upon the roots of the clovers in their decay.

Next to timothy, redtop is probably the most useful grass to sow with these clovers, and may in

some instances be added to timothy in the mixtures. Some other grasses may also be added under certain conditions, or substituted for timothy or redtop. In certain instances, it has also been found profitable to mix certain of the clovers in addition to adding grass seeds when hay is wanted. The more important of these mixtures will be referred to when treating of growing the different varieties in subsequent chapters. When growing them, the aim should be to sow those varieties together which mature about the same time. The advantages from growing them together for hay include larger yields, a finer quality of hay, and a more palatable fodder.

In the past it has been the almost uniform practice to sow alfalfa alone, but this practice is becoming modified to some extent, and is likely to become more so in the future, especially when grown for pasture.

When sown to produce pasture, unless for one or two seasons, clover seed is sown in various mixtures of grasses in all or nearly all instances. The grasses add to the permanency of the pastures, while the clovers usually furnish abundant grazing more quickly than the grasses. Several of them, however, are more short-lived than grasses usually are, hence the latter are relied upon to furnish grazing after the clovers have begun to fail. In laying down permanent pastures, the seed of several varieties is usually sown, but in moderate quantities. The larger the number of the varieties sown that are adapted to the conditions, the more varied, the more pro-

longed and the more ample is the grazing likely to be.

When clovers, except the crimson variety, are sown for the exclusive purpose of adding to the fertility of the land, they are usually sown along with some other crop that is to be harvested, the clover being plowed under the following autumn or the next spring. These are usually sown without being mixed with other varieties, and the two kinds most frequently sown primarily to enrich the land are the medium red and crimson varieties. The former grows more quickly than other varieties, and the latter, usually sown alone, comes after some crop already harvested, and is buried in time to sow some other crop on the same land the following spring.

Sowing with or without a Nurse Crop.—Nearly all varieties of clover are usually sown with a nurse crop; that is, a crop which provides shade for the plants when they are young and delicate. But the object in sowing with a nurse crop is not so much to secure protection to the young plants as to get them established in the soil, so that they will produce a full crop the following season. Two varieties, however, are more commonly sown alone. These are alfalfa and crimson clover.

Alfalfa is more commonly sown alone because the young plants are somewhat delicate and easily crowded out by other plants amid which they are growing. Because of the several years during which alfalfa will produce crops when once established, it is deemed proper to sacrifice a nurse crop in order to get a good stand of the young plants. The other

clovers are usually able to make a sufficient stand, though grown along with a nurse crop. In some situations alfalfa will also do similarly, as, for instance, where the conditions are very favorable to its growth. Crimson clover is more commonly sown alone for the reason, first, that it is frequently sown at a season when other crops are not being sown; second, that it grows better without a nurse crop; and third, that if grown with a nurse crop the latter would have to be used in the same way as the clover.

Some have advocated sowing clovers without a nurse crop under any conditions. Such advocacy in the judgment of the author is not wise. It is true that in some instances a stand of the various clovers is more certainly assured when they are sown without a nurse crop, but in such situations it is at least questionable if it would not be better to sow some other crop as a substitute for clover. But there may be instances, as where clover will make a good crop of hay the year that it is sown, when sowing it thus would be justifiable. In a majority of instances, however, it will not make such a crop, because of the presence of weeds, which, in the first place, would hinder growth, and in the second, would injure the quality of the hay.

The nurse crops with which clovers may be sown are the small cereal grains, as rye, barley, wheat and oats. Sometimes they are sown with flax, rape and millet. They usually succeed best when sown along with rye and barley, since these shade them less and are cut earlier, thus making less draft on moisture

in the soil and admitting sunlight at an earlier period. Oats make the least advantageous nurse crop, because of the denseness of the shade, but if they are sown thinly and cut for hay soon after they come into head, they are then a very suitable nurse crop. One chief objection to flax as a nurse crop is that it is commonly sown late. The chief virtue in rape as a nurse crop is that the shade is removed early through pasturing. The millets are objectionable as nurse crops through the denseness of the shade which they furnish and also because of the heavy draught which they make on soil moisture. Peas and vetches should not be used as nurse crops, since they smother the young clover plants through lodging in the advanced stages of their growth.

Amounts of Seed to Sow.—The amounts of clover seed to sow are influenced by the object sought in sowing; by combinations with which the seeds are sown, and by the relative size of the seeds. The soil and climate should also be considered, although these influences are probably less important than those first named.

When clovers are sown for pasture only, or to fertilize the soil speedily and to supply it with humus, the largest amounts of seed are sown. But for these purposes it is seldom necessary to use more than 12 pounds of seed per acre. These amounts refer to the medium red and mammoth varieties, which are more frequently used than the other varieties for the purposes named. They also include the crimson sown usually to fertilize the soil. When sown to provide seed only, 12 pounds per acre of the

medium red, mammoth and crimson varieties will usually suffice. Half the quantity of alsike will be enough, and one-third the quantity of the small white, or a little more than that. Whether alfalfa is grown for seed, for hay or for pasture, about the same amounts of seed are used; that is, 15 to 20 pounds per acre. When sown with nurse crops and simply to improve the soil, it is customary to sow small rather than large quantities of seed, and for the reason that the hazard of failure to secure a stand every season is too considerable to justify the outlay. From 4 to 5 pounds per acre are frequently sown and of the medium or mammoth variety.

When the mammoth and medium varieties of clover are sown for hay with one or two kinds of grass only, it is not common to sow more than 6 to 8 pounds of either per acre. The maximum amount of the seed of the alsike required when thus sown with grasses may be set down at 5 pounds per acre. These three varieties are chiefly used for such mixtures. With more varieties of grass in the mixtures, the quantities of clover seed used will decrease. When clovers are sown with mixtures intended for permanent pastures, it would not be possible to name the amounts of seed to sow without knowing the grasses used also, but it may be said that, as a rule, in those mixtures, the clovers combined seldom form more than one-third of the seed used.

The seeds of some varieties of clover are less than one-third of the size of other varieties. This, therefore, affects proportionately, or at least approxi-

mately so, the amounts of seed required. For instance, while it might be proper to sow 12 pounds of medium or mammoth clover to accomplish a certain result, less than one-third of the quantity of the small white variety would suffice for the same end.

The influences of climate and soil on the quantities of seed required are various, so various that to consider them fully here would unduly prolong the discussion. But it may be said that the harder the conditions in both respects, the more the quantity of seed required and *vice versa*.

Pasturing.—When clover seed is sown in nurse crops that are matured before being harvested, the pasturing of the stand secured the autumn following is usually to be avoided. Removing the covering which the plants have provided for themselves is against their passing through the winter in the best form. In some instances the injury proves so serious as to result in a loss of all, or nearly all, the plants. The colder the winters, the less the normal snowfall and the more the deficiency of moisture, the greater is the hazard. But in some instances so great is the growth of the clover plants that not to graze them down in part at least would incur the danger of smothering many of the plants, especially in regions where the snowfall is at all considerable.

But when the seed is sown alone or in mixtures of grain and even of other grasses in the spring, grazing the same season will have the effect of strengthening the plants. This result is due chiefly to the removal of the shade that weeds and

other plants would furnish were they not thus eaten down, but it is also due in part to the larger share of soil moisture that is thus left for the clover plants. Pasturing clover sown thus should be avoided when the ground is so wet as to poach or become impact in consequence. Unless on light, spongy soils which readily lose their moisture, such grazing should not begin until the plants have made considerable growth, nor should it be too close, or root development in the pastures will be hindered.

It would not be possible to fix the stage of growth when the grazing should begin on clover fields kept for pasture subsequent to the season of sowing. The largest amount of food would be furnished if grazing were deferred until the blossoming stage were reached and the crop were then grazed down quickly. But this is not usually practicable, hence the grazing usually begins at a period considerably earlier. In general, however, the plants should not be grazed down very closely, or growth will be more or less hindered.

Grazing clover in the spring and somewhat closely for several weeks after growth begins, has been thought conducive to abundant seed production. This result is due probably to the greater increase in the seed heads that follow such grazing. This would seem to explain why clover that has been judiciously grazed produces even more seed than that clipped off by the mower after it has begun to grow freely.

In nearly all localities the grazing of medium red clover, and even of mammoth clover, somewhat closely in the autumn of the second year, is to be

practised rather than avoided. These two varieties being essentially biennial in their habit of growth will not usually survive the second winter, even though not grazed, hence not to graze them would result in a loss of the pasture.

With nearly all kinds of clover there is some danger from bloat in grazing them with cattle or sheep while yet quite succulent, and the danger is intensified when the animals are turned in to graze with empty stomachs or when the clover is wet with dew or rain. When such bloating occurs, for the method of procedure see page 95. The danger that bloat will be produced is lessened in proportion as other grasses abound in the pastures.

Harvesting.—All the varieties of clover, except alfalfa, are best cut for hay when in full bloom. Here and there a head may have turned brown. If cut earlier, the crop is difficult to cure, nor will it contain a maximum of nutriment. If cut later it loses much in palatability. Alfalfa should be cut a little earlier, or just when it is nicely coming into bloom, as if cut later the shedding of the leaves in the curing is likely to be large.

All clovers are much injured by exposure to rain or dew. They will also lose much if cured in the swath, without being frequently stirred with the tedder; that is, it will take serious injury if cured in the swath as it fell from the mower. If cured thus, it will lose in aroma and palatability, through the breaking of leaves and, consequently, in feeding value. To avoid these losses, clover is more frequently cured in the cock. When cured thus, it pre-

serves the bright green color, the aroma and the tint of the blossoms, it is less liable to heat in the mow or stack and is greatly relished by live stock when fed to them.

To cure it thus, it is usually teded once or twice after it has lost some of its moisture. It is then raked as soon as it is dried enough to rake easily, and put up into cocks. When the quantity to be cured is not large caps are sometimes used to cover the cocks to shed the rain when the weather is showery. These are simply square strips of some kind of material that will shed rain, weighted at the corners to keep them from blowing away. The clover remains in the cocks for two or three days, or until it has gone through the "sweating" process. Exposure to two or three showers of rain falling at intervals while partially cured in the swath or winrow will greatly injure clover hay.

When the area to be harvested is large, clover is sometimes cured in the swath. When thus cured it is stirred with the tedder often enough to aid in curing the hay quickly. It is then raked into winrows and drawn from these to the place of storage. In good weather clover may be cured thus so as to make fairly good hay, but not so good as is made by the other method of curing. It is much more expeditiously made, but there is some loss in leaves, in color and in palatability.

Some farmers cure clover by allowing it to wilt a little after it is cut, and then drawing and storing it in a large mow. They claim that it must be entirely free from rain or dew when thus stored. This

plan of curing clover has been successfully practised by some farmers for many years; others who have tried it have failed, which makes it evident that when stored thus, close attention must be given to all the details essential to success.

Clover may also be cured in the silo. While some have succeeded in making good ensilage, in many cases it has not proved satisfactory. The time may come when the conditions to be observed in making good silage from clover will be such that the element of hazard in making the same will be removed. In the meantime, it will usually be more satisfactory to cure clover in the ordinary way.

Grasses cure more easily and more quickly than clovers. Consequently, when these are grown together so that the grasses form a considerable proportion of the hay, the methods followed in curing the grasses will answer also for the clovers. For these methods the reader is referred to the book "Grasses and How to Grow Them" by the author. The influence that grasses thus exert on the growing of clovers furnishes a weighty reason for growing them together.

Storing.—Clovers are ready to store when enough moisture has left the stems to prevent excessive fermentation when put into the place of storage. Hay that has been cured in the cock is much less liable to heat when stored so as to produce mould, than hay cured in the swath or winrow. The former has already gone through the heating process or, at least, partially so. Some experience is necessary to enable one to be quite sure as to the measure of the

fitness of hay for being stored. When it can be pitched without excessive labor it is ready for being stored, but the unskilled will not likely be able to judge of this accurately. If a wisp is taken some distance from the top of the winrow or cock and twisted between the hands, if moisture exudes it is too damp, and if the hay breaks asunder readily it is too dry. When no moisture is perceptible and yet the wisp does not break asunder, the hay is ready to be drawn. Care must be taken that the wisp chosen be representative of the mass of the hay. To make sure of this, the test should be applied several times.

Where practicable the aim should be to store clover hay under cover, owing to the little power which it has to shed rain in the stack. This is only necessary, however, in climates with considerable rainfall during the year and where irrigation is practised, as in the mountain States clover hay may be kept in the stack without any loss from rain, and it can be cured exactly as the ranchman may desire, since he is never embarrassed when making hay by bad weather. When storing clovers, the time of the day at which it is stored influences the keeping qualities of the hay. Hay stored at noontide may keep properly, whereas, if the same were stored while dew is falling it might be too damp for being thus stored.

Much care should be taken in stacking clover hay that it may shed rain properly. The following should be observed among other rules of less importance that may be given: 1. Make a foundation of rails, poles or old straw or hay that will prevent

the hay near the ground from taking injury from the ground moisture. 2. Keep the heart of the stack highest from the first and the slope gradual and even from the center toward the sides. 3. Keep the stack evenly trodden, or it will settle unevenly, and the stack will lean to one side accordingly. 4. Increase the diameter from the ground upward until ready to draw in or narrow to form the top. 5. Aim to form the top by gradual rather than abrupt narrowing. 6. Top out by using some other kind of hay or grass that sheds the rain better than clover. 7. Suspend weights to some kind of ropes, stretching over the top of the stack to prevent the wind from removing the material put on to protect the clover from rain.

Feeding.—The clovers furnish a ration more nearly in balance than almost any other kind of food. If the animals to which they are fed could consume enough of them to produce the desired end, concentrated foods would not be wanted. They are so bulky, however, relatively, that to horses and mules at work, to dairy cows in milk and cattle that are being fattened, to sheep under similar conditions, and to swine, it is necessary to add the concentrated grain foods, more or less, according to the precise object. But for horses, mules, cattle, sheep and goats that are growing subsequent to the weaning stage, and for mature animals of these respective classes not producing, that is, not yielding returns, a good quality of clover hay will suffice for a considerable time at least without the necessity of adding any other food.

It is considered inferior to timothy as a fodder for horses. This preference is doubtless owing largely to the fact, first, that clover breaks up more and loses more leaves when being handled, especially when being transported; and second, that clover is frequently cured so imperfectly as to create dust from over-fermentation or through breaking of the leaves, because of being over-dried, and the dust thus created is prejudicial to the health of these animals. It tends to produce "heaves." This may in part be obviated by sprinkling the hay before it is fed. When clover is properly cured, it is a more nutritious hay than timothy, and is so far preferable for horses, but since timothy transports in much better form, it is always likely to be more popular in the general market than clover. The possibility of feeding clover to horses for successive years without any evils resulting is made very apparent from feeding alfalfa thus in certain areas of the West.

Clover hay is specially useful as a fodder for milk-producing animals, owing to the high protein content which it contains. Dairymen prefer it to nearly all kinds of fodders grown, and the same is true of shepherds. When very coarse, however, a considerable proportion of the stems is likely to be left uneaten, especially by sheep. Because of this it should be the aim to grow it so that this coarseness of stem will not be present. This is accomplished, first, by growing it thickly, and second, by growing the clovers in combination with one another and also with certain of the grasses.

Clovers are especially helpful in balancing the ration where corn is the principal food crop grown. The protein of the clover crop aids greatly in balancing the excess of carbo-hydrates in the corn crop, hence much attention should be given to the production of clovers in such areas.

Renewing.—Because of the comparatively short life of several of the most useful of the varieties of clover, no attempt is usually made to renew them when they fail, unless when growing in pasture somewhat permanent in character. To this, however, there may be some exceptions. On certain porous soils it has been found possible to maintain medium red clover and also the mammoth and alsike varieties for several years by simply allowing some of the seed to ripen in the autumn, and in this way to re-seed the land, a result made possible through moderate grazing of the meadow in the autumn, and in some instances through the absence of grazing altogether, as when the conditions may not be specially favorable to the growth of clover.

It is not uncommon, however, to renew alfalfa, by adding more seed when it is disked in the spring, as it sometimes is to aid in removing weeds from the land. The results vary much with the favorableness of the conditions for growing alfalfa or the opposite.

In pastures more or less permanent in character, clovers may be renewed by disking the ground, adding more clover seed, and then smoothing the surface by running over it the harrow, and in some instances also the roller. This work is best done

when the frost has just left the ground for a short distance below the surface.

Some kinds of clover are so persistent in their habit of growth that when once in the soil they remain, and therefore do not usually require renewal. These include the small white, the yellow, the Japan, burr clover and sweet clover. In soils congenial to these respective varieties, the seeds usually remain in the soil in sufficient quantities to restock the land with plants when it is again laid down to grass. Nearly all of these varieties are persistent seed producers; hence, even though grazed, enough seed is formed to produce another crop of plants.

Clovers as Soil Improvers.—All things considered, no class of plants grown upon the farm are so beneficent in the influence which they exert upon the land as clovers. They improve it by enriching it; they improve it mechanically; and they aid plant growth by gathering and assimilating, as it were, food for other plants.

All clovers have the power of drawing nitrogen from the air and depositing the same in the tubercles formed on the roots of the plants. These tubercles are small, warty-like substances, which appear during the growing season. They are more commonly formed on the roots within the cultivable area, and therefore are easily accessible to the roots of the plants which immediately follow. Clovers are not equally capable of thus drawing nitrogen from the air, nor are the same varieties equally capable of doing this under varying conditions. The relative capabilities of varieties to thus deposit nitro-

gen in the soil is by no means equal, but up to the present time it would seem correct to say that relative capability in all of these has not yet been definitely ascertained. With reference to the whole question much has yet to be learned, but it is now certain that in all, or nearly all, instances in which clovers are grown on land, they leave it much richer in nitrogen than it was when they were sown upon the same.

They also add to the fertility of the surface soil by gathering plant food in the subsoil below where many plants feed. They have much power to do this, because they are deep rooted and they are strong feeders; that is, they have much power to take up food in the soil or subsoil. Part of the food thus gathered in the subsoil helps to form roots in the cultivable area and part aids in forming top growth for pasture or for hay. If grazed down or if made into hay and fed so that the manure goes back upon the land the fertility of the same is increased in all leading essentials. This increase is partly made at the expense of the fertility in the subsoil. But the stores of fertility in the subsoil are such usually as to admit of thus being drawn upon indefinitely.

Clovers improve soils mechanically by rendering them more friable, by giving them increased power to hold moisture, and by improving drainage in the subsoil. Of course, they have not the power to do this equally, but they all have this power in degree and in all the ways that have been named.

Clovers send down a tap root into the soil and

subsoil as they grow. From the tap roots branch off lateral roots in an outward and downward direction. From these laterals many rootlets penetrate through the soil. When the plants are numerous, these roots and rootlets fill the soil. When it is broken up, therefore, particles of soil are so separated that they tend to fall apart, hence the soil is always made more or less friable, even when it consists of the stiffest clays. The shade furnished by the clover also furthers friability. This friability makes the land easier to work, and it is also more easily penetrated by the roots of plants. The influence on aeration is also marked. The air can more readily penetrate through the interstices in the soil, and, in consequence, chemical changes in the soil favorable to plant growth are facilitated.

The roots of clovers are usually so numerous that they literally fill the soil with vegetable matter. This matter, in process of decay, greatly increases the power of the soil to hold moisture, whether it falls from the clouds or ascends from the subsoil through capillary attraction. The moisture thus held is greatly beneficial to the plants that immediately follow, especially in a dry season and in open soils, and the influence thus exerted frequently goes on, though with decreasing potency, for two, three or four seasons.

Reference has already been made to the tap root which clover sends down into the soil and subsoil. In the strong varieties this tap root goes down deeply. When the crop is plowed up, the roots decay, and when they do, for a time at least, they fur-

fish channels down which the surface water percolates, if present in excess. Thus it is that clover aids in draining lands under the conditions named. The channels thus opened do not close immediately with the decay of the clover roots, hence the downward movement of water in the soil is facilitated for some time subsequently.

It has been stated that clovers have more power than some other plants to gather plant food in the soil. In some instances they literally fill the soil with their roots. When other plants are sown after the clover has been broken up they feed richly on the decaying roots of the clover. Thus it is that clover gathers food for other plants which they would not be so well able to gather for themselves, and puts it in a form in which it can be easily appropriated by these. The nitrogen in clover is yielded up more gradually and continuously as nitrates than it could be obtained from any form of top dressings that can be given to the land. In this fact is found one important reason why cereal grains thrive so well after clover.

Since the roots of clovers act so beneficently on soils, it is highly important that they be increased to the greatest extent practicable. Owing to the relation between the growth of the roots of plants and the parts produced above ground, development in root growth is promoted much more when the clover is cut for hay than when it is fed off by grazing. Experiments have also demonstrated that the development of root growth is much enhanced in medium red clover by taking a second cutting for

hay or seed. They have also demonstrated that more nitrogen is left in the soil by clover roots after a seed crop than after a crop of hay.

From what has been said, it will be apparent that the extent to which clovers enrich the soil will depend upon the strength of the growth of the plants and certain other conditions. It will not be possible to reduce to figures the additions in plant food which clovers add to the soil other than in a comparative way. Dr. Voelker has stated that there is fully three times as much nitrogen in a crop of clover as in the average produce of the grain and straw of wheat per acre. Dr. Kedzie is on record as having said that in the hay or sod furnished by a good crop of clover, there is enough nitrogen for more than four average crops of wheat, enough phosphoric acid for more than two average crops and enough of potash for more than six average crops. He has said, moreover, that the roots and stubble contain fully as much of these elements as hay.

It will also be apparent that where clover grows in good form no cheaper or better way can be adopted in manuring land, and that in certain areas the judicious use of land plaster on the clover hastens the renovating process. It is thought that in some instances the mere loading and spreading of barnyard manure costs more than the clover and plaster. Especially will this be true of fields distant from the farm steading. It is specially important, therefore, that in enriching these, clover will be utilized to the fullest extent practicable.

Clover as a Weed Destroyer.—Where clover is much grown, at least in some of its varieties, it becomes an aid in reducing the prevalence of many forms of weed growth. It is thus helpful in some instances, because of the number of the cuttings secured; in others because of its smothering tendencies, and in yet others because of the season of the year when it is sown and harvested or plowed under, as the case may be.

Alfalfa and medium red clover are cut more frequently than the other varieties and, therefore, because of this, render more service than these in checking weed growth. The former is cut so frequently as to make it practically impossible for most forms of annual weed life to mature seed in the crop. The same is true of biennials and also perennials. But there are some forms of perennial weeds which multiply through the medium of their rootstocks that may eventually crowd alfalfa. Medium red clover is usually cut twice a year, hence, in it annuals and biennials cannot mature seed, except in exceptional instances, and because of the short duration of its life, perennials have not time to spread so as to do much harm.

The clovers that are most helpful in smothering weeds are the mammoth, the medium and the alsike varieties. These are thus helpful in the order named. To accomplish such an end they must grow vigorously, and the plants must be numerous on the ground. When grown thus, but few forms of weed life can make any material headway in the clover crop. Even perennials may be greatly weakened,

and in some instances virtually smothered by such growth of clover. To insure a sufficient growth of clover it may be advantageous to top dress the crop with farmyard manure sufficiently decayed, and in the case of medium red clover to dress the second cutting with land plaster. If the second growth is plowed under, subsequent cultivation of the surface will further aid in completing the work of destruction.

The crimson variety is sown and also harvested at such a time that the influence on weed eradication is very marked. The ground is usually prepared in the summer and so late that weeds which sprout after the clover has been sown cannot mature the same autumn. In the spring it is harvested before any weeds can ripen. When plowed under, rather than harvested, the result is the same.

When clover is grown in short rotations, its power to destroy weeds is increased. For instance, when the medium red or mammoth varieties are grown in the three years' rotation of corn or some root crop, followed by grain seeded with clover, the effects upon weed eradication are very marked, if the cultivation given to the corn or roots is ample. Under such a system weeds could be virtually prevented from maturing seeds at any time, especially if the medium variety of clover were sown, and if the stubbles were mown some time subsequent to the harvesting of the grain crop. Such a system of rotation faithfully carried out for a number of years should practically eradicate all, or nearly all, the noxious forms of weed life.

Clover Sickness. — On certain of the soils of Great Britain and probably on those of other countries in Europe, where clover has been grown quite frequently and for a long period, as good crops cannot be grown as previously, and in some instances the crop is virtually a failure. The plants will start from seed in the early spring and grow with sufficient vigor for a time, after which they will show signs of wilting and finally they die. Various theories were advanced for a time as to the cause before it was ascertained by experiment what produced these results. Some thought they arose from lack of water in the soil, others claimed that they were due to the presence of parasites, which in some way preyed upon the roots, others again attributed them to improper soil conditions. It is now just about certain that they arose from a deficiency of soluble potash in the subsoil. Such, at least, was the conclusion reached by Kutzleb as the result of experiments conducted with a view to ascertain the cause of clover wilt.

The cause being known, the remedy is not difficult. It is to grow clover less frequently on such soils. Sufficient time must be given to enable more of the inert potash in the subsoil to become available. Another way would be to apply potash somewhat freely to these soils, and subsoil them where this may be necessary.

It is thought that clover sickness is as yet unknown in the United States and Canada, although its presence had sometimes been suspected in some sections where clover has been much grown. This

does not mean that it may not yet come to this country. Should the symptoms given above appear on soils on which clover has been grown frequently and for a long period, it would be the part of wisdom to take such indications as a hint to grow clover less frequently in the rotation.

Possible Improvement in Clovers.—Some close observers have noticed that there is much lack of uniformity in the plants found growing in an ordinary field of clover, especially of the medium red and mammoth varieties. Many of the plants vary in characteristics of stem, leaf, flower and seed; in the size and vigor of the plants; in the rapidity with which they grow; and in earliness or lateness in maturing. So great are these differences that it may be said they run all the way from almost valueless to high excellence. Here, then, is a wide-open door of opportunity for improving clover plants through selection. This question has not been given that attention in the past which its importance demands.

There may be a difference in view as to all the essential features of improvement that are to be sought for, but there will probably be agreement with reference to the following in desirable varieties: 1. They will have the power to grow quickly and continuously under average conditions. This power will render them valuable as pasture plants in proportion as they possess it. 2. They will produce many stems not too coarse in character. This will affect favorably the character of the hay and will also have a bearing on increase in the production of

seed. 3. There should be an abundance of leaves. Such production will affect favorably palatability in the pasture and also in the hay. 4. The blossoms should be so short that the honey which they contain may be accessible to the ordinary honey bee. The importance of this characteristic cannot be easily overestimated. It would not only tend to a great increase in seed production through the favorable influence which it would have on fertilization, but it would greatly increase the honey harvest that would be gathered every year, and 5. They should be possessed of much vigor and hardihood; that is, they should have much power to grow under adverse conditions, as of drought and cold. The person who will furnish a variety of red clover possessed of these characteristics will confer a boon on American agriculture.

Bacteria and Clovers.—The fact has long been known, even as long ago as the days of Pliny, and probably much before those days, that clover, when grown in the rotation, had the power to bring fertility to the soil. This fact was generally recognized in modern agriculture and to the extent, in some instances, of giving it a place even in the short rotations. But until recent decades, it was only partially known how clover accomplished such fertilization. It was thought it thus gathered fertility by feeding deeply in the subsoil, and through the plant food thus gathered, the root system of the plants were so strengthened in the cultivated surface section of soil as to account for the increased production in the plants that followed clover. According

to this view, the stems and leaves of the plants were thus equally benefited and, consequently, when these were plowed under where they had grown these also added plant food to the cultivated portion of the soil, in addition to what it possessed when the clover seed which produced the plants was sown upon it. In brief, this theory claimed that fertility was added by the clover plants gathering fertility in the subsoil and depositing it so near the surface that it became easily accessible to the roots of other plants sown after the clover and which had not the same power of feeding so deeply. This theory was true in part. The three important elements of plant food, nitrogen, phosphoric acid and potash, were and are thus increased in the soil, but this does not account for the source from which the greater portion of the nitrogen thus deposited in the soil was drawn, as will be shown below.

It was also noticed that when the seed of any variety of clover was sown on certain soils, the plants would grow with more or less vigor for a time and then they would fail to make progress, and in some instances would perish. It was further noticed that if farmyard manure was applied freely to such land, the growth made was more vigorous. Yet, again, it was noticed that by sowing clover at short intervals on such soils, the improvement in the growth of the plants was constant. But it was not understood why clover plants behaved thus under the conditions named. It is now known that ill success at the first was owing to the lack of certain micro-organisms, more commonly termed bacteria, in the

soil, the presence of which are essential to enable clover plants to secure additional nitrogen to that found in the soil and subsoil on which to feed. When manure was applied, as stated above, the clover plants secured much or all of their nitrogen from the manure. Bacteria were introduced in very limited numbers at first, it may be through the medium of the seed or in some other way, and because of an inherent power which they possess to increase rapidly in connection with continued sowing of clover at short intervals, they came at length to be so numerous in the soil as to make possible the growth of good crops of clover where these could not be thus grown a few years previously.

Careful observers had noticed that certain warty-like substances were found attached to the roots of clover plants, and that the more vigorously the plants grew, the larger and more numerous were these substances, as a rule. It was thought by many that these warty substances, now spoken of as nodules, were caused by worms biting the roots or because of some unfavorable climatic influence or abnormal condition of soil. It is now known that they are owing to the presence of bacteria, whose special function is the assimilation of free nitrogen obtained in the air found in the interstices; that is, the air spaces between the particles of soil. This they store up in the nodules for the use of the clover plants and also the crops that shall follow them.

The nodules in clover plants vary in size, from a pin head to that of a pea, and they are frequently present in large numbers. Bacteria are present

within them in countless myriads. They gain an entrance into the plant through the root hairs. The exact way in which benefit thus comes to the clover plants is not fully understood, but it is now quite generally conceded that the nitrogen taken in by these minute forms of life is converted into soluble compounds, which are stored in the tissues of the roots, stems and leaves of the plants, thus furnishing an explanation to the increased vigor. It cannot be definitely ascertained at present, if, indeed, ever, what proportion of the nitrogen in clover is taken from the air and from the soil, respectively, since it will vary with conditions, but when these are normal, it is almost certain that by far the larger proportion comes from the air. But it has been noticed that when soil is freely supplied with nitrogen, as in liberal applications of farmyard manure, the plants do not form nodules so freely as when nitrogen is less plentiful in the soil. The inference would, therefore, seem to be correct, that when plants are well supplied with nitrogen in the soil they are less diligent, so to speak, in gathering it from the air. In other words, clover plants will take more nitrogen from the air when the soil is more or less nitrogen hungry than when nitrogen abounds in the soil. And yet the plants should be able to get some nitrogen from the soil in addition to what the seed furnishes to give them a vigorous start.

This power to form tubercles, and thus to store up nitrogen, is by no means confined to clovers. It is possessed by all legumes, as peas, beans and vetches. It is claimed that some of these, as soy beans, cow,

peas and velvet beans, have even greater power to gather nitrogen from the air and store it in the soil than clover, since the nodules formed on the roots of these are frequently larger. In some instances, on the roots of the velvet bean they grow in clusters as large as an ordinary potato. With reference to all these leguminous plants it has been demonstrated that under proper conditions good crops may be grown and removed from the soil and leave it much richer in nitrogen than when the seed was sown. It is thus possible by sowing these crops at suitable intervals to keep the soil sufficiently supplied with nitrogen to grow good crops other than legumes, adapted to the locality, without the necessity for purchasing the nitrogen of commerce in any of its forms. They may be made to more than maintain the supply of nitrogen, notwithstanding the constant loss of the same by leeching down into the subsoil in the form of nitrates, and through the more or less constant escape of the same into the air in the form of ammonia, during those portions of the year when the ground is not frozen.

They will do this in addition to the food supplies which they furnish, hence they may be made to supply this most important element of fertility, and by far the most costly when purchased in the market, virtually without cost. The favorable influences which these plants thus exert upon crop production is invaluable to the farmer. They make it possible for him to be almost entirely independent of the nitrogen of commerce, which, at the rate of consumption during recent years, will soon be so far

reduced as to be a comparatively insignificant factor in its relation to crop production. It is possible, however, and not altogether improbable, that by the aid of electricity a manufactured nitrate of soda or of potash may be put upon the market at a price which will put it within reach of the farmer. The power of legumes to increase the nitrogen content in the soil should allay apprehension with reference to the possible exhaustion of the world's supply of nitrogen, notwithstanding the enormous waste of the same in various ways.

The more common sources of loss in nitrogen are, first, through the leeching of nitrates into the drainage water; second, through oxidation; third, through the use of explosives in war; and fourth, through the waste of the sewerage of cities. When plant and animal products are changed into soluble nitrates, they are usually soon lost to the soil, unless taken up by the roots of plants. When vegetable matter on or near the surface of the ground is broken down and decomposed, in the process of oxidation, there is frequently much loss of nitrogen, as in the rapid decomposition of farmyard manure in the absence of some material, as land plaster, to arrest and hold the escaping ammonia. Through explosives used in war there is an enormous vegetable loss of nitrogen, as nitrate salts, which should rather be used to preserve and sustain life than to destroy it. The waste of nitrogen through the loss of sewerage is enormous, nor does there seem to be any practicable way of saving the bulk of it.

In many soils the germs which produce nodules are present when clovers are first grown on them. But where they are not present, the clover plants have no more power to gather nitrogen than wheat or other non-leguminous crops. But since in other soils they are almost entirely absent, how shall they be introduced? The process of introducing them is generally referred to as a process of inoculation, and soils when treated successfully are said to be inoculated.

Three methods have been adopted. By the first, as previously indicated, the grower perseveres in sowing clover at short intervals in the rotation. He may also add farmyard manure occasionally, and thus, through the inherent power of multiplication in the bacteria, they increase sufficiently to enable the land to grow good crops. By the second method, inoculating is effected through soil which is possessed of the requisite bacteria; and by the third, it is effected through the aid of a prepared product named nitragin.

When fields are to be inoculated by using soil it is obtained from areas which have grown clovers successfully quite recently, and which are, therefore, likely to be well filled with the desired bacteria. In some instances the seed is mixed with the soil and these are sown together. To thus mix the seed with the soil and then sow both together broadcast or with a seed drill is usually effective, and it is practicable when minimum quantities of soil well laden with germs are used. In other instances the soil containing germs is scattered broadcast before or

soon after the seed is sown. Considerable quantities of earth must needs be applied by this method.

It should be remembered that each class of legumes has its own proper bacteria. Because of this, inoculation can only, or at least chiefly, be effected through the use of soils on which that particular class of legumes have grown, or which are possessed of bacteria proper to that particular species. In other words, bacteria necessary to the growth of vetches will not answer for the growth of clovers, and *vice versa*. Nor will the bacteria requisite to grow medium red clover answer for growing alfalfa. In other words, the bacteria proper to the growth of one member of even a family of plants will not always answer for the growth of another member of the same. But in some instances it is thought that it will answer. The study of this phase of the question has not yet progressed far enough to reflect as much light upon it as could be desired. It is certainly known, however, that alfalfa will grow on soils that grow burr clover (*Medicago maculata*) and sweet clover (*Melilotus alba*), hence the inference that soil from fields of either will inoculate for alfalfa.

Nitragin is the name given by certain German investigators to a commercial product put upon the market, which claims to be a pure culture of the root tubercle organism. These cultures were sold in the liquid form, and it was customary when using them to treat the seed with them before it was planted. Their use has been largely abandoned, because of the few successes which followed their use

compared with the many failures. But it is now believed that these cultures can be prepared and used so as to be generally effective and without excessive cost to the grower.

In preparing cultures it has been found that by gradually reducing the amount of nitrogen in the culture of media, it is possible to increase the nitrogen fixing power in these germs from five to ten times as much as usually occurs in nature. It is now known that the bacteria thus grown upon nitrogen free media retain high activity if carefully dried and then revived in liquid media at the end of the varying lengths of time. Some absorbent is used to soak up the tubercle-forming organisms. The cultures are then allowed to dry, and when in that condition they can be safely sent to any part of the country without losing their efficacy. It is necessary to revive the dry germs by immersing them in water. By adding certain nutrient salts the bacteria are greatly increased if allowed to stand for a limited time—as short, in some instances, as 24 hours. The culture thus sent out in a dry form, and no larger than a yeast cake, may thus be made to furnish bacteria sufficient to inoculate not less than an acre of land. It is stated that the amount of inoculating material thus obtained is only limited by the quantity of the nutrient water solution used in increasing the germs, so that the cost of inoculating land by this process is not large. The culture may be applied by simply soaking the seed in it, by spraying the soil, or by first mixing the culture into earth, spreading it over the field and then harrowing it. Inocu-

lations thus tried under the supervision of the United States Department of Agriculture have proved quite successful.

Where any legume is extensively grown surrounding soils come to be inoculated through the agency of winds and water. The increase brought to the yield of plants on various soils runs all the way from a slight gain to 1000-fold. And when soil is once inoculated it remains so for a long time, even though the proper legume should not be grown again on the same soil.

The amount of nitrogen that may thus be brought to many soils by growing clover and other legumes upon them is only hedged in practically by the nature of the rotation fixed upon. An acre of clover when matured will sometimes add 200 to 300 pounds of nitrogen to the soil under favorable conditions. Where the soil contains the requisite bacteria, the young plants begin to form tubercles when but a few weeks old, and continue to do so while the plant is active until mature. That the plants use much of the nitrogen while growing would seem to be clear, from the fact that toward the close of the growing season the tubercles become more or less broken down and shrunken.

CHAPTER III

MEDIUM RED CLOVER

Medium Red Clover (*Trifolium pratense*) is also known by the names Common Red Clover, Broad-Leaved Clover and Meadow Trefoil. The term medium has doubtless come to be applied to it because the plants are in size intermediate between the Mammoth variety (*Trifolium magnum*) and the smaller varieties, as the Alsike (*Trifolium hybridum*) and the small white (*Trifolium repens*). But by no designation is it so frequently referred to as that of Red Clover.

This plant is spreading and upright in its habit of growth. Several branches rise up from the crown of each plant, and these in turn frequently become branched more or less in their upward growth. The heads which produce the flowers are nearly globular in shape, inclining to ovate, and average about one inch in diameter. Each plant contains several heads, and frequently a large number when the growth is not too crowded. When in full flower these are of a beautiful purple crimson, hence, a field of luxuriant red clover is beautiful to look upon. The stems of the plants are slightly hairy, and ordinarily they stand at least fairly erect and reach the height of about one foot or more; but when the growth is rank, they will grow much

higher, even as high as 4 feet in some instances, but when they grow much higher than the average given, the crop usually lodges. The leaves are numerous, and many of them have very frequently, if not, indeed, always, a whitish mark in the center, resembling a horseshoe. The tap roots go down deeply into the soil. Usually they penetrate the same to about 2 feet, but in some instances, as when subsoils are open and well stored with accessible food, they go down to the depth of 5 or 6 feet. The tap roots are numerously branched, and the branches extend in all directions. When they are short, as they must needs be in very stiff subsoils and on thin land underlaid with hard soil, the branches become about as large as the tap roots. It has been computed that the weight of the roots in the soil is about equal to the weight of the stem and leaves.

Medium red clover is ordinarily biennial in its habit of growth, but under some conditions it is perennial. Usually in much of the Mississippi basin it is biennial, especially on prairie soils. On the clay loam soils of Ontario, Ohio, Michigan, Wisconsin, Indiana and some other States, it is essentially biennial, but many of the plants will survive for a longer period. In the mountain valleys in the Northwestern States, and on the Pacific slope west of the Cascade Mountains, it is perennial. Medium red clover meadows in these have been cut for several successive years without re-seeding the crop. The duration of this plant is also more or less influenced by pasturing as compared with cutting for seed. Grazing the plants has the effect of prolong-

ing the period of their growth, while maturing seed from them has the opposite effect.

Medium red clover is characterized by a rapid growth. Seed sown in the spring has in certain climates produced a crop of hay in 120 days from the date of sowing. It is also most persistent in its growth from spring until fall when sufficient moisture is present. In this property it far outranks any of the other varieties of clover. It comes into bloom in the South during the latter half of May and in the North during the month of June, early or later, according to location, and in about sixty days from the time that it is cut for hay. Ordinarily, a second cutting of hay may be taken from it and still later some pasture.

It furnishes excellent pasture, soiling food and hay for nearly all classes of live stock. While it is much relished by the stock, it is probably not exceeded in its capacity for quick and prolonged growth throughout the growing season by any pasture plant, except alfalfa. For a similar reason it stands high as a soiling food. No other variety of clover grown in America will furnish as much of either pasture or soiling food. For animals producing milk and for young animals, the pasture is particularly excellent. It is also the standard pasture for swine where it can be grown, and where alfalfa is not a staple crop. When the hay is well cured, it makes a ration in even balance for cattle and sheep, and for horses it is equally good. The prejudice which exists in some quarters against feeding it to horses has arisen, in part, at least, from

feeding it when improperly harvested, when over-ripe, when damaged by rain, or by overcuring in the sun, or when it may have been stored so green as to induce molding. It may also be fed with much advantage to brood sows and other swine in winter.

As a soil improver, medium red clover is probably without a rival, unless it be in mammoth clover, and in one respect it exceeds the mammoth variety; that is, in the more prolonged season, during which it may be plowed under as a green manure. Its quick growth peculiarly adap's it to soil enrichment. For this reason, it is more sown than any of the other varieties in the spring of the year, along with the small cereal grains to be plowed under in the late autumn or in the following spring, after the clover has made a vigorous start, since it produces two crops in one season, the first crop may be harvested and the second plowed under after having made a full growth. This can be said of no other variety of clover. More enrichment is also obtained from the falling of the leaves when two crops are grown than from the other varieties.

The influence of this plant on weed destruction when grown for hay is greater than with the other varieties of clover. This is owing in part to the shade resulting from its rapid growth and in part to the two cuttings which are usually made of the crop. These two cuttings prevent the maturing of the seeds in nearly all annual weeds, and to a very great extent in all classes of biennials. The power of this crop to smother out perennials is also considerable, and when this is linked with the weakening



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Fig. 2. Medium Red Clover (*Trifolium pratense*)

Oregon Experiment Station

caused by the two cuttings, it sometimes proves effective in completely eradicating for the time being this class of weeds.

Distribution.—Medium red clover is thought to be native to Europe. It was probably introduced into England some time early in the seventeenth century. That it was attracting attention about the middle of the century or a little later, is rendered probable by the fact that it is discussed at considerable length in the third edition of Blyth's "Improver Improved," published in 1662, while it is not mentioned in the first edition, published in 1650. It was doubtless introduced into the United States by the early colonists and at sundry times.

Medium red clover will grow in good form only in the temperate zone, since it cannot stand excessive heat or excessive cold. The northerly limit of its successful growth in North America is somewhere about 50° north latitude on the wind-swept prairies, but on suitable soils, and protected somewhat by trees and winter snows, it will probably grow 10 degrees further to the north. In British Columbia, on the Pacific slope, it will probably grow as far north as Alaska. But on prairies eastward from the Rocky Mountains, it has not been grown with much success much further north than 48°, unless under the eastern shadow of the Rocky Mountains. Low temperatures in winter, where there is only a moderate covering of snow, are far less fatal to clover plants than exposure to the sweep of the cold winds. Even where the thermometer is not so low as in the areas just referred to, such winds are par-

ticularly damaging to the plants when they blow fiercely just after a thaw which has removed a previous covering of snow. In some instances, one cold wave under the conditions named has proved fatal to promising crops of clover over extended areas.

In a general way, the southerly limit of vigorous and reliable growth may be put at about 37° . But in some localities good crops may be grown further South, especially in some parts of Tennessee. Nor would it be correct to say that medium red clover grows at its best in many localities much south of 38° . On the plateaus it can be grown further South, where the soil is suitable.

This plant flourishes best in a moist climate. In fact, the abundance and continuance of the growth for the season are largely dependent on the amount of the precipitation, and on the distribution of the same throughout the season. In climates in which it is usual for a long spell of dry weather to occur in mid-summer, the plants will not make rapid growth after the first cutting of the season; but under conditions the opposite, they will grow continuously from spring until fall. Continuous growth may be secured through all the season on irrigated land. Although the plants root deeply, they will succumb under drought beyond a certain degree, and in some soils the end comes much more quickly than on others; on porous and sandy soils, it comes much sooner than on clays. On the latter, drought must be excessive to destroy clover plants that have been well rooted. White clover can withstand much heat when

supplied with moisture. Moderate temperatures are much more favorable to its growth.

Spring weather, characterized by prolonged periods of alternate freezing and thawing, is disastrous to the plants on dry soils, possessed of an excess of moisture, when not covered with snow. They are gradually drawn up out of the soil and left to die on the surface. In some instances, the destruction of an otherwise fine stand is complete. In other instances, it is partial, and when it is, a heavy roller run over the land is helpful in firming the soil around the roots that have been thus disturbed.

Medium red clover can be grown with some success in certain parts of almost every State in the Union. But in paying crops it is not much grown south of parallel 37° . With irrigation it grows most vigorously in the mountain valleys between the Rocky and Cascade mountains, and between about 37° and 50° north latitude. In these valleys its habit of growth is perennial. Without irrigation, the highest adaptation, all things considered, is found in Washington and Oregon, west of the Cascades, except where shallow soils lying on gravels exist. East of the mountains, the best crops are in the States of Michigan, Ohio, Indiana, Kentucky, Illinois, Missouri, Iowa, Wisconsin and Minnesota. The soils of Northern Minnesota, Wisconsin and Michigan, that have produced hardwood timber, have unusually high adaptation to the growth of this plant, and as the snow usually covers the ground in these areas in winter, the crop may be relied upon with much certainty. But on the sandy soils, which

more or less abound in these areas, it does not succeed so well. It has not yet proved a marked success in Western Minnesota or in the Dakotas, owing in part probably to the lack of the proper bacteria in the soil. Its growth in these localities, however, is extending from year to year. Indiana and Ohio are great clover States, and the same is true of much of Illinois and Iowa; but southward in these States there is some hazard to the young plants from drought and heat in summer, and to an occasional frost in winter when the ground is bare.

East of the States named, it would probably be correct to say that the highest adaptation is found in New York and Pennsylvania, particularly the former, in many parts of which excellent crops are grown. In various parts of the New England States good crops may also be grown. Much of the soil in these is not sufficiently fertile to grow clover as it can be grown in the more Central States. The same is true of the States of Delaware, Maryland and Eastern Virginia, east of the Rocky Mountains, south from the Canadian boundary and west from Minnesota, Iowa and Missouri, but little success has heretofore attended the efforts to grow medium red clover. This statement does not apply equally to Eastern Nebraska and Kansas. Usually the climate is not moist enough in summer, the sweep of the cold winds is too great in winter, the snowfall is usually insufficient to protect the plants, and it may be also that the requisite bacteria is lacking in the soil. Sometime, however, these adverse conditions may in part be overcome by man's resourcefulness. In parts of

States that lie south of the 37th parallel, it may be found profitable to grow crops of medium red clover; but in these, other legumes, as crimson clover, cow peas and soy beans, will probably furnish food more reliably and more cheaply.

In Canada the highest all-round adaptation for clover is in Ontario and Quebec, unless it be the mountain valleys and tide lands of British Columbia. Because of the high adaptation in the soil of the two provinces first named, and the plentifulness of the snowfall, clover in these is one of the surest of the crops grown. The maritime provinces of New Brunswick, Nova Scotia and Prince Edward's Island, particularly the former, have soils a little too hungry to produce the highest returns in clover. On the open prairies between Ontario and the Rocky Mountains, not much success has attended the attempts to grow any kind of clover, owing probably to present uncongeniality in soils and more especially in climatic conditions. However, there are good reasons for believing that with the introduction of hardy varieties and through the use of Northern grown seed, an inoculated soil, where inoculation may be necessary, that medium red clover will yet be grown over wide areas in all the provinces of Northwestern Canada, south of and including the Saskatchewan valley.

Soils.—Fortunately, this most useful plant will grow in a considerable variety of soils, though, of course, not equally well. Highest in general suitability, probably, are clay loams underlaid with a moderately porous clay subsoil. They should at

the same time be moist and reasonably well stored with humus. On such a soil, in a climate with sufficient rainfall and properly distributed, a stand of clover should be looked upon as reasonably certain any season when properly sown. It would also be correct to say that on the volcanic soils of the mountain States in the West, clover will grow equally well when supplied with moisture, and in these it is also very tenacious of life.

Next in adaptation are what may be termed loam soils, also underlaid with clay. The proportion of the clay in them will exercise an important influence on the growth of the clover. Loamy sands will grow clover better than sandy loams, although both are very suitable, the other conditions being right.

It would seem to be correct to assign third place to stiff clays, whether of the white or red cast. The better that these are supplied with vegetable matter, and the more moist the season, the better is the stand of the clover likely to be. In seasons that are generally favorable, excellent crops of clover may be obtained from such soils, but in dry seasons it is easy to secure a good stand of the plants. They are also considerably liable to heave in these soils in the spring of the year from the action of the frost. The more perfectly they are drained, the less will be the injury from this source, but it is scarcely possible to drain such lands so perfectly that there will be no loss of clover plants in these from the source named in the winters, characterized by frequent rains, accompanied by frequent alternations of freezing and thaw-

ing. The loss from this source in such lands varies from nothing at all to 100 per cent.

Nearly, if not equal to the farmer, are dark loam soils with a gravel or sand drainage underneath, providing, first, that the sand and gravel do not come too near the surface, and second, that the normal rainfall is sufficient. On such soils it seldom fails to grow, is not liable to heave in the winter or spring, and usually produces excellent crops when these soils are properly tilled. It has special adaptation for being grown on calcareous or limy soils. It also, usually, grows well on soils underlaid with yellow clay of more or less tenacity.

The black humus soils of the prairie vary much in their suitability for growing medium red clover. Much depends on the clay content in such soils. The more of this element in them and the nearer an underlying clay subsoil is to the surface, the better will this clover grow on them. In large areas of the prairie, red clover will grow more successfully on the subsoil when laid bare than when on the surface soil. It has been the experience in many instances that when the humus soils of the prairie, porous and spongy in character, were first tilled, clover grew on them so shyly that it was difficult to get a good stand of the same until it had been sown for several seasons successively or at intervals. Eventually, good crops were grown on these lands, and are now being grown on them. This was the experience that faced a majority of the first settlers on the prairie where excellent crops are now being grown, and it is the experience which faces many to-day, who are

located on sections of the prairie but newly broken.

Two reasons may be given by way of explanation, but these may not furnish all the reasons for the experience just referred to. First, much of the land was so porous in its nature that in dry seasons the young plants perished for want of moisture. As such lands become worn through cropping, they lie more firmly and compactly; hence, there is less loss of moisture through the free penetration of the soil within a short distance of the surface of the dry atmosphere. And second, the requisite bacteria is not in these soils until it is brought to them by sowing seed repeatedly, more or less of which grows, and in growing increases the bacteria in the soil until that point is reached when good crops of clover can be grown with the usual regularity.

The suitability of sandy and gravelly lands for growing clover depends much on the amount of plant food which they contain, on the character of the climate, and on the subsoil. Such soils when possessed of some loam when underlaid with clay, and in a climate with 20 inches and more per annum of rainfall, usually grow good crops of clover; but when conditions the opposite prevail, the growth of this plant is precarious. However, when sandy or gravelly soils low in fertility are underlaid with the same and the rainfall is sufficient, good crops of clover may be grown if these soils are first sufficiently supplied with vegetable matter and then sufficiently fertilized.

Muck soils do not seem to have the proper elements for growing clover in the best form. But

when these have in them some clay, and especially when they are underlaid with clay not distant from the surface, they will grow good crops of clover, especially of the alsike variety. Thus it is that lands which have grown black ash and tamarack generally make good clover lands also. But clover will not succeed well on unreduced peaty soils, since it is not able in these to gather food supplies. But when sufficiently reduced, some kinds of clover will succeed better on these than on some other soils.

Deposit soils, such as are found in the bottom lands of rivers and streams, vary much in the suitability for growing clover, owing to the great differences in the compositions; but since they are usually possessed of sufficient friability, fertility and moisture, good crops of clover may generally be grown upon them where the climatic conditions are suitable. The injury from overflow on such soils will depend on the depth of the same and its duration, also the season of the year when it occurs. Overflow in the spring season before growth has begun, or when it is about starting, will be helpful rather than harmful, especially if some deposit is left on the land by the subsiding waters. But if the overflow should be deep and of any considerable duration, and, moreover, if it should occur when the clover was somewhat advanced in growth, and in hot weather, the submergence of the clover would probably be fatal to it.

It may be proper to state here that the lands which grow hardwood timber will usually grow clover.

By hardwood timber is meant such trees as maple, beech, birch, oak, elm, basswood, butternut and walnut. Where forests are found comprising one or more varieties of these trees anywhere on this continent, and especially comprising several of them, the conclusion is safe that medium red clover will grow, or, at least, can be grown, on such soils. If a considerable sprinkling of pine trees is found in the same, the indications are not changed in consequence. Where the forest is largely composed of maple and birch, excellent crops of clover may be looked for when the land has been cleared. But because of what has been said, the conclusion must not be reached that clover will not grow well under some conditions where soft woods abound, but rather that where the former abound the indications of suitability for clover production are more certain than where soft timbers abound.

† **Place in the Rotation.**—Medium red clover may be made to precede or to follow almost any crop that is grown upon the farm. Notwithstanding, there are certain crops which it precedes or follows with much more advantage than others. Since it brings nitrogen to the soil from the air and deposits the same for the benefit of the crops that immediately follow, it is advantageous to plant such crops after it as require much nitrogen to make them productive, as, for instance, wheat. Since, through the medium of its roots, it stores the ground with humus, such crops should come after it as feed generously on humus, as, for instance, corn and potatoes. And since it tends to lessen weed growth

through smothering, it may with advantage be followed by crops for which a clean seed bed is specially advantageous, as flax. It may, therefore, be followed with much advantage by wheat, oats or barley, corn and sorghum in all their varieties, flax, potatoes, field roots, vegetables and such small fruits as strawberries. Where wheat is a success it is usually first grown among the small cereal grains after clover, since it is less able to flourish under the conditions which become decreasingly favorable in the years that follow the breaking up of the clover. Whether wheat or flax, corn or potatoes should immediately follow the growing of clover, should be determined in great part by the immediate necessity for growing one or the other of these crops, but also to some extent by the crops that are to follow them.

Clover may follow such crops as require cultivation while they are growing, and of a character that will clean the soil. This means that it may with advantage be made to follow corn, sorghum, potatoes or field roots. It may also follow the summer fallow bare, or producing crops for being plowed under where these come into the rotation. Of course, since clover can to a considerable extent supply its own nitrogen, it may be successfully grown on lands that are not clean, and that may not possess high fertility, but when thus sown the nurse crop with which it is usually sown is not likely to succeed well, because of the presence of weeds in it, and from the same cause the quality of the first of the clover is likely to be much impaired. The conditions of the

time of sowing are also less favorable for getting a stand of the seed.

There is probably no rotation in which clover may be grown with more advantage than when it is made to alternate with corn or potatoes and some small cereal grains, as wheat or oats, growing each crop for but one season. Of course the clover must be sown with the grain and harvested the following year, taking from it two cuttings. In no other form of rotation, perhaps, can clover be used to better advantage, nor would there seem to be any other way in which land may be made to produce abundantly for so large a term of years without fertilization other than that given to the soil by the clover. It would fully supply the needs of the crops alternating with it in the line of humus, and also in that of nitrogen. In time the supply of phosphoric acid and potash might run low, but not for a long term of years. The cultivation given to the corn and potatoes would keep the land clean. Fortunate is the neighborhood in which a rotation may be practised, and fortunate are the tillers of the soil who are in a position to adopt it.

Medium red clover may be followed with much advantage by certain catch crops sown at various times through the season of growth. It may be pastured in the spring for several weeks, and the land then plowed and sowed with millet or rape, or planted with corn, sorghum, late potatoes, or certain vegetables, or it may be allowed to grow for several weeks and then plowed, to be followed by one or the other of these crops. It may also be harvested

for hay in time to follow it with millet or rape for pasture, and under some conditions with fodder corn. But when the stand of clover is good, it would usually be profitable to utilize the clover for food rather than the crops mentioned, since doing so would involve but little labor and outlay. After the second cutting for the season, winter rye may be grown as a catch crop by growing it as a pasture crop.

Preparing the Soil.—Speaking in a general way, it would be correct to say that it would not be easy to get soil in too friable a condition for the advantageous reception of medium red clover seed. In other words, it does not often happen that soils are in too fine tilth to sow seed upon them without such fineness resulting in positive benefit to the plants. The exceptions would be clays of fine texture in climates subject to rainfalls so heavy as to produce impaction. On the other hand, the hazard would be even greater to sow clover on these soils when in a cloddy condition. The rootlets would not then be able to penetrate the soil with sufficient ease to find enough food and moisture to properly nourish them. Some soils are naturally friable, and in these a tilth sufficiently fine can be realized ordinarily with but little labor. Other soils, as stiff clays, frequently require much labor to bring them into the condition required. Usually, however, if sufficient time elapses between the plowing of the land and the sowing of the seed, this work may be materially lessened by using the harrow and roller judiciously soon after rainfall.

When preparing prairie soils so open that they will lift with the wind, the aim should be to firm them rather than to render them more open and porous; otherwise they will not retain sufficient moisture to properly sustain the young plants, if prolonged dry weather follows the sowing of the seed. Plowing such land in the autumn aids in securing such density. The same result follows summerfallowing the land or growing upon it a cultivated crop after the bare fallow, or after the cultivated crop has been harvested prior to the sowing of the clover seed, otherwise the desired firmness of the land will be lessened, and weed seeds will be brought to the surface, which will produce plants to the detriment of the clover. In preparing such lands for the seed, cultivation near the surface is preferable to plowing.

When the clover is sown late in the season, as is sometimes the case, in locations where the winters are comparatively mild, the ground may be made reasonably clean before the seed is sown, by stirring it occasionally at intervals before sowing the seed. This is done with some form of harrow or weeder, and, of course, subsequently to the plowing of the land.

Sowing. —The time for sowing clover seed is influenced considerably by the climatic conditions. Under some conditions it may be sown in the early autumn. It may be thus sown in the Southern States and with much likelihood that a stand will be secured, yet in some instances an inauspicious winter proves disastrous to the plants: all things

considered, it is probably safer to sow clover in the South at that season than the spring, when vegetation is beginning to start. It may also succeed in some instances in areas well to the North when sown in the early autumn, providing snow covers the ground all the winter, but should the snow fail to come the subsequent winter, or fail to lie when it does come, the clover plants would perish. The element of hazard, therefore, is too great in northerly areas to justify sowing the seed thus. But on the bench lands of the mountain valleys there may be instances in which the seed may be sown so late in the autumn that it will not sprout before winter sets in, but lies in the soil ready to utilize the moisture, so all important in those areas, as soon as the earliest growth begins in the spring.

The seed may be sown with no little assurance of success in the late summer. But this can only be done where moisture is reasonably plentiful from the time of sowing onward, and where the winters are not really severe. In some of the Central States this method of sowing may succeed reasonably well. Clover and timothy sown thus without any nurse crop will produce a full crop the next season. When the seed is sown thus, it may, of course, be made to follow a crop grown on the land the same season. It may also insure a crop the following season, when the clover seed sown the spring previously may for some reason have failed.

While medium red clover is frequently sown in the South and in some areas of the far West in the months of January and February on the snow, in

the North it is usually sown in the early spring. This also is in a great majority of instances the best time for sowing. In many locations it may be sown with safety as soon as the winter snows have gone. On the whole, the earlier that it is sown in the spring the better, that the young plants may have all the benefit possible from the moisture, which is more abundant than later. But there are certain areas, as, for instance, in the northerly limits of the Mississippi basin, in which young clover plants perish by frost after they have germinated. This, however, does not happen very frequently. When the seed is sown on the snow, or while the ground is yet in a honeycombed condition from early frost, it must of necessity be sown early. But where the hazard is present that the young plants will be killed by frost, it will be safer to defer sowing the seed until it can be covered with the harrow when sown.

Whether it will be more advisable to sow the seed on bare ground earlier than the season when growth begins, or to sow later and cover with the harrow, will depend to a considerable degree upon the soil and the condition in which it happens to be. On timber soils newly cleaned the early sowing would be quite safe where the young plants are not liable to be killed after germination, because of the abundance of humus in them. On the same soils, early sowing would probably be preferable, even when much reduced in humus, providing they were in a honeycombed condition at the time of sowing. This condition is far more characteristic of clay and clay loam soils, than of those sandy in texture. To sow

the seed on clay soils that are worn would be to throw it away, unless in a most favorable season for growth. The same would prove true of the sandy soils low in humus, since these do not honeycomb at any season. Seed sown on honeycombed ground falls into openings made in the soil, and is covered by the action of the frost and the sun on the same. The rule should be to defer sowing the seed where the ground does not honeycomb until it can be covered with the harrow.

In some instances the seed is sown successfully just after a light fall of snow in the spring. The seed is carried down into little crevices or fissures in the soil when these are present, but the seed should not be thus sown. Usually it is not quite safe to sow clover seed where the winter snow still lingers to any considerable depth, lest much of it should be carried down to the lower lands by the sudden melting of the snows. The chief advantage of sowing before the ground can be harrowed arises from the benefit which the young plants derive from the plentiful supply of moisture in the soil at that season. They are more firmly rooted than plants sown later, and, therefore, can better withstand the dry weather that frequently characterizes the later months of the summer. There is also the further advantage that the labor of harrowing at a season that is usually a busy one is dispensed with.

Various modes of sowing clover seed have been adopted. Sometimes it is sown by hand. In other instances a sower is used which is strapped to the shoulder and turned with a crank. Sometimes the

seed is sown by a distributor, which is wheeled over the ground on a frame resembling that of a wheelbarrow. Again, it is sown with a seeder attachment to the ordinary grain drill or to the broadcast seeder, and yet again with the grain in the ordinary drill tubes, or scattered with the same by the broadcast seeder; which of these methods should be adopted will depend on such conditions as relate to season, climate and soil.

The seed may be sown by hand at almost any time desired, whether it is covered or not. The advantages of hand sowing are that it may be done under some conditions when no other method will answer as well, as, for instance, when it is sown upon snow or upon the ground honeycombed. The disadvantages are that it takes more time than some of the other methods, especially when the sower only scatters the seed with one hand, that it cannot be thus sown when the wind blows stiffly or fitfully, and most of all, only a limited number of persons who sow seed are thus able to sow it with complete regularity. A still time should, if possible, be chosen for hand sowing; such a time is usually found in the early morning. When one hand is used, the seed may be sown from a light dish or pail or sowing-bag, but when both hands are used a sowing-box or a sowing-sack suspended in front of the breast is necessary. Clover seed may be sown when a considerable breeze is blowing by having a due regard to the wind. When facing it, the cast of seed should be low; when going before the wind it should be high. But when the wind is

blowing at right angles, much care must be observed by the sower as to where he walks, in relation to the cast that is being sown.

When the seed is sown on grain that has been drilled, the rows of grain will suffice to serve as a guide to the sower, and when the grain is not up, the drill marks may be made to serve the same end.

The advantages of the hand seeder held in place by straps are that the sowing may be done by an individual who cannot sow by hand, that the seed may be easily distributed and that it may be used with advantage in sowing seed among brush. The disadvantages are that it cannot be used when much wind is stirring, and when using it stakes are sometimes necessary for the guidance of the sower.

The advantages from using the seeder wheeled over the ground are that the work may be done by any one able to wheel the seeder, that the seed is distributed evenly, that it may be sown when a fairly stiff wind is blowing, and that stakes are not necessary for the guidance of the sower, as the distance of the cast may be gauged at least fairly well by the wheel marks made. One disadvantage is that it cannot be used with much satisfaction on certain soils when the ground is cloddy or frozen, or when it is wet. There is also the disadvantage to all three methods of sowing by hand, that it is frequently necessary to provide a covering for the seed by subsequently using the harrow.

The advantages from sowing with the seeder attachment to the grain drill are that the seed may be made to fall before or behind the tubes as may be

desired, or it may be sown with the seed along with the grain, and that when sown by any of these methods there is much saving of time as compared with sowing by hand. In some sections of the prairie the seed is sown with the grain drill by driving the same across the newly sown grain rows. If necessary to insure sufficiently thin sowing, the seed should be first mixed with some substance such as common salt.

In the moist areas of the upper Atlantic coast, Ontario and the Puget Sound region, the seed is frequently made to fall behind the grain tubes on clay and clay loam soils, and is covered by running the roller over the ground subsequently; but in States more inland the seed is usually made to fall before the drill tubes, when, in some instances, the sowing of the grain will provide a sufficient covering; but in others the harrow is used in addition, and sometimes both the harrow and the roller. When clover seed is sown along with grain and by the same tubes, it will in some soils be buried too deeply, but in others the objection does not hold good. The young plants are also injured more by shade from the grain, since they grow only in the line of the row along with the grain, and yet this method of sowing clover seed in some localities seems to answer reasonably well.

When the broadcast seeder is used in sowing clover seed, time is also saved as compared with hand sowing, but the seed can only fall before the seeder, and must, therefore, be given the same covering as the grain, as, when the seed is sown with the grain

drill, it will in some instances be buried too deeply. In other instances it is not so.

The depth to which the seed of medium and other clovers ought to be buried should vary with soil and climatic conditions, and with the season of sowing. The more stiff the soil, the more moist the climate, and the earlier that the seed is sown, the less the covering required, and *vice versa*. As has been shown, under certain conditions (see page 22), early sown clover seed does not require any covering artificially given, and sometimes when sown later, a reasonably copious rain will provide sufficient covering, providing it falls quite soon after the sowing of the seed. But in certain of the soft, open, spongy soils of the prairie, it may sometimes be buried to the depth of at least 3 inches, with apparent benefit. Lower than 5 or 6 inches in any soil, clover seed will not germinate till brought nearer the surface. On all soils that lift with the wind, the seed should, as a rule, be buried deeply. Ordinarily, from half an inch to an inch, or an approximation to these distances, is considered a proper depth to bury clover seed.

Some authorities recommend sowing medium and other clovers without any nurse crop. The advantages claimed are that more or less of a crop may be obtained the same season, and that a stand of clover is more certain when the seed is sown thus. The first claim is correct in the main. In some localities favored with long seasons for growth, as in certain areas of Missouri, for instance, good yields may be obtained from sowing the seed thus. This has

happened even in Minnesota. But in other areas and under other conditions, the yield would be light. In some localities, as, for instance, the Willamette Valley, Oregon, satisfactory returns have been obtained by sowing clover seed and rape seed in May and then pasturing both.

The chief objections to sowing clover seed thus are, first, that in a great majority of instances a sufficient stand of the plants may be obtained when the seed is sown with a nurse crop; and second, that when it is not thus sown, the first cutting of the hay will contain more or less of weeds. That a stand is more assured when clover seed is sown alone in areas where adverse weather conditions prevail cannot be disputed. Nevertheless, the fact remains that whenever in order to get a stand of a short-lived crop, like clover, it is necessary to sow it alone, and in many instances get but little return the same season, it will be well to consider if there is not some more satisfactory way of securing a crop that will prove an equivalent. In northerly areas the stubbles of the nurse crop frequently render substantial service to the clover by holding the snow on the crop, and also by protecting it more or less from the effect of the cold winds. The old-time practice of sowing clover with a nurse crop is likely to be continued, notwithstanding that it has some disadvantages.

These disadvantages include the following: 1. The young plants are liable to be weakened by the crowding and by overmuch shading from the grain when it grows rankly and thickly, and to such an extent that they perish; 2. When the grain lodges, as it

frequently does, on rich ground, the clover plants underneath the lodged portions succumb from want of light; 3. Where the supply of moisture is low, in the struggle for the same between the stronger plants of the nurse crop and the weaker plants of the clover, the former secures the larger share. As a result, when the nurse crop is harvested, should the weather prove hot and dry beyond a certain degree, the clover plants will die. This is an experience not at all uncommon on the loose prairie soils of the upper Mississippi basin.

Injury from crowding and overshadowing may be prevented, or at least lessened, by pasturing the nurse crop with sheep for a time, at an early stage in its growth. The lodging of the grain may also be prevented by the same means. Injury from drought may also be lessened by cutting the crop at the proper stage of advancement, and making it into hay, as in the ripening stage of growth it draws most heavily on the moisture in the soil. The oat crop is the most suitable for being thus dealt with.

Clover seed may be sown with any of the small cereal grains as a nurse crop, but not with equal advantage. Rye, barley, wheat and oats are probably suitable in the order named. Rye shades less than wheat and oats and is harvested early; hence, its suitability for a nurse crop. Winter rye and winter wheat are more suitable than spring varieties of the same, since on these the crop may usually be sown earlier, and the soil is likely to lose less moisture from surface evaporation. The marked suitability of barley as a nurse crop arises chiefly from the

short period which it occupies the ground. Nor is the shade so dense as from grains that grow taller. Oats are the least suitable of all the crops named as a nurse crop, since they are characterized by a dense growth of leaves, which shut out the sunlight too much when the growth is rank. Notwithstanding, the oat crop may well serve such an end when sown thinly and cut for hay. Mixed grains grown together, as, for instance, wheat and oats, or a mixture of the three, answer quite as well for a nurse crop as clover and oats. The objection to them for such use arises from the fact that they are frequently sown more thickly than grain sown alone.

Clover may also be sown with flax or millet or mixed grains grown to provide soiling food. When the weather is moist, it is likely to succeed well with flax, as the latter does not form so dense a shade when it is growing as some other crops. But flax is usually sown so much later than these crops, that in some climates the dry weather following injures and in some instances destroys the young plants. The dense shade furnished by millet is also detrimental to the clover plants; nevertheless, owing to the short period which the former occupies the ground, under favorable conditions a stand of clover may be secured. But since millet is sown later than flax, it frequently happens that there is not sufficient moisture in the soil to sustain both crops. Mixed grains sown as soiling food are usually sown reasonably early, and as they are cut before maturity, the danger is so far lessened that the young

plants will perish from want of moisture, but since these crops are usually grown thickly and on rich land, owing to the dense character of the growth, the plants are much more likely to be injured by the dense shade thus provided.

Clover seed may also be sown with corn and certain other crops that are usually grazed down, as rape and mixed grains. When sown with corn, the seed is usually scattered over the ground just before the last cultivation given to the corn. Attention is now being given to the introduction of cultivators which scatter such seeds as clover and rape in front of them, and so preclude the necessity for hand sowing. From Central Ohio southward, this method of securing a stand of clover will succeed in corn-growing areas, the other conditions being right. North from the areas named, the young clover plants may be winter killed when the seed is sown thus. The less dense the shade furnished by the corn, and the less dry the weather subsequently to sowing the seed, the better will be the stand of the plants secured.

When sown with rape that has been broadcast, clover usually makes a good stand, providing the rape crop is not sown too late in the season. When the rape is grazed down, the grazing does not appear to materially injure the clover, and when the shade has been removed by such grazing, the clover plants may be expected to make a vigorous growth on such land. In northerly areas, clover seed may be sown along with rape seed as late as the end of May. If sown later than that time, the season may prove

too short subsequently to the grazing of the rape to allow the plants to gather sufficient strength to carry them safely through northern winters. When clover seed is sown with rape, the seeds may be mixed and sown together.

Clover seed in several of the varieties may be successfully sown on certain grain crops grown to provide grazing, especially when these are sown early. Such pastures may consist of any one of the small cereal grains, or more than one, or of all of them.

The seed may be sown in these the same as with any crop sown to furnish grain. A stand of clover may thus be secured under some conditions in which the clover would perish if sown along with the grain to be harvested; under other conditions it would not succeed so well. The former include soils so open as to readily lose moisture by surface evaporation. The tramping of the animals on these increases their power to hold moisture, the grazing down of the grain lessens its demands upon the same, thus leaving more for the clover plants, and they are further strengthened by the freer access of sunlight. The latter include firm, stiff clays in rainy climates. To pasture these when thus sown, if moist beyond a certain degree, would result in so impacting them that the yield of the pasture would be greatly decreased in consequence.

Medium red clover is quite frequently sown alone; that is, without admixture with clovers or grasses. It is always sown thus when it is to be plowed under, as green manure. It is also usually sown alone in rotations where it is to be cropped or grazed for

one year. But when grown for meadow, which is to remain longer than one season, it is commonly sown along with timothy. The first year after sowing, the crop is chiefly clover, and subsequently it is chiefly timothy. Orchard grass or tall oat grass, or both, may also be sown along with medium red clover, since these are ready for being cut at the same time as the clover.

When medium red clover is sown to provide pasture for periods of limited duration, it is frequently sown along with alsike clover and timothy. Sometimes a moderate amount of alfalfa seed is added. But in arable soils in the semi-arid West, these will provide pastures for many years in succession, if supplied with moisture. The same is true of much of the land west of the Cascades, and without irrigation. East from the Mississippi and for some distance west from it, much of the medium red clover will disappear after being grazed for one season, but the alsike, timothy and alfalfa will endure for a longer period.

In permanent pastures, whether few or many varieties of seed are sown, medium red clover is usually included in the mixture. It is sown because of the amount of the grazing which it furnishes the season after sowing, and with the expectation that it will virtually entirely disappear in the pastures in two or three seasons after it has been sown.

When medium red clover is sown for being plowed under as green manure, it is always sown with a nurse crop. Some farmers, in localities well adapted to the growth of clover, sow more or less of

the medium red variety on all, or nearly all, of the land devoted to the growth of such cereals as rye, wheat, barley and oats, when the land is to be plowed the autumn or spring following. Reduced quantities of seed are used. They believe that the benefit from the young clover plants to the land will more than pay for the cost of the seed and the sowing of the same.

The amount of seed to sow will depend on the degree of suitability in the conditions for growing medium red clover. The more favorable these are, the less the necessity for using maximum quantities of seed, and *vice versa*. More seed is required when the clover is not grown with other grasses or clovers than when it is grown with these. When grown without admixture, 16 pounds of seed per acre may be named as the maximum quantity to sow and 8 pounds as the minimum, with 12 pounds as an average. With all the conditions quite favorable, 10 pounds should suffice. In New England and some of the Atlantic States, many growers sow much more seed than the quantities named, and it may be that the necessities of the land call for more. In Great Britain also, considerably larger quantities are sown.

When sown in grass or clover mixtures, the amount of the seed required will vary with the other factors of the mixture, and the amount of each that is sown; that is, with the character of the hay or pasture that is sought. The seed is much more frequently sown with timothy than with any other kind of grass, and the average amount of each of

these to sow per acre may be put at 8 pounds of clover and 6 pounds of timothy. When other clovers are added, as the mammoth or the alsike, for every pound of the seed of the former added, the seed of the medium red may be reduced by one pound, and for every pound of the alsike added it may be reduced by $1\frac{1}{2}$ pounds. In mixtures for permanent pastures, 6 pounds may be fixed upon as the maximum quantity of medium red clover seed to sow, and 3 pounds as the average quantity. When sown to provide green manure, maximum quantities of seed are used when it is desired to improve the soil quickly. Usually not less than 12 pounds per acre are sown, and quite frequently more. But when the gradual improvement of the land is sought, by sowing the seed on all land devoted to the small cereal grains, not more than 6 pounds per acre are used, and frequently even less than 4 pounds. The greater the hazard to the plants in sowing the seed thus, the less the quantities of the seed that are usually sown, with a view to reduce the loss in case of failure to secure a stand of the clover.

A stand of medium red clover is sometimes secured by what may be termed self-sowing. For instance, where clover has been cut for hay and then allowed to mature even but a portion of the seed before being plowed under the same autumn, the seed thus buried remains in the ground without sprouting. When the land is again plowed to the same depth and sown with some kind of grain, the clover seed thus brought to the surface will germinate. If the plowing last referred to is done in the autumn,

it ought to be done late rather than early, lest the seed should sprout in the autumn and perish in the winter, or be destroyed by the cultivation given in sowing the grain crop that follows. The same result may be obtained from clover pastured after the first cutting for the season, when the pasturing is not close.

When medium red clover is much grown for seed, many of the ripe heads are not cut by the mower, since they lie near the ground, and many break off in the curing process. The seed thus becomes so distributed in the ground, that many plants come up and grow amid the grain every season. These may, of course, be grazed or plowed under for the enrichment of the land, as desired. Seed thus buried is, therefore, not lost by any means. The plants which grow will render much assistance in keeping the land in a good condition of tilth, as well as in enhancing its fertility.

When clover seed is much grown, therefore, on any piece of land, the quantity of seed sown may be reduced materially. In fact, it may be so much reduced that it has been found possible to grow clover in rotation for many years without adding seed. The first growth of the clover was taken as hay, and the second growth as seed. The ground was then plowed and a crop of corn was taken. The corn land was then plowed and sown with some cereal, such as wheat, oats or barley.

Pasturing.—Medium red clover will furnish grazing very suitable for any kind of live stock kept upon the farm. All farm animals relish it, but not

so highly as blue grass, when the latter is tender and succulent. No plant is equally suitable in providing pasture for swine, unless it be alfalfa; hence, for that class of stock, it has come to be the staple pasture outside of areas where alfalfa may be readily grown. When desired, the grazing may begin even at a reasonably early stage in the growth of the plants, and it may continue to the end of the pasturing season.

Usually it is considered unwise to pasture medium red clover the same season in which it has been sown when sown with a nurse crop. It has been noticed that when so pastured, it does not winter so well, and that the later and more close the pasturing and the colder the winter following, the greater is the hazard from pasturing the clover. This hazard arises chiefly from the exposure of the roots to the sweep of the cold winds. It should be the rule, therefore, not only to refrain from pasturing clover thus, but also to leave the stubbles high when pasturing the grain. Where the snowfall is light and the cold is intense, to leave the stubbles thus high is important, since they aid in holding the snow. But there may be instances when the clover plants grow so vigorously that in places of heavy snowfall, smothering may result unless the mass of vegetation is in some way removed. In such instances, pasturing may be in order; but when practised, the grazing should be with cattle rather than sheep or horses, and it should cease before the covering is removed. There may also be locations where much benefit follows in several ways close, or

reasonably close, cutting of the stubbles quite soon after the nurse crop has been harvested.

When clover is sown without a nurse crop, it may be not only proper, but advantageous, to pasture it. The grazing should not, however, be continued so late that the plants will not have time to make a sufficiency of growth to protect them in winter. Such grazing is better adapted to areas in which the season of growth is long, rather than short; where weed growth is abundant, as on certain of the soils of the prairie, it may be necessary to call in the aid of the mower once or even twice during the season of growth.

When a crop of medium red clover is desired, the surest way to obtain it in good form is to pasture the field during the early part of the season, and closely enough to have the clover eaten down on every part of the field. When it is not so eaten, the mower should be so used that the growth and maturing of the seed crop may be even and uniform. The season for removing the live stock will depend upon latitude and altitude, but it will be correct to say that it ought to be from two to three weeks earlier than the proper season for cutting clover for hay.

When clover is not grazed the year that it is sown, in some seasons the stronger plants will bear seed, if allowed. To such an extent does this follow under certain conditions and in certain areas, that a considerable crop of seed could be obtained if this were desired, even as many as 4 or 5 bushels per acre in some instances. But it has been noticed that if thus allowed to produce seed, the effect upon the growth

of the crop the next season is decidedly injurious. To prevent such a result the mower should be run over the field as soon as much hazard is certainly apparent, and the earlier in the season that this can be done the better, for the reason that all weeds growing are clipped off, and the clover has also a better chance to provide protection for the winter by growth subsequently made. When there is an over-luxuriant growth in the plants, it may be well to thus mow the field, even though seed should not be produced. The growth made by the plants and the mulch provided by the portion cut make an excellent preparation for entering the cold season.

But few pasture crops grown will furnish as much grazing in one season as medium red clover. It will probably furnish the most grazing if allowed to grow up before it is grazed until the stage of bloom is approached or reached, but since it is seldom practicable to graze it down quickly enough after that stage has been reached, and since there is frequently waste from tramping, grazing usually begins, and properly so, at an earlier period.

When cattle and sheep graze upon young clover, there is some danger that hoven or bloating may result to the extent of proving quickly fatal if not promptly relieved. The danger is greater if the animals are hungry when turned in upon the clover, and when it is wet with dew or rain, or in a more than ordinarily succulent condition. Such danger may be lessened, if not, indeed, entirely eliminated, by giving the animals access to other food, as dry clover hay, for instance, before turning them in on

the pasture, and the danger is always less in proportion as grasses are abundant in the pasture.

Should bloating occur, relief must usually be prompt to be effective. In mild cases, certain medicines may bring relief. One of the most potent is the following: Give spirits of turpentine in doses of 1 to 5 tablespoonfuls, according to the size of the animal. Dilute with milk before administering. In bad cases, the paunch should be at once punctured. The best instruments are the trocar and canula, but in the absence of these a pocket knife and goose quill may be made to answer. The puncture is made on the left side, at a point midway between the last rib and hook point, and but a few inches from the backbone. The thrusting instrument should point downward and slightly inward going into the paunch. With much promptness the canula or the quill should be pushed down into the paunch and held there till the gas escapes. Before the tube is withdrawn the contents of the paunch that have risen in the same should be first pushed down.

Harvesting for Hay.—Medium red clover is at its best for cutting for hay when in full bloom, and when a few of the heads which first bloomed are beginning to turn brown: that is to say, in the later rather than in the earlier stage of full bloom. If cut sooner, the curing of the crop is tedious. If cut later the stalks lose in palatability. But when the weather is showery it may be better to defer cutting even for several days after the clover has reached the proper stage for harvesting, as the injury from rain while the crop is being cured may

be greater than the injury from overmaturity in the same before it is mown.

When curing the crop, the aim should be to preserve to the greatest extent practicable the loss of the leaves. To accomplish such a result, the clover ought to be protected as far as possible from exposure to dew or rain, and also from excessive exposure to sunshine. Dew injures more or less the color of the hay and detracts from its palatability. Rain intensifies such injury in proportion as the crop being harvested is exposed to it. It also washes out certain substances, which, when present, affect favorably its aroma.

The injury from such exposure increases with the interval between cutting and storing the crop. Exposure to successive showers may so seriously injure the hay as to render it almost valueless for feeding. After the mown clover has been exposed in the swath to the sunlight beyond a certain time, it turns brown, and if exposed thus long enough the aroma will be lost. The aim should be, therefore, to cure the clover to the greatest extent practicable by the aid of the wind rather than by that of the sun.

The method of procedure to be followed is in outline as given below: Mow as far as possible when the meadow is not wet with rain or dew. Mow in the afternoon rather than the forenoon, as the injury from dew the night following will be less. Stir with the tedder as soon as the clover has wilted somewhat. The tedder should be used once, twice

or oftener as the circumstances may require. The heavier the crop and the less drying the weather, the more the tedding that should be given. Sometimes tedding once, and in nearly all instances twice, will be sufficient. The hay should then be raked. It is ready for being raked as soon as the work can be done easily and in an efficient manner. When clover is not dry enough for being raked, the draught on the rake will be unnecessarily heavy, the dumping of the hay will be laborious, and it does not rake as clean as it would if the hay were in a fit condition for being raked.

The aim should be to have the crop put up in heaps, usually called "cocks," but sometimes called "coils," before the second night arrives after the mowing of the clover; and in order to accomplish this, it may be necessary to work on until the shades of evening are drawing near.

When there is a reasonable certainty that the weather shall continue dry, it is quite practicable to cure clover in the winrow, but in showery weather to attempt to do so would mean ruin to the clover. In no form does it take injury so quickly from rain as in the winrow, and when rain saturates it, much labor is involved in spreading it out again. Nor is it possible to make hay quite so good in quantity when clover is cured in the winrow, as the surface exposed to the sunshine is much greater than when it is mixed with timothy or some other grass that purpose, nevertheless, to cure it thus, especially when it is mixed with timothy or some other grass that

cures more easily and readily than clover. It may also be taken up with the hay-loader when cured thus, which very much facilitates easy storing. But when it is to be lifted with the hay-loader, the winrows should be made small rather than large.

When the clover is to be put up into cocks, these should be small rather than large, if quick curing is desired. In making these, skilled labor counts for much. The cocks are simply little miniature stacks. The part next to the ground has less diameter than the center of the cock. As each forkful is put on after the first, the fork is turned over so that the hay spreads out over the surface of the heap as it is being deposited. Smaller forkfuls are put on as the top is being reached. The center is kept highest when making the cock. Each one may be made to contain about 100 pounds and upward of cured hay, but in some instances they should not contain more than half the amount to facilitate drying. When the heap has become large enough, the inverted fork should be made to draw down on every side the loose portions, which in turn are put upon the top of the cock. Such trimming is an important aid to the shedding of rain. An expert hand will put up one of these cocks of hay in less time than it takes to read about how it is done.

A light rain will not very much injure a crop of clover after it has been put up into cocks, but a soaking rain will probably penetrate them to the bottom. To guard against this, in localities where the rainfall may be considerable in harvest time, hay caps are frequently used. These may be made from

a good quality of unbleached muslin or strong cotton, or they may be obtained from some of those who deal in tent awnings and stack covers. When of good quality and well cared for they should last for 10 to 20 years. Care should be taken in putting them on lest the wind which frequently precedes a thunder storm should blow them away. The pins used at the corners of the caps should be carefully and firmly inserted in the hay or the ground, or the caps should have sufficiently heavy weights attached to them at the corners to prevent their lifting with the wind. In putting up the hay the size of the cocks should be adjusted to the size of the covers used. One person should apply the covers as quickly as two will put up the hay.

When clover hay is put up into cocks, it undergoes what is termed the "heating" process; that is, it becomes warm in the center of the heaps up to a certain point, after which the heat gradually leaves it. The heat thus generated is proportionate to the size of the cocks and the amount of moisture in the clover. The sweating process usually covers two or three days, after which the hay is ready for being stored. When clover is cured in the winrow, it does not go through the sweating process to the same extent as when cured in the cock; hence, it is liable to sweat in the mow, and to such an extent as to induce mold, if it has been stored away with moisture in it beyond a certain degree. If a wisp of clover is taken from the least cured portion of the winrow or cock, and twisted between the hands, it is considered ready for being stored if no liquid is discernible. If over-

cured, when thus twisted it will break asunder. A skilled workmen can also judge fairly well of the degree of the curing by the weight when lifted with the fork.

Under some conditions, it may be advisable to "open out" the cocks two or three hours before drawing them, that the hot sunshine may remove undue moisture. When this is done, if the cocks are taken down in distinct forkfuls, as it were, each being given a place distinct from the others, the lifting of these will be much easier than if the clover in each cock had been strewn carelessly over the ground. The lowest forkful in the cock should be turned over, since the hay in it will have imbibed more or less of dampness from the ground. But in some instances the weather for harvesting is so favorable that the precaution is unnecessary of thus opening out the cocks or even of making them at all.

Storing.— Storing clover under cover is far preferable to putting it up in stacks, except in rainless climates. With the aid of the hay-loader in lifting it from winrows in the field, and of the hay fork in unloading, the hand labor in storing is greatly reduced, but when it is unloaded with the horse fork, the aim should be to dump the hay from the fork on different parts of the mow or stack, lest it should become too solidly pressed together under the dump, and heat and mold in consequence.

When the hay is stacked, especially in climates of considerable rainfall, a bottom should be prepared on which to stack it. This may be made of poles or rails. A few of these should first be laid one way

on the ground and parallel, and ~~over~~ across them. Where such material cannot be had, old straw or hay of but little value should be spread over the stack bottom to a considerable depth. Where these precautions are not taken, the hay in the bottom of the stack will be spoiled for some distance upward by moisture ascending from the ground. In building the stack, the center should be kept considerably higher than the outer edges, that rain may be shed, and the width of the same should increase up to at least two-thirds of the height, the better to protect the hay underneath. The tramping should be even, or the hay in settling will draw to one side, and the topping out should be gradual rather than abrupt.

In topping out a clover stack some hay should be used not easily penetrated by rain, as, for instance, blue grass obtained from fence corners, or slough hay obtained from marshes. The last-named is better put on green. If the clover is not thus protected, a considerable quantity will spoil on the top of the stacks. It is not a good hay to turn rain. The shape of the stack should in a considerable degree be determined by its size. It is probably preferable to make small stacks round, since they are more easily kept in shape, but large stacks should be long rather than round, as large, round stacks call for undue height in bringing them to a top. Because of the ease with which rain penetrates clover, it is very desirable to have it put under a roof. Where it cannot be protected by the roof of a barn or stable, the aim should be to store it in a hay shed; that is to say, a frame structure, open on

all sides and covered with a roof. Such sheds may be constructed in a timber country without great cost.

Should the clover hay be stored a little under-cured, some growers favor sowing salt, say, from 4 to 8 quarts over each load when spread over the mow. They do so under the conviction that its preservative qualities will be to some extent efficacious in preventing the hay from molding, and that it adds to the palatability of the hay. While it may render some service in both of these respects, it would seem probable that the benefits claimed have been overrated.

The more frequently clover hay is handled, the more is its feeding value impaired, because of the loss of heads and leaves which attend each handling of the crop. Because of this, it is not so good a crop for baling as timothy, and also for other reasons. It should be the aim when storing it for home feeding to place it where it can be fed as far as possible directly from the place of storage. In the location of hay sheds, therefore, due attention should be given to this matter.

In climates that are moist, some growers store clover in a mow when it has only reached the wilting stage, in the curing process. When thus stored it is preserved on the principle which preserves silage. The aim is when storing to exclude the air as far as possible by impacting the mass of green clover through its own weight, aided by tramping. It should be more or less wilted before being stored, according to the succulence in it, and it is con-

sidered highly important that it shall also be free from external moisture. When thus stored it should be in large mows, and it should be well tramped, otherwise the impaction may not be sufficient. To this method of storage there are the following objections: 1. The hay has to be handled while it is yet green and wet. 2. There is hazard that much of the hay will be spoiled in unskilled hands. 3. Under the most favorable conditions more or less of the clover is pretty certain to mold near the edges of the mass. Where clover can be made into hay in the ordinary way without incurring much hazard of spoiling, the practice of storing it away in the green form, except in a silo, would seem of questionable propriety. The making of clover into ensilage is discussed in the book "Soiling Crops and the Silo" by the author.

Securing Seed. As a rule, seed is not produced from the first cutting for the season of medium red clover. It is claimed that this is due to lack of pollenization in the blossoms, and because they are in advance of the active period of working in bumble bees, the medium through which fertilization is chiefly effected. This would seem to be a sufficient explanation as to why medium red clover plants will frequently bear seed the first year, if allowed to, though the first cutting from older plants will have little or no seed. But it is claimed that the ordinary honey bee may be and is the medium for fertilizing alsike and small white clover, but not that through which the mammoth variety is fertilized.

Experience has shown, further, that, as a rule, bet-

ter crops of clover seed may be obtained from clover that has been pastured off than from that which has been mown for hay, although to this rule there are some exceptions. This arises, in part, from the fact that the energies of the plant have been less drawn upon in producing growth, and, therefore, can produce superior seed heads and seed, and in part from the further fact that there is usually more moisture in the soil at the season when the plants which have been pastured off are growing. There would seem to be some relation between the growing of good crops of clover seed and pasturing the same with sheep. It has been claimed that so great is the increase of seed in some instances from pasturing with sheep till about June 1st, say, in the latitude of Ohio, that the farmer who has no sheep could afford to give the grazing to one who has, because of the extra return in seed resulting. The best crops of seed are obtained when the growth is what may be termed medium or normal. Summers, therefore, that are unusually wet or dry are not favorable to the production of clover seed.

If weeds are growing amid the clover plants that are likely to mature seed, they should, where practicable, be removed. The Canada thistle, ragweed, plantain and burdock are among the weeds that may thus ripen seeds in medium clover. When not too numerous they can be cut with the spud. When too numerous to be thus cut, where practicable, they should be kept from seeding with the aid of the scythe. To prevent them from maturing is important, as the seeds of certain weeds cannot be sepa-

rated from those of clover with the fanning mill, they are so alike in size.

The crop is ready for being cut when the heads have all turned brown, except a few of the smaller and later ones. It may be cut by the mower as ordinarily used, by the mower, with a board or zinc platform attachment to the cutter bar, by the self-rake reaper, or by the grain binder. The objection to the first method is that the seed has to be raked and that the raking results in the loss of much seed; to the second, that it calls for an additional man to rake off the clover; and to the third, that the binder is heavier than the self-rake reaper. The latter lays the clover off in loose sheaves. These may be made large or small, as desired, and if care is taken to lay them off in rows, the lifting of the crop is rendered much easier.

When the clover is cut with the mower, it should be raked into winrows while it is a little damp, as, for instance, in the evening. If raked in the heat of the day many of the heads will break off and will thus be lost. From the winrows it is lifted with large forks. When the crop is laid off in sheaves it may be necessary to turn them once, even in the absence of rain, but frequently this is not necessary. In the turning process gentle handling is important, lest much of the seed should be lost. The seed heads of a mature crop break off very easily in the hours of bright sunshine. Rather than turn the sheaves over, it may be better, in many instances, just to lift them with a fork with many tines, and set them down easily again on ground which is not damp

under them, like unto that from which they have been removed.

Clover seed may be stored in the barn or stack, or it may be threshed directly in the field or from the same. The labor involved in handling the crop is less when it is threshed at once than by any other method, but frequently at such a busy season it is not easily possible to secure the labor required for this work. It is usually ready for being threshed in two or three days after the crop has been cut, but when the weather is fair it may remain in the field for as many weeks after being harvested without any serious damage to the seed. If, however, the straw, or "haulm," as it is more commonly called, is to be fed to live stock, the more quickly that the threshing is done after harvesting, the more valuable will the haulm be for such a use.

When stored in the barn or stack, it is common to defer threshing until the advent of frosty weather, for the reason, first, that the seed is then more easily separated from the chaff which encases it; and second, that farm work is not then so pressing. When threshed in or directly from the field, bright weather ought to be chosen for doing the work, otherwise more or less of the seed will remain in the chaff.

In lifting the crop for threshing or for storage, much care should be exercised, as the heads break off easily. The fork used in lifting it, whether with iron or with wooden prongs, should have these long and so numerous that in lifting the tines would go under rather than down through the bunch to be lifted. The wagon rack should also be covered with

canvas, if all the seed is to be saved. If stored in stacks much care should be used in making these, as the seed crop in the stack is even more easily injured by rain than the hay crop. The covering of old hay of some kind that will shed rain easily should be most carefully put on.

Years ago the idea prevailed that clover seed could not be successfully threshed until the straw had, in a sense, rotted in the field by lying exposed in the same for several weeks. The introduction of improved machinery has dispelled this idea. The seed is more commonly threshed by a machine made purposely for threshing clover called a "clover huller." The cylinder teeth used in it are much closer than in the ordinary grain separator. The sieves are also different, and the work is less rapidly done than if done by the former. During recent years, however, the seed is successfully threshed with an ordinary grain threshing machine, and the work of threshing is thus more expeditiously done. Certain attachments are necessary, but it is claimed that not more than an hour is necessary to put these in place, or to prepare the machine again for threshing grain.

Since the seed is not deemed sufficiently clean for market as it comes from the machine, it should be carefully winnowed by running it through a fanning mill with the requisite equipment of sieves. It is important that this work should be carefully done if the seed is to grade as No. 1 in the market. If it does not, the price will be discounted in proportion as it falls below the standard. A certain proportion of the seed thus separated will be small and

light. This, if sold at all, must be sold at a discount. If mixed with weed seeds it should be ground and fed to some kind of stock.

The haulm, when the seed crop has been well saved, has some feeding value, especially for cattle. If not well saved it is only fit for litter, but even when thus used its fertilizing value is about two-thirds that of clover hay. More or less seed remains in the chaff, and because of this the latter is sometimes drawn and strewn over pastures, or in certain by places where clover plants are wanted. Seed sown in the chaff has much power to grow, owing, it is thought, to the ability of the hull enclosing the seed to hold moisture. The yields in the seed crops of medium red clover vary all the way from 1 to 8 bushels per acre. The average yields under certain conditions are from 3 to 4 bushels per acre. Under conditions less favorable, from 2 to 3 bushels.

Within the past two decades the seed crop has been seriously injured by an insect commonly spoken of as the clover midge (*Cecidomyia legumini-cola*) which preys upon the heads so that they fail to produce. A field thus affected will not come properly into bloom. The remedy consists in so grazing or cutting the clover that the bloom will come at that season of the summer when the insects do not work upon the heads. This season can only be determined by actual test. In Northern areas it can usually be accomplished by pushing the period of bloom usual for the second crop two to four weeks forward.

Renewing.—When clover is grown for hay, it is not usual to try to renew the crop, because of the short-lived period of the plant. But in some instances it has been found advantageous. On light prairie soils sandy in texture, located in the upper Mississippi basin, it has been found possible to grow timothy meadow for several years in succession with a goodly sprinkling of clover in it without re-seeding. In such instances, the land is not pastured at all, except in seasons quite favorable to growth, and in these the pasturing is not close. The clover plants that grow after the crop has been cut for hay produce seed. The heads in due time break off and are scattered more or less over the soil by the winds. In time they disintegrate, and more or less of the seed germinates, thus forming new plants, some of which, especially in favorable seasons, retain their hold upon the soil. This method may be worthy of imitation in localities where it has been found difficult to get a stand in dry seasons on this class of soils.

When the stand of clover secured is variable, that is to say, partial, as when the clover is abundant in the lower portions of the land and entirely absent on the higher ground, it may be worth while to re-sow the seed on the latter early the following spring. But before doing so, the land should be carefully disked in the fall, and the clover seed harrowed or otherwise covered in the spring. Should the summer following prove favorable, the seed thus sown may produce hay, but not likely in time to be harvested with the other portions of the field. But though it should not produce much hay the seed is

likely to be benefited to an extent that will far more than repay the outlay involved in labor and seed.

If the clover has been sown for pasture, the renewal of the same on higher ground may be made as stated above, but with the difference that the same kind or kinds of grain may also be sown at the same time as the clover is becoming rooted.

In pastures, medium red clover may be renewed whenever the attempt is made to renew the pastures, as by disking them and then sowing upon them the seeds of certain grasses or clovers or both. The disking is usually done in the spring and while the frost is out for only a short distance below the surface. The amount of seed to sow need not be large, usually not more than 2 or 3 pounds per acre, especially when seed of other varieties is sown at the same time. One stroke of the harrow following will provide a sufficient covering for the seed.

Clover as a Fertilizer.—It would probably be correct to say that no plant has yet been introduced into American agriculture that has been found so generally useful as clover in fertilizing land and in improving the mechanical condition. Some who have investigated claim that there is more nitrogen in a clover sod after the removal of a good crop of clover than will suffice for four average farm crops, more phosphoric acid than will suffice for two, and more potash than will suffice for six. It begins to draw nitrogen from the air as soon as the tubercles commence to form and continues to add thus to the enrichment of the land during all the succeeding period of active growth. As previously stated, the

nitrogen is drawn in great part from the air; consequently, soil from which a bountiful crop of clover has been removed will be considerably richer in nitrogen than before it grew the same, and this will hold true as intimated above, even though the crop should be removed and sold. Under the same conditions it will also be true in available phosphoric acid and potash. But the latter are gathered from the soil and subsoil while the plants were growing. Consequently, if crops of clover are grown in short rotation periods and if no fertilizer is given to the land other than the clover brings to it, while it will be abundantly supplied with nitrogen, a time will come when the supply of phosphoric acid and potash may be so reduced that the soil will not grow even good crops of clover. When this point is reached the soil is spoken of as "clover sick." Happily, however, nearly all soils are so well stored with phosphoric acid and potash that this result is not likely to follow for many years. But lest it should, attention should be given to fertilizing the land occasionally with farmyard manure, or with phosphoric acid and potash applied as commercial fertilizers. Because of this, and also for other reasons, it is usually considered more profitable in the end to feed clover on the farm and return it to the land in the form of manure. But clover may cease to grow on land where once it grew well, because of other reasons, such as changes in the mechanical condition of the soil caused by the depletion of its humus and changes in its chemical condition, such as increased acidity. The remedy is the removal of the cause.

The roots also put large quantities of humus in the soil. Where crops are regularly grown in short rotations they will suffice to keep it amply supplied for ordinary production. Because of this it is usually considered more profitable to cut both the crops which medium red clover produces in one season, or to pasture off one or both, than to plow under either as green manure. But when soils are too stiff or too open in character it may be advantageous to bury clover to restore the equilibrium. It may also be necessary to bury an occasional crop in order to put the land quickly in a condition to produce some desired crop, the growth of which calls for large supplies of humus. When clover is plowed under it will usually be found more profitable to bury the second growth of the season than the first. The crop is in the best condition for being plowed under when the plants are coming into bloom. If left until the stems lose their succulence the slow decay following in conjunction with the bulkiness of the mass plowed under might prove harmful to the crop following the clover. The influence of the roots upon the mechanical condition of the soil is most beneficial. The roots go down deep into the subsoil and also abound in fibrous growth. The tap roots in their decay furnish openings through which the superfluous water may go down into the subsoil. The fibers adhering to the main roots so ramify through the soil that when even stiff land is filled with them it is rendered friable, and is consequently brought into a good mechanical condition.

While all varieties of clover may be utilized in

producing food and in enriching land, none is equal to the medium red for the two purposes combined. This arises from the fact that none save the medium red grows two crops in one season under ordinary conditions. Though the first crop should be taken for food, as it generally is, there is still ample time for a second crop to grow for plowing under the same season. This second growth is ready for being plowed under when time is less valuable than it would be when the mammoth or alsike varieties would be in season for being thus covered. And yet the work may be done sufficiently early to admit of sowing fall or winter crops on the land which produced the clover.

CHAPTER IV

ALFALFA

Alfalfa (*Medicago sativa*) previous to its introduction into California, from Chili, about the middle of the last century, was usually known by the French name Lucerne. The name Alfalfa is probably Arabic in its origin, and the term Lucerne has probably been given to it from the Canton Lucerne in Switzerland. It has followed the plant into Spain and South America, and now it seems probable that soon it will be known by no other name over all the United States and Canada. It has also been known by names applied to it from various countries for which it has shown high adaptation, as, for instance, Sicilian Clover, Mexican Clover, Chilian Clover, Brazilian Clover, Styrian Clover and Burgundy Clover. In yet other instances, names have been applied to it indicative of some peculiarity of growth, as, for instance, Branching Clover, Perennial Clover, Stem Clover and Monthly Clover.

Alfalfa is upright and branching in its habit of growth, more so than the common varieties of clover. It usually grows to the height of 2 to 3 feet, but it has been known to reach a much greater height. Although possessed of a single stem when the plants are young, the number of the stems increases up to a certain limit, with the age of the



Fig. 3. Alfalfa (*Medicago sativa*)

plants and the number of the cuttings. Forty to fifty stalks frequently grow up from the crown of a single plant where the conditions are quite favorable to growth, and in some instances as many as a hundred. The leaves are not large, but numerous, and in the curing of the plants they drop off much more easily than those of the more valuable of the clovers. The flowers are borne toward the top of the stems and branches, and they are in a long cluster, rather than in a compact head. They are usually of a bluish tint, but the shades of the color vary with the strain from blue to pink and yellow. The seeds are borne in spirally coiled pods. They resemble those of red clover in size, but are less uniform in shape. The color should be a light olive green. The tap roots go down deeply into the soil and subsoil where the conditions as to texture and moisture are favorable. It has been claimed that alfalfa roots have gone down into congenial subsoils 40 to 50 feet, but usually less, probably, than one-fourth of the distances mentioned would measure the depths to which the roots go. And with decreasing porosity in the subsoil, there will be decrease in root penetration until it will reach in some instances not more than 3 to 4 feet. But where the roots are thus hindered from going deeper, they branch out more in their search for food.

Alfalfa is perennial. In the duration of its growth, no fodder plant grown under domestication will equal it. It has been known, it is claimed, to produce profitable crops for half a century. In some of the Western States are meadows from 25 to 40

years old. Ordinarily, however, the season of profitable growth is not more than, say, 6 to 12 years when grown on upland soils. The meadows usually become more or less weedy or possessed by various grasses, and some of the plants die. The plants at first send up a single stem. When this matures or is cut back the uncut portion of the stem dies down to the crown of the plant, which then sends out other stems. This is repeated as often as the stems are cut down until many stems grow up from one plant as indicated above, unless the plants are so crowded that such multiplication is more or less hindered. The plants grow rapidly as soon as spring arrives, and as often as cut off they at once spring again into vigorous life, where the conditions are favorable to such growth; hence, from one to twelve cuttings of soiling may be obtained in a single season, the former result being obtained in arid climates, where the conditions are unpropitious, and the latter being possible only in congenial soils, where the winters are very mild and where the soils are irrigated. Usually, however, even on upland soils and in the absence of irrigation, not fewer than 3 to 5 cuttings of soiling food are obtained each year and not fewer than 2 to 4 crops of hay.

A number of varieties so called are grown in this country. They differ from each other more, however, in their adaptation in essential properties relating to the quality of the pasture and fodder produced, than in the quality of food product obtained from them. The variety commonly grown from seed produced in the West is usually spoken of

simply as alfalfa, while that grown from seed European in origin has been more commonly called Lucerne. The former of these has a tendency to grow taller than the latter and to send its roots down to a greater depth. In addition to these, such strains as the Turkestan, the Rhenish, the Minnesota and Sand Lucerne have been introduced.

The Turkestan variety was introduced by the United States Department of Agriculture during recent years. It was brought from provinces beyond the Caspian in Russia, Asia. The object sought was to introduce a variety that would better withstand the rigors of a climate dry in summer and cold in winter than the variety commonly grown. Some strains of this variety have proved drought resistant to a remarkable degree. It has also shown itself capable of enduring without injury temperatures so low as to result in the destruction of plants of the common variety. In trials made by growers in North Dakota and Northern Minnesota, it has been found able to endure the winter's cold in these areas. But it has also been found that while the plants produced some seed in the Central Mountain States, they did not produce much seed when grown in the Northern States. Unless seed can be secured from plants grown in the latter in sufficient quantities to meet the needs of growers, it is feared that in time some of the hardy characteristics of this variety will be lost if the Central and Southern Mountain States must be relied upon as the American sources of seed supplies.

The Rhenish strain comes from Central Europe.

It has been highly commended by some European seedsmen for its hardihood, but it has been as yet grown to only a limited extent in America. The Minnesota strain was doubtless brought to Carver County by German farmers, by whom it has been grown in the neighborhood of Lake Waconia for nearly 20 years. It has been found much hardier than the common variety when grown in that neighborhood, and the endurance of plants grown from seed of this strain far northward has been very pronounced. As this variety produces reasonably good seed crops in Central Minnesota, it would seem reasonable to expect that it will become popular in Northern areas. Sand Lucerne, which comes from Central Europe, has considerable adaptation for poor and light soils, and in trials made at the Michigan experiment station was found possessed of distinctive merit for such soils.

Where alfalfa can be grown freely, it is unexcelled as a pasture for swine, and is in favor also as a pasture for horses. While cattle and sheep grazed upon it are exceedingly fond of it, the danger that it will produce bloat in them is so frequently present as to greatly neutralize its value for such a use. It is a favorite pasture for fowls. In furnishing soiling food where it produces freely, it is without an equal in all the United States. It is highly relished by all kinds of farm animals, not excluding rabbits and goats, and when fed judiciously may be fed in this form with perfect safety. Its high value in producing such food rests on its productiveness, its high palatability and the abundant nutri-

tion which it contains. As a hay crop, it is greatly prized. Even swine may be wintered in a large measure on cured alfalfa hay.

As a fertilizer, the value of alfalfa will be largely dependent on the use that is made of the plants. When pastured or fed upon the farm, the fertility resulting being put back upon the land, it ranks highly as a producer of fertility. But this question is further discussed on page 191. As a destroyer of weeds much will depend upon the way in which it is grown. This question also is discussed again. (See page 185.)

Distribution.—It is thought that alfalfa is more widely distributed over the earth's surface, furnishes more food for live stock, and has been widely cultivated for a longer period than any other legume. It is grown over wide areas of Asia, Europe, North and South America, and its cultivation is constantly extending. It was grown on the irrigated plains of Babylon long before the days of Nebuchadnezzar. It was the principal fodder used in the stables of the kings of Persia. From Persia, it is thought, it was brought to Greece about 470 B. C., and that its cultivation in Italy began at least two centuries before the Christian era. Several Roman writers, as Virgil, Columella and Varro, mention it. From Italy it was introduced into Spain and from Spain it was doubtless carried by missionaries of the Roman Catholic Church to Mexico and the South American States which lie west of the Andes, as Peru and Chili. In the arid and semi-arid regions of the Andes, the conditions were found so favorable

to the growth of alfalfa that it is now the principal forage crop grown. It is almost certain that it was brought from Chili to California, from which it has spread over much of the cultivated portion of the arid and semi-arid west. Western grown seed is also the chief source of supply at the present time for all the States of the Union.

Fully a century ago attempts were made by Chancellor Livingstone and others to introduce it into the Eastern States, but without much success, owing, probably, to the lack of knowledge on the part of the people as to how it should be grown. The seed at that time was doubtless brought from European sources, probably France. It has been noticed by more recent growers in these States that the results from sowing such seed do not prove as satisfactory as those from American grown seed, but that alone should not sufficiently explain why the attempts to grow alfalfa just referred to were not successful.

But it is not alone in the areas named that alfalfa has proved so helpful to agriculture. In Central Asia and northward it has for long centuries furnished the Tartars with the principal forage crop grown. In Turkestan and other places it will grow under conditions so dry as to forbid the vigorous growth of many hardy grasses. In Southern Asia, from India to Arabia, it has lost none of the popular favor accorded to it long centuries ago. In Southern Russia it is extensively grown, and up and down the basin of the Danube. In the Mediterranean provinces of Southern Europe it is still one

of the leading forage crops. In France it stands high in the popular estimate, and also in some parts of Germany. And even in humid England it is grown more or less freely on dry, calcareous soils. And the day is doubtless near when in many parts of Africa, Australia, New Zealand and Eastern South America this great fodder plant will be found capable of yielding abundant harvests. In some parts of Argentina it has been claimed that it grows like a weed.

It is believed by many that alfalfa if exposed to very low temperatures will perish and that it cannot stand as much winter exposure as medium red or alsike clover. This is only true of some varieties. Other varieties, as the Turkestan, for instance, will endure lower temperatures and more exposure than the clovers named. Alfalfa has been grown with some success at the government experiment station, Indian Head, Sark, Canada, and yet it sometimes winter kills in Texas. As with clover, it is injured most by exposure to sweeping winds blowing over it in winter when the mercury is low, and the injury is more fatal just after the removal of a snow covering and when the plants are young. Ice forming over the fields after a sudden thaw and remaining for a time is very liable to kill the plants. It can stand considerably more summer heat than any of the clovers grown northward, as witnessed in the good crops grown in some parts of Louisiana during the hottest weather of summer. Nevertheless, with reference to temperatures, what may be termed a mild climate, such as characterizes

Southern France in Europe and Western California in the United States, is best adapted to its growth.

It is better adapted to climates that are dry, where the plants can be irrigated, as then rains do not interfere with the harvesting of the hay. Even in the absence of irrigation, a climate that is reasonably dry is preferable to one where drenching rains frequently fall, which wash away the soil when sandy, or which fill it full of water when composed of clay. But where rains fall frequently and in moderation, as in the northern Puget Sound region, the effect is helpful to the growth of the alfalfa plants, although it may add somewhat to the labor of making alfalfa hay, and to the hazard in curing it. Alfalfa will maintain its hold for years on some portions of the table lands of the mountain States under conditions so dry that the plants can only furnish one cutting of hay in a season. It is safe to assume, therefore, that alfalfa can be grown under a wider range of climatic conditions than any other legume grown in the United States. But the influence which climate should be allowed to exercise on the use that is to be made of it should not be lost from view. In climates much subject to frequent rains in summer, it should be grown rather for soiling food and pasture than for hay, whereas in dry climates, and especially where it can be irrigated, it should be grown for hay, soiling food and pasture, but especially the former.

While alfalfa can be successfully grown in one or the other of its varieties in some portion of every State in the Union, it has its favorite feeding

grounds. The best conditions for growing it are found in the valleys of all the Rocky Mountain States, where the growth can be regulated by the application of irrigating waters. In these the conditions southward are superior to those northward, because of the milder climate, which precludes the danger of winter killing by exposure, which occasionally happens in the more northerly of the mountain States, and because of the more prolonged season for growth, which adds to the number of the cuttings. This does not mean that the river bottoms in other parts of the United States will not be found good for growing alfalfa. It can be grown in many of these; in fact, in nearly all of them, and to some extent by the aid of irrigation, if the waste waters were stored, but the deposit soil in these valleys being of much closer texture than that in the western alleys, is, on the whole, lower in adaptation than the soil in the latter.

In the western valleys of the mountain States, alfalfa is the crop around which it may be said that agricultural production centers. It is the principal hay crop of those States. The extent to which it may be grown there is revolutionizing the production of live stock on the ranges, as it is providing food for them in winter, which is fast removing, and will probably soon entirely remove, the element of hazard from live stock dependent on the range pastures for support in that season. The dairy and swine industries in those valleys must largely depend upon it. Fruit orchards must ultimately grow on buried alfalfa meadows, and the rotation of all

crops in the same will be largely dependent upon the growing of alfalfa. Next in adaptation to the mountain States are, it is thought, certain soils that lie between the Rocky Mountains and the Mississippi, especially such as are in proximity to rivers, or are underlaid with sheet water not far distant from the surface. But an unusually large proportion of the upland soil in these States, from Central Minnesota southward, have high adaptation for the growth of this plant. Particularly is this true of the soils of Nebraska and Kansas and of considerable portions of Missouri, Arkansas and Louisiana.

In States east of the Mississippi, the adaptation is not so general, and is more dependent on soil conditions than on those that are climatic. In nearly all of the river bottoms of these States it will grow with more or less success. On nearly all upland soils it will also grow well, where the subsoil furnishes naturally good drainage. For the exception, see page 132. But in no State east of the Mississippi, is such a proportion of the area so highly adapted to growing alfalfa as in many of the States west of that river. In other States areas are found in which alfalfa will produce excellent crops, but usually these do not embrace the larger portion of the entire area in any State. In a considerable number of the States such areas are more or less limited, and usually they are distributed variously in the different States; that is, they do not lie side by side. The favorite soil conditions in these are a good loam, preferably more or less sandy and resting upon a porous subsoil.

A more exact idea will be given of relative adaptation in various States in what is now submitted. In California, Nevada, Utah, Colorado and New Mexico, alfalfa is now grown chiefly by the aid of irrigation, and all of these States have highest adaptation for its growth. In some parts of California 6 to 10 tons of cured hay are obtained in one year, with pasture in winter additional. In Utah, good crops have been grown successively on the same land for more than a quarter of a century. In Colorado two cuttings are obtained the first season, and it is said that there the plants are not easily destroyed. It yields enormously in the irrigated valleys of New Mexico and Arizona.

In Washington, Oregon, Idaho, Montana and Wyoming, it is grown with and without irrigation. In large areas in all these States, excellent crops are and may be grown, but the season of growth being shorter, not so many cuttings are obtained per year as in the mountain States further south. In Northern Idaho two cuttings may be obtained per year, even on high, dry land.

In North Dakota, especially westward, alfalfa gives promise of successful growth. It will grow well in much of South Dakota, especially on sandy soils not too distant from water. In Minnesota it has been grown successfully in Carver County since 1886. Good success is being obtained from growing it in other parts of the State, even in some parts of the Red River valley. In Western Iowa it is being grown with much success, and in some portions of Eastern Iowa. In Missouri, the two important cen-

ters for growing it are the northwest and the southeast, but in other areas it has also done well. In Kansas it will grow well in all parts of the State where the subsoil is porous. It has been cut for hay in that State in less than 60 days from the date of sowing. It grows equally well over at least two-thirds of Nebraska, especially the eastern half, and its growth in Nebraska is rapidly extending. In the Arkansas valley it luxuriates, and it is also being grown in Oklahoma. In Louisiana immense fields are being grown along the Red River and in other parts of the State. In Texas it is being grown more or less north, east and south, and especially in the valley of the Brazos.

In the Southern States alfalfa has not in many instances been given a good chance where tried. The plants have too frequently had to contend there as elsewhere with ill-prepared and weedy soils and imprudent pasturing. Yet it is being grown with considerable success, though as yet in limited areas, in all the Southern States. It has done well in parts of Kentucky, Tennessee, Mississippi and Alabama, and in Georgia are some alfalfa meadows 25 years old. In the other Southeastern States, viz., Virginia, the Carolinas and Florida, it does well only in areas more or less circumscribed, but it has been grown with some success even in the rainy climate of Southern Florida.

In the States northward from the Ohio River, that is, Illinois, Indiana, Ohio, Michigan and Wisconsin, the necessity for growing alfalfa has not been so much felt as in some other States, because of the

excellence of the crops of clover grown in these. Its growth, however, is extending in all of these States. Much of the soil in Illinois, it is said, must first be inoculated with the bacteria proper to alfalfa before vigorous crops can be grown, and this is probably true of sections of Indiana soil. Some sections of Ohio are becoming noted for the crops of alfalfa which they have grown, and in Wisconsin Hon. W. D. Hoard succeeded in securing 5.7 tons of alfalfa hay in one season from four cuttings made on three-fifths of an acre.

In all the Eastern and New England States, alfalfa is being grown to some extent. In some counties of New York, as Onondaga and Madison, it is becoming the leading soiling and hay crop. In Massachusetts it has borne cuttings year after year on sandy loam soil. On Long Island three to four cuttings each season have been obtained for a series of years. It is believed that it will grow over nearly the whole of Southern Maryland and also in much of the eastern part of that State, and its growth has been quite successful in parts of Delaware and Pennsylvania.

Alfalfa will grow well in considerable areas in Canada. The statement would seem safe that at the present time profitable crops could be grown in some parts of every province of Canada in which the land is tilled. In Quebec, even on high land, it usually endures the winters. Near Montreal it has been cut for soiling food at the height of 30 inches as early as May 15th. In some parts of Eastern Ontario good crops can be grown, and also over considerable

areas of Western Ontario. The author grew it with much success at the experiment station at Guelph in 1890 and subsequently, and during recent years considerable areas are being grown in several of the Lake Erie counties and in those that lie north from them. But in no part of Ontario are the conditions for growing alfalfa better than in some of the mountain valleys of British Columbia.

But few crops, if, indeed, any, are being experimented with at the present time to so great an extent as alfalfa; hence, the expectation is reasonable that there will be an enormous increase in the area grown in the future that is near. The two chief causes of failure in the past were want of knowledge in growing and caring for it on the part of the growers, and the absence of the proper bacteria in the soil. Acidity in some soils and want of drainage in others are also responsible for many of the failures referred to. But even where it does grow reasonably well, some trouble is found from the alfalfa failing in spots. In some instances the cause can be traced, as when coated with ice in winter, or where the soil is not uniform, but in other instances the precise causes have not been determined. Notwithstanding these drawbacks, however, greatly increased areas will be grown in the future, especially in States in which the dairy interest is paramount or even important.

Soils.—It was formerly thought by many that alfalfa would only grow vigorously on soils and subsoils sandy in character, and underlaid at some distance from the surface with water. It is now

being ascertained that it will grow on a great variety of soils, providing they are reasonably fertile, free from acidity, sufficiently porous below to carry away water with reasonable quickness, and not underlaid with hard pan or a subsoil so tenacious that it is almost impervious to water.

The best soils for alfalfa are those of the Western mountain States, and in these the deposit soils of the river valleys stand among the foremost. These soils are usually of much depth. Many of them have water underneath, and the subsoil is usually so porous that the roots can go far down in them, such is the character of nearly all the bottom land west of the Mississippi. But in nearly all of the mountain region of the West, from Banff in British Columbia to Mexico, alfalfa will grow well under irrigation, or in the absence of irrigation, if ground water is not too distant from the surface. In this region alfalfa grows more vigorously and more persistently than in almost any other portion of the United States.

In regions where alfalfa is not dependent upon irrigation, the best soils probably are deep, rich calcareous loams, clay or sandy, and underlaid with what may be termed a mild or reasonably porous clay subsoil. With such soils the plants may be in no way influenced by sheet water below, as on some of these in Nebraska, for instance, such water is fully 150 feet below the surface. These soils are usually possessed of abundant food supplies to nourish the plants, and the roots can go far down into the subsoils to gather food and moisture. Such

lands are found more or less in nearly all the States of the Union east from the Rocky Mountains; hence, when the requisite bacteria are present, good crops can be grown on them in every State in the Union.

On the ordinary black soils of the prairie, alfalfa will usually grow reasonably well if underlaid with clay not too distant nor too tenacious. When the roots get down into the subsoil, they can usually find much food in the same, and unless in very dry areas a sufficiency of moisture, but in many instances it may be necessary to introduce the requisite bacteria, and to apply farmyard manure to encourage sufficient growth to carry the roots down quickly to the subsoil. In some prairie soils the growth will be vigorous from the start, but usually these are lands that have grown hardwood timber, and that have in them more or less clay.

In climates where the rainfall is considerable, alfalfa will frequently grow well on gravelly soils and on those that are stony. Some of the best alfalfa soils in the State of New York, New England States, and in the Canadian provinces of Quebec and Ontario are of this character.

Alfalfa will frequently grow fairly well even on stiff clays, and in some instances on gumbo soils. But these soils must not be so retentive as to collect and hold water for any considerable time within a few feet of the surface. Such lands have usually much staying power; hence, alfalfa grown on them frequently improves for years after it has been sown. On the reddish soils that cover much of the South, it has been found, as in growing alfalfa on stiff

clays in the North, that where deep subsoiling is practiced alfalfa is not only more easily established, but it also grows with added vigor.

On upland soils sandy or gravelly in character where the rainfall is much less than normal and where the subsoil is not underlaid with sheet water, alfalfa will not usually succeed, notwithstanding that it may grow well on these soils where the rainfall is normal. On such soils it is not easy to get a stand of the plants, as they are much apt to perish in the dry weather of the first season, but if once established on such soils the plants have much power to grow even where the rainfall is considerably less than normal.

Alfalfa will not grow well in soils naturally wet until they are drained. And when drained it will not grow with normal vigor, on what may be termed slough soils, where the subsoil is far down and covered with a deep covering of vegetable mold. What are termed slough soils in the Western prairies, therefore, are not well fitted for the growth of alfalfa. On these it may not succeed well, when it may grow with much vigor on the adjoining upland. When some wet soils are drained, alfalfa may not succeed well on them for a time and later may grow luxuriantly. This may arise from the lack of time for proper aeration after being drained, or from the want of lime to further correct acidity in the soil, or from the want of the proper bacteria. Notwithstanding that alfalfa will not grow well on undrained lands that are naturally wet, and notwithstanding that it will perish if the roots reach standing water at a dis-

tance too near the surface, the best crops by far are usually grown on irrigated lands. This arises, first, from the ability to adjust the supplies of water to meet the needs of the plants, and second, from the congenial character of the soil and subsoil. Next to these the best crops are grown where congenial soils are underlaid with ground water, not too near nor too distant from the surface. On these soils the plants are largely supplied with moisture from the water below ascending on the principle of capillary attraction. How near or how distant such water should be will depend somewhat on subsoil conditions. It would seem correct to say that it ought never to come nearer to the surface than 3 feet, nor should it be more than 20 feet down. The most suitable distance would be, say, 8 to 16 feet. When the roots of alfalfa reach water at too short a depth they will die.

Alfalfa may sometimes be grown satisfactorily on soils subject to overflow, but usually there is hazard in growing it on these. If the overflow occurs comparatively early in the season, if it is not of great depth, if it is of short duration, and if the waters quickly drain out of the subsoil possessed by the alfalfa, it may receive little or no harm from such overflow. Instances are on record wherein ice has formed on alfalfa and yet the plants survived, but such a condition will usually prove fatal to them. But should the overflow take place in hot weather, usually it will injure the plants seriously, and may, indeed, completely destroy them. So great is such hazard, that care must be taken against the applica-

tion of an excess of irrigating waters under such conditions. Overflow waters that are stagnant are more injurious probably than those that are in motion, owing, it may be, to the less supply of dissolved oxygen in the former.

Soils suitable in themselves, but lying on stiff clay bottoms or underlaid with hard pan within two or three feet of the surface, will not maintain a good stand of alfalfa. The plants in these may grow well for a time, probably a year or two, after which they will fail. The roots are not able to go down to gather food. When the subsoils are simply stiff clays, deep subsoiling, as already intimated, may render much service, but when composed of hard pan this may not be practicable. In moist climates, however, reasonably good crops have been obtained from soils with underlying rock not more than four feet below the surface.

The fact should not be overlooked that soils may have the requisite physical conditions for growing alfalfa, and they may possess in fair supply the essential elements of plant food, and yet alfalfa will not succeed at the first when sown on these, because of the absence of the soil bacteria, the presence of which is essential to the vigorous growth of the plants. Because of this, growers should be slow to conclude that alfalfa will not flourish on the soils on which they sow it until they have first tried to grow it on those soils that have been inoculated with the requisite alfalfa bacteria. For the methods of procedure in such cases see page 53. Some persons claim that soils which will grow medium red clover

in good form will also grow alfalfa in good form. This does not necessarily follow. While there is much of similarity in the soils suitable for the growth of both, alfalfa may fail on lands that grow red clover luxuriantly until the bacteria proper to alfalfa have been introduced. Soils may be tested for bacteria, and even in winter, by sowing some seed in pots and treating them like well-cared-for house plants. When the plants are 2 to 3 months old, if tubercles are found on the roots, the conclusion would seem safe that such soil does not require inoculation.

Place in the Rotation.—In a certain sense it can scarcely be said of alfalfa that it is a rotation plant, because of the long term of years for which it is grown in an unbroken succession. Nevertheless, in all places it cannot always be maintained for a long term of successive years without renewal. In the Eastern States it is frequently, though not always so crowded by various grasses, that the fields in which it grows are broken up at some period short of ten years, and not infrequently at the end of five or six years. When thus grown, it becomes a rotation plant, though grown in what may be termed long rotations. But even in the West, where, under irrigation, it may be grown for a quarter of a century or even for a longer period without renewal, it may be used when desired in short rotations. In such situations it grows so readily and becomes established so quickly, that the fields may be broken with a view to alternate with other crops at the end of the second year, or of any year subsequently from

the sowing of the seed that may be desired. Alfalfa in these soils will serve even better than medium red clover in such situations, since while it is growing, it will produce more hay or soiling food, and consequently should excel the former in the fertility which it makes available.

East of the Mississippi and north of the Ohio River, alfalfa will frequently follow cultivated crops, as corn, potatoes and field roots, and when the fields are broken, it will be followed by crops other than legumes. On many soils the influence which this crop has on relieving the surface soil from excessive moisture, through channels opened into the subsoil by the decaying roots, is so helpful as to considerably stimulate production in addition to the fertilizing influence which it exerts directly. Particularly good crops of corn, the small cereal grains, and even field roots may be grown after alfalfa.

On soils east of the Mississippi and south of the Ohio, the rotation will be somewhat similar. But on Southern soils alfalfa will frequently follow immediately crops especially grown to be plowed under as green manures for the benefit of the alfalfa. These crops include cow peas, soy beans, crimson clover, and to a limited extent, burr clover. It will also be followed frequently by crops of cotton and other non-leguminous plants, the growth of which in the United States is confined to the area now being considered.

In the area west of the Mississippi and east of the semi-arid region beside the mountains, alfalfa may follow the small cereal grains, and may in turn be

followed by them and also by millets. It may also follow and precede corn, or the non-saccharine sorghums, where the climatic conditions are suitable for growing the latter.

In the irrigated regions of the West, alfalfa may be made to serve almost any purpose in the rotation that may be desired. By growing it as a rotation crop in these valleys it may be made to furnish the soil indefinitely with supplies of nitrogen and humus. In these soils it may be made to follow directly almost any crop grown on them, and similarly it may be made to precede the growth of almost any crop for which the locality has marked adaptation. Small cereal grains, timothy, vegetables, field roots, potatoes, corn, small fruits and orchards may be profitably grown on buried alfalfa meadows. This does not imply, however, that alfalfa meadows should not, as a rule, be maintained for a long term of years.

Preparing the Soil.—In preparing the soil for alfalfa the aim should be to make a seed-bed clean, rich, fine, moist, even, and sufficiently firm or friable, according to the conditions. The subsoil should also be made sufficiently dry and open. From what has just been said, it will be apparent that in properly preparing the seed-bed, it will be necessary to study closely the requisite conditions.

The advantage from having a clean seed-bed will be apparent when it is called to mind that alfalfa is a somewhat delicate plant when young, and that because of this, it is ill able to overcome in the fight with weeds. Cleanness in the surface soil may be

obtained by summerfallowing the land, by growing a root crop or a crop of corn or any of the non-saccharine sorghums. When the seed is spring sown, this preparation must be given the year previously, but when autumn sown, it may be given the same season. In preparing the land thus, the aim should be to make the surface as clean as possible, rather than to get weed seeds out of the lower strata of the cultivated soil, in which they will likely perish before the field sown to alfalfa is broken up again. Summerfallowing makes an excellent preparation for the land, because of the fine opportunity which it furnishes for cleaning the same perfectly and leveling it off properly. The excellent condition in which it puts the seed-bed, viewed from the standpoint of the duration of the years of cropping that are likely to follow, would seem to more than justify such preparation of the land. The outcome may more than justify the loss of the crop for one season when thus summerfallowing the land. But it may not be necessary to lose the production of one season whether the seed is sown spring or autumn, as the summerfallowing in the North may follow the pasturing off of some crop, and in the South the interval for fallowing the land may be sufficiently long after the harvesting of an early winter grain crop, before sowing the seed in the autumn. (See page 136.)

When sowing the seed autumn or spring, on land that is filled with weed seeds near the surface, it is frequently better to defer sowing the seed for some weeks to give time for sprouting many of these than

to sow at once. This suggestion is specially applicable to spring sowing. It should also be mentioned that when the weeds infesting the soil are annual or even biennial in character, the harm done to the alfalfa by these will be much less than when the land is infested with perennials at the time of sowing. The former may be prevented from seeding by clipping back frequently, while the latter remain in the soil, increase from year to year, and injure the plants by crowding. Where crab grass grows abundantly, as in some parts of the South, unless the alfalfa is sown and cultivated, spring sowing ought to be avoided. But it is less objectionable to sow alfalfa on land that is weedy when the adaptation of the land for the crop is high than when it is low, as the alfalfa in the former instance has so much more power to fight its own battle. On good alfalfa soils, therefore, it may be wiser in some instances to sow alfalfa in weed-infested land than to defer sowing for a whole year in order to clean the land.

It is greatly important that the land shall be rich in available plant food on which the seed is sown. If naturally poor, it should be well fertilized before sowing. When this cannot be done, it is better not to sow. A vast preponderance of the land in the Rocky Mountain region, when first broken, would seem to possess abundantly all the essential foods required by alfalfa; hence, for a time, at least, it is not necessary to enrich these before sowing the seed. The sandy and hungry gravelly soils, which are considerable in the South, in the Atlantic States, and in some of the Central and Northern States, should be

fertilized before laying them down to alfalfa. Such fertilization usually calls for both humus and readily available plant food, and these are most cheaply supplied by growing certain green crops and plowing them under, or by applying farmyard manure. These may be supplemented when necessary by commercial fertilizers. Some precede alfalfa on such soils by growing cow peas or soy beans, followed by crimson clover, both crops being plowed in, and shortly before sowing the alfalfa they apply more or less of phosphoric acid and potash, which is usually incorporated in the surface soil by the harrow. On some soils, as in some parts of Florida, two successive crops of cow peas should be plowed under before sowing alfalfa. When farmyard manure can be used in fertilizing those leechy soils it is well when it can be applied on the surface in a somewhat decomposed form and also kept near the surface during the subsequent cultivation given when preparing the seed-bed. In the North it is best applied in the autumn or winter, and in the South in the summer. But on loam soils with a reasonably retentive subsoil, the better way to apply farmyard manure is to make a heavy application of the same to the crop preceding the alfalfa. It has thus become incorporated with the soil, and many weed seeds in it will have sprouted before sowing the alfalfa. The results from applying manure on soil somewhat stiff and not highly productive have been noticeably marked. This may have been owing in part to the mechanical influence of the manure on the land. The relation between the free application of farmyard

manure and abundant growth in alfalfa is so marked in all, or nearly all, soils west of the Mississippi River that in many instances better crops will be obtained from poor soils well manured than from good soils unmanured. The relation between abundant manuring and soil inoculation is worthy of more careful study, in the judgment of the author, than has yet been accorded to it.

Fine pulverization of the surface soil is advantageous when sowing alfalfa, because of the influence which it has upon the retention of moisture near the surface, and upon the exclusion from the soil of an overabundance of light. It is in clay soils, of course, that this condition is most difficult to secure. The agencies in securing it are the cultivator, the harrow and the roller, and in many instances the influences of weather, after the land has been plowed, especially when plowed in the autumn prior to spring seeding.

Moistness in the seed-bed sufficient to promptly sprout the seed is a prime essential, but it is very much more important where the seasons are dry than where the lack of rain is but little feared. When the seed is sown after summerfallow or cultivated crops, it is usually considered preferable to make the seed-bed without using the plow, but to this there may be some exceptions. If sowing is deferred for a few weeks in the spring on such lands, or on other lands autumn plowed or early spring plowed, a free use of the harrow ought to be made in the interval, because of the favorable influence which this will have on the retention of moisture. In preparing

some soils for autumn sowing after a grain crop, as in some parts of Nebraska and Kansas, it is only necessary to use the harrow; in preparing others the disk and harrow; and in yet others the disk and harrow and roller. In preparing other soils, as the clays of the South, it may be necessary first to plow and subsoil, and subsequently to use sufficiently the harrow and roller.

Evenness in the soil on the surface is important when it is so retentive that water may collect in the depressions after heavy rain. In such places the plants are much liable to fail, especially in the early winter, or even shortly after they may have begun to grow, if moisture is excessive. In order to smooth and even the land sufficiently, it may be necessary to run over it some form of leveller. This does not mean, however, that it will not be necessary sometimes to plow the land in ridges, or "lands," as they are sometimes called, but it does mean that the slope from the center of the lands toward the furrows shall be even and gradual, in order that an excess of surface water, as in rainy climates, shall be carried away by the latter.

Firmness in the seed-bed is necessary chiefly to prevent too much drying out near the surface in dry weather, and the holding of too much water in the spaces between the particles near the surface in wet weather, followed by freezing of the soil. The less deep the stirring of the cultivated portion when preparing it, the longer the interval between such stirring and the sowing of the seed, and the heavier the pressure when rolling, the more firm will the

seed-bed be. The deeper the land is plowed, therefore, the longer should be the interval before it is sowed, but ample rainfall will shorten this period. Firmness in the seed-bed is more important, relatively, in summer or early autumn when evaporation from the surface soil is the most rapid. On some soils of the Middle States which border on the Mississippi, the early sown autumn crop will sometimes perish after the plants have grown some distance above the ground, because of want of firmness in the soil; hence, in such locations harrowing the surface of the ground thoroughly may sometimes be a more suitable preparation than plowing and harrowing.

Friability in the seed-bed is important when the soils are heavy. The influences which promote it are the presence of humus, liberal cultivation, and sometimes weather influences, as rain and frost. Unless heavy clay soils are brought into this condition, the roots of the alfalfa will not be able to penetrate the soil quickly enough or deeply enough in search of food.

As has been intimated, it will not avail to sow alfalfa in soils not sufficiently drained naturally or otherwise. Usually, good alfalfa soils have sufficient drainage naturally, the subsoil being sufficiently open to admit of the percolation of water down into the subsoil with sufficient quickness. But good crops of alfalfa may be grown on subsoils so retentive that underdrainage is necessary to facilitate the escape of an excess of moisture with sufficient quickness. The question has been raised as to

whether the roots of the plants will be much liable to enter and choke the drains at the joints between the tiles. While it would not be safe to say that this would never happen, it is not likely to happen, owing to the character of the root growth. Where too much water is held near the surface, in climates characterized by alternate freezing and thawing in winter, the young plants will certainly be thrown out through the heaving of the soil.

The subsoiling of lands not sufficiently open below will be greatly helpful to the growth of alfalfa. This may also be true of lands not over-retentive naturally, but made so by the treading of the animals for successive years on the soil under the furrow when plowing the land. In some conditions, without subsoiling thus, the growing of alfalfa will not be successful, but in doing this work, care should be taken not to bring up raw subsoil to the surface. In subsoiling for alfalfa, usually the more deeply the ground can be stirred by the subsoiler, the better will be the results that will follow. Subsoiling is particularly helpful to the growing of alfalfa on many of the clay soils of the South.

In the far West, toward the mountains, and probably within the same, are areas in which excellent stands of alfalfa may be obtained by simply sowing the seed on surfaces stirred with a disk or with a heavy harrow weighted while it is being driven over the land. The implements should be driven first one way and then the other, and, of course, the seed is harrowed after it has been sown. Where the soil is sufficiently level, this plan of preparing will prove

satisfactory, more especially where water can be put upon the land, but it will also succeed frequently in the absence of irrigating waters. In some instances the disking and sowing are both done by the same implement, which is driven both ways across the field.

Alfalfa is sometimes sown, and with profit, on steep hill sides which are inclined to wash. When set on these it tends to prevent the washing of the land. In such situations it is better to sow with a nurse crop, which will help to hold the soil until the alfalfa becomes rooted. Where land is so loose as to blow and irrigation cannot be practiced, only as much should be sown each season as can be covered with stable litter and well-rotted straw drawn out at the proper season.

Sowing.—The best season for sowing alfalfa will depend upon such conditions as relate to soil, moisture and climate. On rather stiff clay soils, the other conditions being right, the most satisfactory results are obtained from sowing the seed in the spring, and on land that has been plowed in the autumn and exposed to the mellowing influences of winter. But to this there may be some exceptions. On lands so light as to lift with the wind, that season should be avoided in sowing, if possible, when lifting winds prevail. Such winds are common in some localities in the spring, and may uncover the seed in some places and bury it too deeply in others.

Where moisture is deficient the seed must be sown at those times when it is most plentiful. This may be in the autumn, but more commonly it is in the

quite early spring. In some of the mountain States the best results have been obtained under semi-arid conditions from sowing the seed in the late autumn, so that it would be ready for germination at the first commencement of the period of growth in the spring. Under some conditions the too dry character of the weather may preclude the sowing of alfalfa in the summer and autumn months. Where moisture is plentiful all the season of growth, alfalfa may be sown almost any time, except the early spring or late autumn. Where irrigating waters are plentiful, the only hindrances to sowing alfalfa at any season of the year are such as may arise from climate. Far South in very mild areas it may be sown almost any time.

Where the temperatures are low in winter, the best results are obtained from sowing alfalfa in the spring and early summer, otherwise the plants do not become sufficiently well established to withstand the rigors of the winter following. Under some conditions, sufficiently satisfactory results follow sowing in the early summer, even in Northern latitudes. Where the winters are sufficiently mild and the moisture is sufficiently plentiful, early autumn sowing, as in August or September, according to the locality, is, all things considered, the most satisfactory, for the reason, first, that it follows, or may follow, a crop grown the same season; second, that the plants are less hindered in their growth by weeds when they are young; and third, that they produce crops of soiling food or hay the first season after sowing. Many weeds do not grow in autumn and

winter; hence, the less injury done by them to alfalfa plants, since the latter are so strong by spring that they overshadow the weeds in their effort to grow. When alfalfa is sown at such a time, the growth of one year virtually is gained by the process.

North of parallel 40° , that is, north of the latitude of Columbus, Ohio, and Denver, Colorado, speaking in a general way, alfalfa is more commonly sown in the spring, but not usually so early as clover, lest the young plants, which are more tender than clover plants, should be nipped by spring frosts. This danger is frequently present in the region of the upper Missouri. East of the Mississippi it may usually be advisable to sow in the spring some distance south from the latitude named. West from the same are areas where early autumn sowing is frequently the best. In much of the Southern and Southwestern States, early autumn sowing is considered better practice than spring sowing, but to this there are exceptions. Under some conditions alternate freezing and thawing of the land near the surface tend to throw out young plants, as, for instance, those autumn sown, more readily than plants from spring-sown seed.

Alfalfa is usually sown much the same as medium red clover (see page 75), but there are the following points of difference: 1. Since alfalfa is more commonly sown in dry areas, it is more important, relatively, that the seed shall be buried more uniformly and deeply in the soil in such areas. 2. Since it is liable to be more injured, relatively, by a nurse

crop than the clovers, it is more frequently sown without one. And 3. Since it is expected to furnish food for a much longer term of years than any of the clovers, it is relatively more important that the seed shall be sown with a view to seek a uniform and sufficient stand of the plants.

Whether the seed is sown by hand, or by any of the hand machines in use, the results will usually prove satisfactory, but in climates where moisture is deficient, decidedly better results are obtained from sowing the seed with some form of seed drill. A press drill is preferred in soils so light and open as to dry out easily or to lift easily with the wind. Under conditions of ample moisture, a light covering with a harrow will suffice, but under conditions the opposite, more covering is necessary. In areas where spring and early autumn showers are frequent, the roller will provide a sufficient covering, especially where the soils are well charged with a clay content. On other soils, as those which cover much of the prairie, the seed should be buried from 1 to 2 inches deep.

Where alfalfa is much sown on soils well supplied with humus, and on the soils which prevail in the Rocky Mountain region, many growers sow the seed with the grain drill, and before sowing they first mix the seed with some material, as earth, some kind of coarse meal, bran or other substance to make it feed out more regularly. In some instances one-half of the seed is sown the first time the drill is driven over the land, and the balance is sown by driving again over the same at right angles

to the drill marks previously made. When thus sown, the plants are more evenly distributed over the soil, and produce, it is thought, a more uniform quality of stalk. This method meets, in part, at least, the objection sometimes made to drill sowing, that it does not distribute the plants sufficiently in the soil.

In the Northern and Atlantic States, also west of the Cascade Mountains, and in some parts of the South, alfalfa is frequently sown with a nurse crop, and under favorable conditions the results are usually satisfactory, if the nurse crop is not sown too thickly. The best nurse crops in the areas named are barley and winter rye, but oats will answer also, if sown thinly and cut for hay. It has also been sown quite successfully along with winter wheat in the spring and also with spring wheat. When sown with winter wheat or winter rye, it is usually advantageous to cover the seed well with the harrow. In many instances, however, even in these areas, it is thought better to sow the seed without a nurse crop, in order that the plants may have all the benefit from moisture and sunlight which it is possible to give them. This is specially desirable when the fear is present that they may succumb the first winter to the severity of the weather. As weeds grow rapidly along with the plants, the mower should be run over the field from one to three times during the season. If the mowing is done at the proper time, it will not be necessary to remove what has been cut off by the mower. It may be allowed to lie as a mulch on the land. But should the growth of

weeds be excessive before the mowing is done, it would then be necessary to remove them, in order to avoid smothering the plants. The clipping back of the alfalfa plants is helpful, rather than hurtful. When not thus clipped back the leaves frequently assume a yellowish tint on the top of the plants, which gradually extends downward until the greater portion of the leaves may be thus affected. Such a condition frequently betokens a lack of nitrogen, but it may also be induced by other causes. When it does appear, the mower should at once be used and also as often as it appears. As soon as mowed off the plants usually stool out, sending up fresh shoots more numerous. They thus form a crown, somewhat like the crown in clover plants. Root growth is also strengthened, and the plants are thus made much stronger for going into the winter. Each clipping during the season, of course, cuts down weeds and prevents them from making seed. If not thus clipped, they would frequently injure the crop more by shade and crowding than would a nurse crop. The mulch thus made through clipping back the plants is in many instances quite helpful to them, because of the check which it gives to the escape of ground moisture. There is some difference in the view held as to whether close clipping is preferable, but the balance of authority is in favor of reasonably close clipping.

Alfalfa is usually sown alone, but in some instances it may be advantageous to sow more or less of some other kind or kinds of grass or clover along with it. When grown for hay it is usually preferable to

sow the seed without admixture. But there may be instances in which medium red or alsike clover may improve the crop the first year or two that it is mown for hay. But where red clover grows much more vigorously than alfalfa the first season, it should not be thus sown in any considerable quantities, or the clover plants will injure the alfalfa plants by crowding and overshadowing. Nevertheless, alfalfa may frequently with profit form a considerable factor in clover grown as pasture.

Where the main purpose of sowing alfalfa is to provide pasture, various grasses and clovers may be sown along with it, and in varying quantities, according to the attendant conditions. The choice of the variety or varieties to sow along with the alfalfa should be based on the needs of the stock to be pastured, and on the degree of the vigor with which these grow and maintain themselves in the locality. In the Northern States and Eastern Canada timothy and Russian brome grass (*Bromus inermis*) may be chosen. In areas with Southern Illinois as a center, red top and timothy should be satisfactory. In the Southern States, the claims of orchard grass and tall oat grass would probably be paramount. In areas with Iowa as a center, nothing would be more suitable, probably, than Russian brome grass. In the mountain States, with Wyoming as a center, timothy and alsike clover would be suitable. In the dry upland country in Washington and Oregon, Russian brome grass or tall oat grass would answer the purpose. In many areas the plan of sowing clover chiefly with the

alfalfa is a good one, providing the alfalfa is cut for a year or two, and is then grazed, as by that time grasses indigenous to the locality, or which grow well in the same, come in to such an extent as to form a very considerable proportion of the pasture. Blue grass frequently behaves thus in the North, and crab grass in the South.

The amounts of seed to sow will vary with the character of the soil and climate, with the use that is to be made of the alfalfa, and with the manner in which it is sown. On soils and in climates quite favorable to the growth of alfalfa it is common to sow more seed than in those with less adaptation, and with a view, probably, to check coarseness in the growth of the stems. If sown thinly in such areas, the rank growth which follows would be coarse. This explains why in the Western and mountain States more seed is usually sown than in the Eastern and Northern States. Averaging the whole country, 20 pounds of seed per acre is more frequently mentioned as the proper amount to sow than any other quantity. In the Northern States many growers sow 15 pounds per acre, and judging by the yield obtained, this amount of seed has proved satisfactory. Some growers even mention 10 to 12 pounds as satisfactory. The amounts last named are certainly too small for average conditions. Fifteen to 20 pounds may be fixed upon as the proper amounts to sow on soil in good condition for speedy germination. But many growers claim satisfactory results from sowing larger amounts of seed than those named. Under semi-arid conditions,

where irrigation cannot be given, a moderate amount of seed will be more satisfactory than very thick seeding, as when sown too thickly the plants would suffer more from want of moisture than if sown more thinly. The aim should be to obtain a stand that will cover the ground evenly and as thickly as will admit of the vigorous growing of the plants. Because of the relatively long duration of the period of the growth of alfalfa fields, it is specially important that good stands shall be obtained at the first, and for the further reason that the plants will then be better able to contend with intruding weeds, the great bane of alfalfa meadows.

When alfalfa is grown mainly for seed, it should be more thinly sown than when it is grown for hay or soiling food. It has been noticed that when the plants stand thickly beyond a certain degree, they do not seed well. Twelve to 16 pounds have been mentioned as quite enough to sow for such production in the mountain States. Where both objects are important, medium thick sowing would be the most suitable.

When sown in combinations such as have been named above, it will be necessary to modify somewhat the amounts of alfalfa seed sown, according to the proportion of the other seeds sown with the alfalfa. But since many grasses are more aggressive than alfalfa, it is not necessary to reduce the amount of alfalfa seed sown proportionately to the amounts of the other seeds that may be sown along with it. In many instances it may be proper not to reduce the amount of the alfalfa seed at all, as

some of these grasses will soon crowd the alfalfa plants, to their injury, even though the usual amount of seed should be sown. The amount of the grasses sown with the alfalfa will, of course, vary. It will seldom be necessary in any instance to sow more than 6 or 7 pounds per acre, and under many conditions not more than 5 pounds. When alfalfa is sown with timothy and clover in temporary meadows or pastures, it is seldom necessary to sow more than 3 to 5 pounds per acre, and the same is true of it when sown in a permanent pasture. The crop is so little grown for hay in mixtures, that it is scarcely necessary to dwell upon the nature of these, or the respective amounts of seed to sow in making them.

When alfalfa is sown with the grain, there will be a saving of seed to the extent of at least 20 per cent., as compared with broadcast sowing. This arises from the more general sprouting of all the seeds, since they are planted at a more uniform depth, and from the subsequent loss of a smaller percentage of the plants through drought, and it may be other causes. But when sowing broadcast, it will in many instances prove more satisfactory to add 20 per cent. to the amounts mentioned above, as suitable for being sown without admixture with other grasses and clovers, rather than to deduct 20 per cent. from these amounts when sowing the seed with the drill.

Cultivating. —Under some conditions, it is, in a sense, necessary to sow alfalfa in rows, and to give it cultivation during the first season and sometimes

for a longer period. In some parts of Florida, for instance, the most satisfactory results have been obtained from sowing in rows with 12 to 24 inches between the rows, and then to cultivate between these as may be necessary to keep down the growth of weeds. Under some conditions also in the Atlantic States, the most satisfactory results have been obtained from sowing alfalfa in rows 14 to 16 inches apart and cultivating between them. Even hand hoeing the first season may be justifiable along the line of the rows for small areas, but with the price of labor as at present, would be too costly for large areas. When grown in rows as indicated in the Atlantic States and westward from these, the yields of seed have been more satisfactory than when sown broadcast, but the crop is less satisfactory for hay, owing to the coarse and uneven character of the stems. The amounts of seed wanted for such sowing will, of course, vary chiefly with the distance between the rows. As small an amount as 6 pounds or even less will in some instances suffice per acre.

Pasturing.—The practice of pasturing alfalfa the first season, especially where it cannot be irrigated, is usually condemned, lest it should weaken the plants unduly for entering the winter. It would seem probable, however, that under some conditions such grazing would be helpful rather than hurtful. The cropping of the plants by stock, in the influence which it exerts upon the plants, is akin to that which arises from cutting them back frequently during the summer. The animals thus grazed will also crop down weeds. This, at least, is true of sheep. The

author has succeeded in getting a good stand of alfalfa by sowing seed at the rate of 15 pounds per acre, along with 2 to 4 pounds of Dwarf Essex rape seed, and grazing the same with sheep. Other growers, during recent years, have succeeded similarly. The grazing should not begin until the plants have made a good start, but it should not be deferred so long that the rape and the weeds will unduly shade the alfalfa plants. The pasturing should not be too close, nor should it be so long continued that the alfalfa plants will not be able to provide a good growth in the early autumn before the advent of winter.

The management of the spring-sown crop the first season requires careful attention in areas where the hazard exists in any considerable degree that the plants may take serious harm at that season, or, indeed, fail altogether. In Western areas, from Canada to Kentucky and Missouri, it is important that the stubbles of the grain shall be cut high, amid which alfalfa grows when it is sown with a nurse crop. When not thus sown, it is of prime importance that the plants shall stand up several inches above the surface of the ground before the advent of winter. This is specially important in States west of the Mississippi River. The objects effected are three-fold. First, the snow is arrested and held for the protection of the plants, and to furnish them with moisture when the snow melts. The extent to which the stubbles and the erect young alfalfa plants will hold snow is simply surprising. On the exposed prairies, the snow usually drifts so com-

pletely from unprotected lands, that during almost any winter a large proportion of the area will be quite bare. The melting of the snow thus held is also of much value to the crop in the moisture which it brings to it, especially in areas where the rainfall is less than normal. Second, the plants are thus protected from the sweep of the cold winds which blow so much of the season in the unprotected prairie, and which are frequently fatal to various winter crops. Third, they are also protected from the intensity of the frost, which may in some instances kill young alfalfa plants in areas northward.

In the Northern States east of Minnesota, the New England States, and the provinces of Canada east of Lake Huron, the considerable covering on the ground is not so important, relatively, to protect the plants against the coming winter, but it is also of considerable importance, as sometimes the early snows melt so completely that the fields are left bare in midwinter. The warm temperatures which melt the snow may be followed by a cold wave, which may be greatly injurious to the plants. There may be instances, as where the snow usually falls very deeply, in which the covering left would prove excessive, and so tend to smother the plants; hence, sometimes it may be necessary to guard against too much covering.

If the plants should lack age or vigor on entering the first winter, a top-dressing of farmyard manure will render great service in protecting them. This, however, is only practicable with comparatively limited areas. It is sometimes practiced in the

North Atlantic States, where the manure thus applied will prove greatly helpful to the growth of the alfalfa during the following season. These precautions to guard against the severity of winter weather are not nearly so necessary in the Rocky Mountain States where irrigation is practiced. In these, alfalfa spring sown is sometimes pastured during the following winter, and without any great harm to the crop. Thus greatly do conditions vary.

It may also be well to remember that where rainfall is usually plentiful and sometimes excessive, that a better stand of the young plants can be obtained when the rainfall is moderate than when it is copious. Saturated ground is hurtful to the young plants. They will not grow properly under such conditions and are likely to assume a sickly appearance. Mildew may appear and the plants may fail in patches. And this may happen on land which will ordinarily produce reasonably good crops of alfalfa after they have once been established.

The value of alfalfa in providing pasture is more restricted than in providing hay. This arises in part from the injury which may come to the plants from grazing too closely at certain times, and in a greater degree from injury which may result to certain animals which may feed upon the plants, more especially cattle and sheep, through bloating, to which it frequently gives rise.

This plant is pre-eminently a pasture for swine. They may be grazed upon it with profit all the season, from spring until fall. No plant now grown in the United States will furnish so much grazing

from a given area in localities well adapted to its growth. Swine are very fond of it. Some growers do not feed any grain supplement to their swine when grazing on alfalfa, but it is generally believed that, under average conditions, it is wise to supplement the alfalfa pasture daily with a light feed of grain, carbonaceous in character, as of rye, corn or barley, and that this should be gradually increased with the advancement of the grazing season. One acre of alfalfa will provide pasture for 5 to 15 head of swine, through all the grazing season, dependent upon the degree of the favorable character of the conditions for growth in the alfalfa, the age of the swine, and the extent to which the pasture is supplemented with grain. But in some instances the area named will graze at least 15 hogs through all the growing season without a grain supplement.

Swine may be turned in to graze on alfalfa when well set, as soon as it begins to grow freely in the spring. It should be so managed that the grazing will be kept reasonably tender and succulent. For swine pasture the plants should never be allowed to reach the blossoming stage. This can be managed by running the field mower over the pasture occasionally when the stems are growing long and coarse. Close and prolonged grazing by swine will tend to shorten the period of the life of the alfalfa. The extent to which this result will follow will depend upon soil and climatic conditions and the closeness of the grazing. To avoid such a result and also to secure the utilization of the food to the ut-

most, some growers advocate cutting the alfalfa and feeding it to swine as soiling. The advisability of handling it thus will be dependent to some extent on the relative price of labor.

The best results, relatively, from growing alfalfa to provide pasture will be found in the Western valleys, where alfalfa grows with much vigor, and in certain areas of the South, where it grows freely and can be pastured during much of the year. In areas eminently adapted to the growth of clover, it is not so necessary to grow alfalfa for such a use. In Western areas, where Canada field peas are a success, and especially where artichokes are not hidden from swine by frost, pork can be grown very cheaply, and without the necessity of harvesting any very large portion of these crops, except through grazing them down by swine.

Such conditions would be highly favorable to the maintenance of health in the swine, and the quality of the pork made would be of the best. In some instances a small stack of Canada field peas is put up in the swine pasture that the swine may help themselves from the same the following year, as in rainless or nearly rainless climates, where such grain will keep long without injury.

Alfalfa furnishes excellent grazing for horses, more especially when they are not at work. Like other succulent pastures, it tends too much to induce laxness in the bowels with horses which graze it, without any dry fodder supplement. But it has high adaptation for providing pasture for brood mares, colts, and horses that are idle or

working but little. While it induces abundant milk production in brood mares, and induces quick and large growth in colts until matured, it is thought by some practical horsemen that horses grown chiefly on alfalfa have not the staying power and endurance of those, for instance, that are grazed chiefly on Kentucky blue grass and some other grasses. There is probably some truth in the surmise, and if so, the objection raised could be met by dividing the grazing either through alternating the same with other pastures or by growing some other grass or grasses along with the alfalfa.

The alfalfa furnishes excellent grazing for cattle, whether they are grown as stockers, are kept for milk producing, or are being fattened for beef. For the two purposes first named it has high excellence, and it will also produce good beef, but alfalfa grazing alone will not finish animals for the block quite so well without a grain supplement as with one. But the danger is usually present to a greater or less degree that cattle thus grazed may suffer from bloat, induced by eating the green alfalfa. This danger increases with the humidity of the atmosphere, with the succulence of the alfalfa, and with the degree of the moisture resting on it, as from dew or rain. This explains why in some sections the losses from this source are much greater than in others. It also explains why such losses are greater in some areas than in others. It is considered that grazing alfalfa with cattle in the mountain valleys is less hazardous than in areas East and Southeast, as the atmosphere is less humid, the danger from the

succulence can be better controlled by the amount of irrigating water supplied, and because of the infrequency of the rainfall. Nevertheless, the losses from bloat are sometimes severe in both cattle and sheep in the mountain States, notwithstanding that some seasons large herds are grazed upon alfalfa through the entire season without any loss.

Cattle grazed upon alfalfa may be so managed that the extent of this hazard will be very much lessened, if not entirely obviated, but with large herds some of the precautionary methods now to be submitted may not always be practicable. They should never be turned in to graze upon alfalfa when hungry. Some grazers adopt the plan of leaving them on the grazing continuously when once put in to graze. Others leave them in for a limited time each day at the first, increasing the duration of the pasturing period from day to day. After managing them thus for a week or two, the animals are only removed from the pasture for such purposes as milking. Others, again, feed some alfalfa or other food in the morning before turning them on to alfalfa pastures. Another plan adopted is to graze them on a field of other grazing, located, if possible, beside the alfalfa field, until after the dew has lifted, and then to open the gate into the alfalfa pasture. This is readily practicable with a herd of cows, but not to anything like the same extent with a large herd being grown for beef.

The danger from bloat in pasturing sheep upon alfalfa is at least as great as in pasturing cattle on the same, and the methods of managing them while

thus being grazed are not far different. So, too, the experiences in such grazing are very similar. The losses from such grazing some seasons have been slight. Other seasons they have proved so heavy as to make such grazing unprofitable. When sheep are being grazed on alfalfa, a light feed of grain given in the early morning reduces materially the danger from bloat. It also enables the flockmaster to finish his sheep or lambs for the market cheaply and in fine form, since this small grain factor, not necessarily more than half a pound a day, whether given as wheat, rye, barley, oats or corn, puts the ration practically in balance for the purpose named, and it may be given to the sheep daily in troughs without taking them out of the pasture.

It is thought that there is more danger to cattle and sheep from grazing on alfalfa than on any of the clovers, and probably such is the case. But whether this is true or not, the danger is very considerable, and is enhanced by the presence of frost as well as the presence of moisture, from much succulence in the plants, from rain and from dew. So great is the danger that the inexperienced should proceed with much caution in such grazing. When bloat does occur, the method of dealing with it is given on page 95.

The tendency to produce bloat in alfalfa pastures decreases with the extent to which other grasses are present in the pastures. Should alfalfa be grown, therefore, for the purpose of providing pasture, some other grass or grasses should be sown along with it. Which of these should be thus sown

ought to depend chiefly on the adaptation of the grasses for producing vigorous growth under the conditions present. In the States east of the Mississippi and north of the Ohio, and in all of Canada east from Lake Huron, alfalfa may be made an important feature in pastures variously composed. For instance, on suitable soils alfalfa may be made an important feature in pastures composed otherwise of medium red and alsike clover and timothy. The author can speak from experience as to the slightness of the danger from grazing cattle and sheep on such pastures. In the Southern States tall oat grass could be sown with the alfalfa, and probably orchard grass. In some areas alfalfa will maintain its hold on lands smitten with Johnson grass, both producing freely. In much of Kansas meadow fescue would answer the purpose, northward brome grass would probably answer, and in some places timothy. In Idaho and the States adjoining, tall oat grass, meadow fescue and orchard grass will all be helpful, and in some of the mountain States it has been found that when alsike clover is grown freely in alfalfa pastures, the tendency to bloat is not only lessened in the animals grazing, but the value of the pasture, especially for winter grazing, is greatly improved. Some grazers, especially in the mountain States, have adopted the plan of sowing other pastures, as wheat or barley, beside the alfalfa pastures, and these are made accessible at will to the animals that are being grazed. The plan has some commendable features, but grazing animals thus does not reduce the danger as much as when they are grazed on pas-

tures in which other grasses grow up amid alfalfa. In some of the Western States pure alfalfa meadows are grazed through successive seasons with but little loss, but in such instances the grazing began in the spring and was continuous. Judicious care should be exercised in grazing alfalfa lest the stand of the plants shall be injured. The liability to injury in the plants from injudicious grazing increases with the lack of adaptation in the soil and climate for abundant and prolonged growth in the alfalfa.

In a large majority of instances, as previously intimated, it is not wise to graze down alfalfa at all closely the season of sowing, and in some instances it should not then be grazed to any extent, lest the plants be unduly weakened for entering the winter. In cold areas the hazard is much greater from such grazing than in those that are mild, and likewise, it is greater when the growth is only moderately vigorous than in areas where alfalfa grows with the vigor of a weed, as in Western mountain valleys. In areas where the winters are cold, and especially where the snowfall is light and the winds have a wide sweep, the animals which graze upon alfalfa should be removed in time to allow the plants to grow up to the height of several inches before the advent of winter. The growth thus secured will catch and hold the snow, and the protection thus furnished is greatly helpful to the preservation and vigor of the plants. Experience has shown that in Northern areas pasturing alfalfa in winter, especially when the ground is bare and frozen, brings imminent hazard to the plants. On the other hand, grazing in winter

in the mountain valleys, when as far north as Central Montana, may be practiced with little or no hazard to the stand of plants when these have become well established. In such areas alfalfa may be grazed practically as may be desired, providing this grazing is not too close.

Cattle injure alfalfa less than other animals when they graze upon it, as they do not crop it too closely; swine injure it more, if the grazing is constant. Horses do even greater injury, through biting the crowns of the plants too closely; but sheep injure alfalfa pastures more than any of these animals, when the grazing is close, owing to the extent to which they trim off the leaves.

As Soiling Food. —For being fed as soiling food, alfalfa has the very highest adaptation, owing, 1. To the long period covered by the growth. 2. To the rapidity of the growth resulting in large relative production. 3. To the palatability of the green food produced. 4. To the entire safety to the animals fed. And 5. To its high feeding value. In Louisiana, for instance, alfalfa may be made to furnish soiling food for nine months in the year. In the North, of course, the duration of production is much less, but it is seldom less than five months. The growth is so rapid that cuttings for soiling food may usually be made at intervals of four to six weeks, according to season and climate; hence, the cuttings for soiling food will run all the way from two to eight or nine each season. It is so palatable that horses, mules, cattle, sheep and swine relish it highly. When wilted a little before being fed, the danger of pro-

ducing bloat is eliminated. Its feeding value is nearly the same as that of the medium red clover, thus making it in itself what may be termed a balanced or perfect food for horses, mules, cattle and sheep until development is completed and subsequently when they are at rest; that is, when they are not producing, as in the form of labor or milk.

The highest use, probably, from feeding alfalfa when green will arise from feeding it to milch cows. Its high protein content in combination with its succulence pre-eminently adapts it to such a use. Wherever alfalfa can be grown and will produce even two cuttings a year, it will serve a good purpose in producing milk. Every dairyman dependent more or less on soiling food will find it to his advantage to grow alfalfa where it may be grown in good form. When fed to milch cows, some meal added, carbonaceous in character, as corn or non-saccharine sorghum seed, may prove a paying investment, and it may also be advisable to alternate the green alfalfa, morning or evening, with such other green crops as oats and peas, millet, rape, corn or sorghum when in season, to provide variety. But even though alfalfa alone should be thus made to supplement the pastures, the outcome should be at least fairly satisfactory. When fed to horses that are working, some care must be exercised in feeding it, lest too lax a condition of the bowels should be induced, and a grain factor should be fed at the same time. It has frequently been given to sheep that were being fitted for show purposes, but may also be fed green to the

entire flock, with a view to supplement the pastures. It has special adaptation for promoting large growth in lambs, and, indeed, in any kind of young stock to which it may be fed. When fed to swine, a small grain supplement properly chosen and fed will insure more satisfactory growth. It is thought that more satisfactory results will be obtained from allowing the alfalfa to get fairly well on toward the blossoming stage before beginning to feed, and to continue to feed until in full bloom. This in practice may not always be possible, but usually an approximation to it may be reached, especially when the production of the alfalfa will more than supply the needs in soiling food. The ideal plan is to commence cutting the alfalfa as soon as a good growth is made, cutting enough daily or every other day to supply the needs of the animals. If the growth becomes too much advanced before the field is gone over thus, the balance should be made into hay, and the cutting should begin again where it began previously.

There is no question but that considerably more food can be obtained from a given area when green alfalfa is fed in the soiling form, instead of being grazed. The difference in such production would not be easy to determine, but of the fact stated there cannot be any doubt. Ordinarily, each cutting of green alfalfa for soiling should not produce less than 4 tons; hence, where 8 cuttings can be secured, not fewer than 32 tons of soiling food could be obtained per season. But whether the increase from soiling alfalfa, as compared with pasturing the

same, would repay the cost of the extra labor, will depend upon conditions that vary with time and place. Alfalfa fields thus managed or cut for hay will also produce for a longer period than when the fields are grazed.

Continuity in the production of soiling food may not be possible some seasons in the absence of irrigation; hence, under such conditions provision should always be made for a supply of such other soiling foods as may be needed, and of a character that will make it practical to turn them into dry fodder when not wanted as soiling food. But where irrigating waters are unfailing, it is quite possible to furnish soiling food from alfalfa soils through practically all the growing season. Dairymen thus located are in a dairyman's paradise.

Alfalfa, like clover, may be made into silage. In dry climates this would seem to be unnecessary, but in rainy climates it may be wise in some instances to make alfalfa ensilage, the better to insure the curing of the crop. What has been said with reference to clover ensilage will apply almost equally to alfalfa. (See page 103.) It would be more desirable, usually, to make the first cutting from alfalfa into ensilage than later cuttings, because of the showery character of the weather at that season, but the strong objection stands in the way of doing so, that no carbonaceous food, as corn, sorghum or soy beans, is ready for going into the silo then as they are later, with a view of aiding in the better preservation of the ensilage and of making a better balanced ration. Good alfalfa silage is more easily

made when the alfalfa has been run through a cutting-box than when in the uncut forms.

Harvesting for Hay.—The best time to harvest alfalfa for hay is just after the blossoms begin to appear. Ordinarily, not more than one-third of the blossoms are out when the harvesting should begin, but when the hay is to be fed to horses the cutting may be deferred until more than half the blooms are out. If cut earlier, the loss of weight in the crop will be considerable, as much as 30 to 45 per cent., as compared with cutting when in full bloom. If cut later, the stems become over-woody, and the loss of leaves in curing will be much greater. When the cutting is delayed beyond the period of early bloom, the growth of the next cutting is retarded, and when it is deferred until some of the leaves turn yellow or until some seed is formed, in many situations the influence on the succeeding crop is seriously adverse, and in some instances this influence would seem to react against the vigorous growth of the plant during the remainder of the season. In other instances, as where the conditions are quite favorable to the growth of the plant, these results are not present in so marked a degree. When large areas of alfalfa are to be harvested, the importance of beginning early cannot easily be overestimated. It would be much better to sacrifice something in loss of weight in the hay, through cutting too early, than to meet with greater loss in weight in the next crop or crops by cutting too long deferred.

1. Much that has been said about the harvesting of



Fig. 4. Field of Alfalfa in California

medium red clover will apply equally to alfalfa. (See page 95.) The mowing should begin as soon as the dew has lifted in the morning. The tedder should follow after the hay has wilted somewhat, and later, the horse rake, the aim being to get the crop made into winrows, preferably small, before nightfall, and when the weather is uncertain, the aim should be also to put the hay up into small cocks the same evening. This may not always be practicable. If the loss of leaves is likely to be considerable when raking the hay, raking should be deferred until the influence of evening dews begins to be felt. After the hay has become wilted it should not be stirred or handled any more than is really necessary, that loss of leaves and of the tips of the stems and branches may be avoided, and the handling during the curing process should be done to the greatest extent practicable before or after the sunshine has waxed strong. In showery weather, when small areas are being harvested, hay caps can be used with profit. Where large areas are to be harvested and where there is no danger of rain, the crop when nicely wilted is drawn into winrows, and in these the curing is completed without further stirring or handling. From the winrows it is drawn usually on rakes of a certain make, and the rake loads thus slid over the ground are lifted bodily onto the stack by the use of the "rickers." (See page 100.)

Storing.—When cured in cocks, these are preferably made small to facilitate quick curing, but usually from two to four days are necessary to com-

plete the curing. If the cocks require opening out before being drawn, the work should be done with care. Ordinary stacking and storing may be done in practically the same way as in handling medium red clover, and the same care is necessary in protecting the stacks. In areas where considerable rain falls in the autumn, hay sheds will prove a great convenience in storing alfalfa in the absence of better facilities. In the Eastern States alfalfa is sometimes stored in mows undercured, by putting it into the mow in alternate layers with straw. The straw not only aids in preserving the alfalfa in good condition, but the alfalfa imparts an aroma to the straw which induces live stock to eat it readily. In showery weather this method of curing alfalfa merits careful attention where straw can be had near at hand and in sufficient quantities.

The method is sometimes adopted of cutting alfalfa even for hay by using the self-rake reaper. The sheaves thus made are allowed to lie on the ground undisturbed until they are ready for being drawn. By this method of cutting, the loss of leaves is almost entirely avoided, but there are these objections to it: that it exposes unduly to sunlight during the curing process, and in case of rain the sheaves are easily saturated and do not dry readily unless turned over.

Rain falling on alfalfa will injure it quite as much as it does red clover. (See page 96.) In climates with much rainfall in May or June, when the first cutting of alfalfa is ready for being harvested, according to locality, in instances not a few much diffi-

culty is found in curing alfalfa without loss. Sometimes the entire cutting will be rendered practically useless by rain. Because of this, as previously intimated, it may be well to arrange, where practicable, to cut the first crop of the season for soiling food.

The number of cuttings during the year depends on such conditions as relate to the length of the season, the character of the soil, the abundance of moisture present, and the use to which the alfalfa is put. In some of the river bottoms southward in the Rocky Mountains, where irrigating waters are plentiful, it is claimed that alfalfa may be made to furnish one cutting for soiling food every month in the year. Even in the Northern western valleys, as many as five or six cuttings for the use named may be obtained. North from the Ohio and Potomac rivers three to five cuttings of soiling food may be looked for each season, and south of these rivers even a larger number. North of the same rivers the hay crops run from two to four, and southward from the same they are seldom less than three. In the western valleys they range from three to five or six, according to location. In States bordering on the semi-arid States eastward and some distance south of the Canadian boundary, from three to four cuttings may usually be expected. In Colorado and States north and south from the same, two good crops of alfalfa may be cut from spring-sown seed the same season, but where irrigation is not practiced it is seldom that one crop of hay is harvested under similar conditions of sowing. But in the semi-arid belt not more than one cutting is usually

obtained each season in the absence of water. But the number of cuttings will be reduced when one of these is a seed crop. When a seed crop is taken, the vitality of the plants is apparently so much reduced for the season that the subsequent growth is much less vigorous than if seed had not been thus taken.

The yield of hay from each cutting will, of course, vary much with conditions, but it is seldom less than a ton. An approximate average would place the average cutting at about $1\frac{1}{4}$ tons, but as much as 2 tons have been obtained per acre at a cutting, and, again, not more than $\frac{1}{2}$ ton. In New Jersey an average of 4.57 tons per acre was obtained under good conditions of management, but without irrigation, at the experiment station for three years in succession. In Kansas, 4 to 6 tons per acre may usually be expected from good soils. In Tulare County, California, as much as 6 to 10 tons have been secured under irrigation.

The yields from the various cuttings are by no means uniform, especially in the absence of irrigation. They are much influenced by rainfall. In such areas, the second cutting is usually the best for the season, the subsequent cuttings being considerably less. Where irrigation is practiced, the crops are much more uniform, but even in mild climates, as the season advances, there is a tendency to lesser yields, indicative of the necessity of at least partial rest for plants during a portion of the year. The yields of alfalfa are usually exceeded by those of no other crop, where the conditions are quite favorable to its growth, even in the absence of irrigation.

At the New Jersey Experiment Station, as stated in Bulletin No. 148, one acre of alfalfa produced 36,540 pounds of green food; of corn, 24,000; of red clover, 14,000; of crimson clover, 14,000; of millet, 16,000; of cow peas, 16,000; and of oats and peas, 14,000 pounds. But where only two, or even three, cuttings can be obtained per year, some crops may produce larger yields than alfalfa. In the distinctive alfalfa belt in the West, no forage crop can be grown that will compare with it in the yields obtained. The protein in alfalfa is also relatively high. At the station quoted above it was found one ton of alfalfa contained 265 pounds of protein; hence, its high relative value as a food; red clover, 246 pounds; timothy, 118 pounds; and wheat bran, 118 pounds. At the Delaware Experiment Station, in Bulletin No. 55, it is stated that maximum crops of cow peas and of crimson clover gave 720 pounds of protein, while a maximum crop of alfalfa gave 1230 pounds.

Where alfalfa is irrigated, it is usual to apply irrigating waters just after each cutting of the crop. It is a matter of some importance that the water shall be applied at once as soon as the previous crop has been harvested, otherwise time will be lost in growing the next crop. There are instances where it is necessary to apply water before the first crop is grown, but usually the moisture which falls in the winter and spring will suffice to produce the first crop of the season. Some irrigators apply water some time previous to harvesting the crop, but not so late as to leave the ground in a soft con-

dition when mowing is begun. The amount of water required will vary with the soil, the season of the year, the distance of the ground water from the surface, and the precipitation. The more porous the soil and subsoil, the hotter the weather, the less the precipitation and the farther below the surface, up to a certain limit, the greater will be the amount of water needed. There are situations, as in some of the islands in the Yellowstone River, in which ground water is so near the surface that alfalfa grown on these is able to get enough of water from this subterranean source to produce good crops. Care should be taken not to apply water in excess of the needs of the crop, or the yields will be proportionately reduced. The amounts that will best serve the end sought can only be ascertained by actual test. Caution is also necessary where the winters are cold not to apply water late or in excessive quantities, lest a sappy condition of the plants shall be induced, which will make them succumb to the cold of the winter following. Moreover, on some soils alfalfa fields will produce good crops, if irrigated only the first season, until the roots get down to moisture, the irrigating waters being utilized when more needed.

Alfalfa hay is rec freely to all kinds of domestic animals on the farm, and with results that should prove highly satisfactory. Properly fed, it is an excellent food for horses and mules. It not only serves to maintain flesh, but it is favorable to glossiness in the coat. Horses that are working hard should be accustomed to it gradually. When it is

fed to them too freely at the first, it induces too much of a laxity in the bowels, too free urination, and profuse sweating. When fed to such horses or mules, some authorities claim that several weeks should be covered in getting them on to what is termed a "full feed" of alfalfa. When fed to milch cows, free lactation results. Alfalfa fine in character is now manufactured into food suitable for calves and other young stock. Cattle and sheep are now fattened for slaughter on alfalfa hay fed alone, but when thus fattened the finish made is not equal to that resulting from adding grain to the alfalfa. To meet the needs of the best markets, alfalfa alone does not produce enough of fat or of firmness in the flesh, but it has been claimed, and probably it is true, that one-half the amount of grain required for finishing along with carbonaceous fodder, such as corn stalks or timothy, will give equally good and quick increase when fed with alfalfa hay. It is most excellent fodder on which to grow cattle and sheep, even in the absence of a grain supplement. The later cuttings of the season are thought to be the most suitable for calves and also for sheep and lambs, because of the greater fineness of the fodder and the greater abundance of leaves on it. Alfalfa hay is used with much advantage in wintering swine, especially brood sows. Swine have been wintered on alfalfa hay without any grain supplement where the winters are mild, but they will fare much better with a grain supplement. It is thought that half the usual amount of grain fed will produce equal results when

fed with alfalfa, to those obtained from feeding a full allowance of grain in its absence. Alfalfa and sorghum properly grown make an excellent food for swine, and the two may be profitably fed thus where the conditions may be over-dry for corn, but not for sorghum. When feeding alfalfa, the aim should be to use it in conjunction with a carbonaceous food, as corn. Fortunate is the country which grows good crops of corn and alfalfa.

Securing Seed. —Localities differ much in their capacity to produce alfalfa seed. The best crops of seed are now grown west and southwest of the Mississippi River. Certain areas in the semi-arid country east of and between the ranges of the Western mountains seem to have special adaptation for growing seed. At the present time the greatest seed-producing States are Kansas, Colorado, Utah, Arizona and California. But in some areas east of that river paying crops can be grown. It has also been noticed that when the crop is sown less thickly than it is usually sown for hay, the plants seed more freely, when sown with sufficient distance between the rows to admit of cultivating the crop, and when such cultivation is given, the influence on seed production is also markedly favorable; such treatment given to the varieties of recent introduction may possibly result in the production of seed from the same, notwithstanding that they bear seed very shyly when grown in the ordinary way.

Nearly all the seed now grown in the United States is produced by fields that have been sown in the usual way, and primarily to produce hay, but in

some areas, especially where irrigation is practiced, it is sometimes grown mainly for seed. On the irrigated lands of the West it is customary to grow the first cutting of the season for hay and the second for seed. But in many instances the second cutting also is made into hay, and the seed is taken from the third cutting; even in the States east of the Mississippi, and also in Ontario and Quebec, seed is usually taken from the second cutting. But in Montana, Washington and Idaho, on the higher altitudes, seed is not unfrequently taken from the first cutting for the season, since, in the short season for growth of those uplands, seed from cuttings later than the first does not always mature so well. In a large majority of instances seed does not form so profusely from plants of the first cutting as from those of later growths. This is thought to arise, in part, at least, from the fact that bees, and it may be other insects, are then less active in searching for food, and because of this do not aid in the fertilization of the plants as they do later. Nor does seed of the first cutting ripen so evenly. An important justification is also found for taking seed from the later cuttings, in the fact that when a crop has produced seed, it grows less vigorously during the subsequent period of growth that same season. So pronounced is this habit of growth in alfalfa, that in many localities, if the first growth is allowed to produce seed, but little subsequent growth will be made again the same season. The second cutting, all things considered, is the most favorable to seed production, as, unless on irrigated lands, the third cut-

ting is not usually possessed of that vigor necessary to induce abundant seeding in the plants.

The yields of seed are also much influenced by moisture. An excess of moisture is more unfavorable to the production of seed than a shortage in the same. Hence, in areas where the rainfall for the season is very abundant, but little seed will be produced. Where irrigation is practiced, the excessive application of water would have a similar effect, though less pronounced in degree; hence, the apportionment of the water to the prospective needs of the seed crop calls for careful adjustment. Where the first crop is grown for seed, where irrigation is practiced, in many instances no water is applied until after the seed crop has been harvested.

The seed is ready for being harvested when a majority of the seed-pods assume a dark brown tint. The pods of later formation will still possess a yellow tint, and some of them may still possess the green color. These do not produce seed nearly equal in quality to the pods which ripen earlier. To wait for all the later maturing pods to ripen before harvesting the crop would mean the loss of much of the best seed through shattering. Another test of maturity is made by shelling the pods in the hand. When the seed can be thus shelled in a majority of the pods in a single plant, it is ready for being harvested. Alfalfa seed shatters easily; hence, it is important to harvest the seed crop with promptness when it is ready, to handle it with due carefulness, and in some instances to refrain from handling during the hottest hours of sunshine.

The seed crop is sometimes cut with the mower and raked into winrows, and in some instances put up into cocks. When it is handled thus, the aim should be to do the work, as far as this may be practicable, in the early and late hours of the day, but not, of course, while much dew is on the crop. Sometimes the seed is drawn from the winrows to the thresher; in other instances from the cocks, and in yet other instances it is stacked before being threshed, a work that calls for the exercise of much care in the storing of the crop, lest the seed should be injured by heating in the stack. This method of harvesting is usually attended with much loss of seed.

There is probably no better way of harvesting alfalfa than to cut it with the self-rake reaper or the binder. The loose sheaves dry quickly, and when lifted, the aim is to carry them directly to the thresher. Less seed, it is considered, will be lost in this way than by the other mode of harvesting given above, and the work is more expeditiously done. But owing to the difficulty in securing a thresher to thresh the seed, it is sometimes found necessary to stack the crop, but in areas where irrigation is practiced such stacking is seldom necessary.

The seed is frequently threshed with the ordinary threshing machine, but in many instances it is also threshed with a clover huller. The huller does the work less quickly, but probably, on the whole, more perfectly. Threshing machines, with or even without certain adjustments in the arrangement of the teeth in the cylinder and

concave, and with extra screens, are now doing the work with much despatch, and with a fair measure of satisfaction. But the opinion is held by competent judges that a machine that would more completely combine the qualities of the thresher and the huller would be still more satisfactory. It is easily possible to have the crop too dry to thresh in the best condition, and care should be taken to regulate the feed in threshing so that the alfalfa will not enter the cylinder in bunches. More than 200 bushels of seed have been threshed in a day from crops which yielded abundantly. The seed should be carefully winnowed before putting it on the market. The seed crops, as would naturally be expected, vary much; crops are harvested which run all the way from 1 to 20 bushels per acre. From irrigated lands the yields are, of course, much more uniform than from unirrigated lands, since in the former the supply of moisture may be controlled. Fair to good average yields on these may be stated at from 4 to 6 bushels, good yields at from 6 to 8 bushels per acre, and specially good yields at from 10 to 12 bushels. The bushel weighs 60 pounds. Growing alfalfa seed under irrigation has frequently proved very profitable. The seed grown in such areas is larger and more attractive to the eye than that ordinarily grown in the absence of irrigation, and because of this many are lured into sowing it on unirrigated land when the former would better serve their purpose. The seed is frequently adulterated with that of yellow clover (*Medicago lupulina*), which resembles it closely, but this is more

likely to be true of imported than of American grown seed.

Renewing.—Alfalfa may be renewed and also renovated where the stand secured at the first has been insufficient, where it may have been injured from various causes, where it is being crowded with weeds, and even with useful grasses, and where the land requires enriching.

The stand of alfalfa secured is sometimes thin and uneven. This may arise from such causes as sowing too little seed, whether over-dry or through the crowding of the young plants. When this happens, in many situations it is quite practicable to thicken the stand by disking the ground more or less, adding fresh seed, according to the need of the crop, and then covering the seed thus added with the harrow. Such renovation would be comparatively easy on clean land, were it not for fact that the alfalfa plants already rooted overshadow the young plants, always to their injury, and sometimes to their total destruction. The spring will probably be the best season to attempt such renovation, but there may be instances where the winters are not severe, in which autumn seeding will succeed as well or better than spring seeding. Because of the uncertainty of the results of such renovation, the aim should be so to prepare the land and sow the seed that a good, thick stand will be secured at the first.

Should the alfalfa fields be spotted, because in places the nurse crop lodged and smothered the plants, or because excessive moisture destroyed them on the lower portions of the field in an abnor-

mally wet season, the renewing process is simple indeed. It consists in disking those parts so thoroughly as to destroy all vegetation that may have become rooted on them, and sowing seed in the usual way without a nurse crop. But should the low places be such as to hold an excess of water at any time of the year under normal conditions for days in succession, even though it should not rise to the surface, the attempts to make alfalfa grow successfully on these will prove abortive.

When weeds and grasses crowd the crop, the plan of disking the fields to destroy these is becoming quite common, especially in the West. The work is usually done in the early spring. In doing it, disk harrows are driven over the field, usually two ways, the second disking being done at right angles to the first. The disks are set at that angle which will do the least injury to the plants, and that will at the same time do the work effectively. This can only be determined by actual test in each instance. Some of the crowns of the plants will be split open by the disk, which some authorities claim is an advantage in that it tends to an increase in the number of the stems produced, an opinion which is by no means held in common at the present time, and yet there are localities where it has certainly proved advantageous. Occasionally, a plant will be cut off. There can be no doubt, however, that such disking, when necessary, does tend to clean the land and also to strengthen growth in the alfalfa crop, on the principle that cultivation which does not seriously disturb growing plants is always helpful to

them. The frequency of such diskings will depend on the needs of the crop. Some advocate disking every spring, some every other spring, and some not at all. That plan which disks the ground only when it is necessary to keep the weeds at bay would seem to be the most sensible. This would mean that sometimes, as where crab grass has a firm hold, disking may be necessary at least for a time every spring. In other instances it would be necessary only every second or third season, and in yet other instances not at all. However, some growers in dry areas advocate disking frequently, as, for instance, after some of the cuttings of the hay, and with a view to retain moisture. It is at least questionable, however, if disking so frequently would not soon tend to thin the plants too much, to say nothing of the labor while the work is being done.

The idea of stirring the surface soil in alfalfa fields is by no means new. In England the plan prevailed to some extent years ago of harrowing the fields in the autumn with heavy harrows until, when the process was completed, they would take on the appearance of the bare fallow for a time. In the Eastern States and in some parts of Canada the harrow is used instead of the disk, but usually the latter will do the work more effectively and with less cost. Frequently, when the disk has been used on alfalfa, it may also be advantageous to run a light harrow over the ground to smoothen the surface.

With a view to renovate the crop and increase the yields, in some sections, as in the Atlantic States,

it has been recommended to top-dress alfalfa fields with farmyard manure every autumn. This, no doubt, would prove very effective, but it would also be very expensive, unless in the neighborhood of large cities. It would be impracticable without neglecting the needs of the other crops of the farm. In the mountain areas of the West, it has been found that the cost of fertilizing with farmyard manure is in the meantime greater than the increased production in the alfalfa is worth, but it may not be always thus, even on these rich lands. Some Eastern growers also apply more or less gypsum. This is generally sown over the fields after the crop has begun to grow in the spring.

Renovating alfalfa fields is much more easily and effectively done, as would naturally be expected, in areas where conditions are highly favorable to its growth than where these are only moderately favorable. In some of the mountain valleys instances have occurred in which alfalfa fields have been plowed and sown with oats, with a result, first that a good crop of oats was reaped, and second, that fairly good crops of alfalfa were harvested the following season without resowing the field.

Sources of Injury to Alfalfa.—Chief among the sources of injury to alfalfa, after the plants have become established, are frost in saturated ground, ice, floods, grasshoppers, gophers, dodder, and pasturing by live stock in the late autumn or winter. When it happens that two or three of these act in conjunction, the injury following is just so much more rapid and complete. As has been intimated,

where water is excessive, in a climate which in winter or spring is characterized by alternations of freezing and thawing, the plants will either have the roots snapped asunder, or they will be gradually raised out of the ground. This will only happen in soil with a subsoil more retentive than is compatible with well-doing of the highest order in the plants. The danger from this source is greatest during the first winter after sowing the plants, as then the roots are not really established. The only remedy for such a contingency is the draining of the land.

Some reference has also been made to injury done through ice, where it collects in low places in land. The destructiveness of the ice depends on its thickness and its nearness to the ground. When it rests upon the ground for any considerable time the plants die. If, however, water intervenes, the plants may live when the submergence is for a limited time. One instance is on record in Onondaga County in New York State, in which alfalfa survived submergence for a considerable period under a thin sheet of water covered by three inches of ice, but when growth came it was for a time less vigorous than normal.

Floods in warm weather are greatly injurious to alfalfa. The extent of the injury done increases with increase of depth in the waters of submergence, increase in stagnation in the waters, and increase in the duration of the period of overflow. Stagnant water sooner loses its dissolved nitrogen; hence, the plants cannot breathe normally. The

harm done, therefore, by floods in each case can only be known by waiting to see the results. These summer floods always harm the crops temporarily, and in many instance kill them outright. Occasional periods of overflow should not prevent the sowing of alfalfa on such lands, since on these it is usually not difficult to start a new crop, but the seed should not be sown on such lands when overflow occurs at such a season. When it occurs in cool weather and quickly subsides, it may be possible to grow paying crops of alfalfa.

In some areas grasshoppers are a real scourge in alfalfa fields. Because of the shade provided by the ground and the influence which this exerts in softening it, they are encouraged to deposit their eggs and remain so as to prove a source of trouble the following year. It has been found that through disking of the land both ways after sharp frosts have come is greatly effective in destroying the grasshopper eggs deposited in the soil. They are thus exposed to the action of the subsequent frosts and so perish. The disking has also tended to stimulate growth in the crop the following year. The eggs will not, of course, be all destroyed by such disking, but so large a percentage will, that the crop should be practically protected from serious injury, unless when grasshoppers come from elsewhere.

It would seem correct to say that gophers do more injury to alfalfa fields in certain areas of the West than comes to them from all other sources combined. They not only destroy the plants by feeding upon them, but they fill the soil with mounds, which

greatly interfere with the harvesting of the crops. They are destroyed by giving them poisoned food, trapping, shooting, and suffocating through the use of bisulphide of carbon. Poison is frequently administered by soaking grain in strychnine or dropping it on pieces of potato and putting the same in or near the burrows. Bisulphide of carbon is put upon a rag or other substance, which is put into the burrow and the opening closed.

Dodder is a parasitical plant introduced, probably, in seed from Europe, which feeds upon alfalfa plants, to their destruction. The seeds of alfalfa sometimes become so impregnated with the seeds of dodder that the latter will grow where the seed is sown, thus introducing it to new centers. The dodder starts in the soil and soon throws up its golden-colored thread-like stems, which reach out and fasten on the alfalfa plants that grow sufficiently near. The dodder then loses its hold upon the soil and gets its food entirely from the alfalfa plants, which it ultimately destroys. But since the seeds of the dodder remain at least for a time in the soil, and the adjacent soil becomes infected with them, the circles in which the dodder feeds continually widen. In certain parts of New York State some fields have become so seriously affected as to lead to investigations conducted through officials from the State experiment station. Pending these investigations, the exercise of great care in the purchase of seed and the immediate plowing of the infested areas are recommended.

Some reference has already been made to injuri-

ous results from pasturing close in the autumn or winter, except in the most favored alfalfa regions. In addition to what has been already said, the wisdom of not grazing alfalfa the first year is here emphasized, and also the mistake of grazing at any time when the ground is frozen, at least in areas east of and, generally speaking, adjacent to the Mississippi River.

Alfalfa as a Fertilizer.—Alfalfa is not considered equal to medium red clover as a direct means of fertilizing and otherwise improving the land on which it grows. This does not arise from less inherent power on the part of alfalfa to draw nitrogen from the air and deposit it in the soil, but rather from the fact that clover establishes itself more quickly, and is much more frequently grown in the rotation. Several crops of medium red clover can be grown in short rotations, each one being a source of much benefit to the crops that follow, while one crop of alfalfa occupies the land. But when the alfalfa is all fed upon the farm on which it grew, where the plants grow freely, it then becomes a source of fertilization without a rival, probably, among plants grown upon the farm.

The fertility thus furnished does not consist so much in the plant food deposited in the soil directly as in that furnished in the successive crops that are grown and fed every year. In Farmers' Bulletin No. 133, published by the United States Department of Agriculture, it is stated that the Wyoming Experiment Station found 44 pounds of nitrogen, 8.27 pounds of phosphoric acid, and

50.95 pounds of potash in one ton of alfalfa. This would mean that in the yield of alfalfa hay from a given area, estimated at four tons per acre for the season, alfalfa would furnish 176 pounds of nitrogen, 33.08 pounds of phosphoric acid, and 203.8 pounds of potash. If this alfalfa were fed upon the farm, it would not only prove a cheap source of protein for feeding, but it would furnish fertility, as stated above, without seriously diminishing the supply of the same in the surface soil, since much of the fertilizing material produced would come from the air and subsoil. The manure thus made, if carefully saved and applied, would thus add materially to the fertility of the land. If, however, the alfalfa were sold, the mineral matter drawn from the cultivable area of the soil and from the subsoil lying under it would be reduced to the extent of the draft made upon these in growing the alfalfa.

The direct influence of alfalfa upon the fertility of the land on which it grows is shown in the greatly increased production in the crops which follow alfalfa. This increase is not only marked, but it is frequently discernible for several successive years. But as has been intimated, the benefit that would otherwise accrue from growing alfalfa as a direct means of fertilizing the land is much circumscribed by the long term of years for which it is usually grown.

The mechanical effects of alfalfa upon the land are beneficent. It improves the tilth by means of the shade furnished, and the extent to which the

roots fill the soil. These in their decay further influence favorably that friability which is so desirable in soils that are cultivated, and as previously stated, the long, deep roots in their decay exercise a salutary influence on drainage.

The work of breaking alfalfa fields is frequently laborious, owing to the number and size of the roots. If, however, a plow is used, the share of which has a serrated edge, the roots will be cut or broken off more easily and more effectively.

CHAPTER V

ALSIKE CLOVER

Alsike Clover (*Trifolium hybridum*) takes its name from a parish in the south of Sweden. From there it is probable that it was introduced into England. Linnæus gave it the name of *hybridum*, imagining it to be a cross between the red and the white varieties. Botanists do not generally hold this view. It is known by various names, as Swedish, White Swedish, Alsace, Hybrid, Perennial Hybrid, Elegant and Pod Clover, but more commonly in America it is spoken of as alsike.

The plants of this variety are more slender than those of the medium red variety, although they grow in some instances to a greater height. The slender stems are much branched. The leaves are numerous and oblong in shape, the flowers are of a pinkish tint, the heads are globular and are about three-fourths of an inch in diameter, and the pods, like those in white clover, contain more than one seed. The roots are in no small degree fibrous, and yet the slender tap root goes down to a considerable distance.

Alsike clover is a perennial. In favorable situations it will live for many years. Ordinarily, it grows to the height of 18 to 24 inches, but in slough



Fig. 5. Alsike Clover (*Trifolium hybridum*)

lands it sometimes grows to the height of 5 feet. The plants do not reach their full size until the second year, and in some instances until a period even later. They grow less rapidly than those of medium red clover, are several weeks later coming into flower, and grow much less vigorously in the autumn. Ordinarily, they furnish but one cutting of hay each year. Because of the more fibrous character of the root growth, the plants do not heave so readily as those of red clover. In moist situations they are much given to lodge; hence, the importance of growing this crop, when grown for hay, along with some kind of grass that will help to keep the stems erect.

Alsike clover furnishes a large amount of pasture. It is relished, at least, fairly well. The leaves are slightly bitter, but not enough to seriously interfere with their palatability. The quality of the hay is excellent. This arises from its fineness, from the number of the small branches and leaves on the stems, and from its fragrance when well cured. While it makes a very suitable hay for horses and cattle, it has peculiar adaptation for sheep, owing to its fineness.

As a fertilizer it is probably not equal to medium red clover, since the root growth is not so bulky. Nor does it produce a second cutting anything like so vigorous as the former. Nevertheless, the roots possess even stiff soils to such an extent that they not only furnish them with much plant food, but they also tend to disintegrate them and to render them more easy to pulverize.

As a honey plant, alsike clover is without a rival among clovers, unless it be in the small white variety. It is a great favorite with beekeepers. Many of them sow it to enable them to furnish pastures for their bees. The bloom remains for a relatively long period. The honey is also accessible to the common honey bee, since the branches are numerous on the stems, and since each branch bears a head, the flower heads are relatively quite numerous. Since the honey is accessible to the common bee, pollination in the plants is assured; hence, the failures in the seed crop are few, and when other conditions are favorable, seed production is abundant. Because of the many good qualities of this clover it is deservedly a favorite wherever it can be successfully grown. When in full bloom, a field of alsike clover is a very beautiful sight. The flowers are a pale white at first, but gradually they deepen into a beautiful pink of tinted shades, and their fragrance is fully equal to their beauty.

Distribution. —Alsike clover is found in Europe, Northern Africa and Western Asia. In these it has been cultivated for a long time, but its favorite home in the Old World would seem to be in Northern Europe. It would doubtless be correct to say that it is indigenous to Europe, and probably that it is indigenous to each of the three continents named. It is not indigenous to America, but was introduced into the same probably from Great Britain or Scandinavia. In some parts of North America it grows with a luxuriance equal to, if not, indeed, greater, than that shown by this plant when

grown under the most favorable conditions which Europe furnishes.

This plant is better adapted to a cool and humid climate than to one hot and dry. It is even more hardy than medium red clover, in the sense of enduring cold, and will live under conditions of climate so austere as to be fatal to red clover. It may, therefore, be grown further north than medium red clover, and under conditions so exposed as to cause medium red clover to fail. But it does not succeed quite so well as the former toward the southerly limit of the successful production of medium red clover; hence, the limit of production in the semi-arid belt ceases sooner than in the case of the other variety. The best climatic conditions for growing it are found not far from the boundary line between the United States and Canada, and in the vicinity of the Atlantic and Pacific oceans and the Great Lakes.

In the United States the best crops are grown in the States which border on Canada, and in these the highest adaptation, climate and soil considered, is found in Michigan, Wisconsin and Northeastern Minnesota. But in New York the adaptation is also high, and also in certain parts of Montana, Idaho and Washington. Good crops may also be grown in nearly all the second tier of States that lie southward from the Canadian boundary. The exceptions are those embraced in the semi-arid belt. Further south than the second tier of States to which reference has just been made, the successful growth of alsike generally lessens, and yet in parts of these

States, as, for instance, Kentucky, Tennessee and Missouri, good crops are grown. Some of the Rocky Mountain valleys, more especially those that can be irrigated, and that are also sufficiently elevated, grow excellent crops of alsike. Much of the province of Ontario has very high adaptation to the growth of alsike clover, and in several counties of that province large quantities are grown, not only for hay, but also for seed. In Ontario County in the said province, are certain clay soils rich in lime; in fact, almost marley in character, which have been found especially well adapted to growing alsike clover seed, and in certain areas in proximity to the Georgian Bay, adaptation exists about equally high. In some parts of Quebec good crops are also grown. But this variety of clover has not been grown as yet with much success in Manitoba, Assiniboia, Alberta or Saskatchewan. Both soil and climate, however, in these provinces should not be uncongenial to it in the main. In the cultivable lands of British Columbia, as in those of Washington, it grows remarkably well. Especially in the river bottoms and on the tide lands can immense crops be grown, as also on the tide lands of Nova Scotia and New Brunswick, but not on the upland sandy soils of these provinces.

Soils. —The most suitable soil for alsike clover is a moist clay loam, not too friable nor too dense, and moist and deep. A goodly impregnation of lime in the same is favorable to maximum production. Abundant moisture conduces to the same end. This plant will, however, produce good crops, and in a

moist season, excellent crops, on the stiffest clays, whether white or red, after a good stand has once been secured, providing hard pan is not found near the surface, but in dry seasons it is not easy to secure a stand on such soils. The plants send their fibrous roots down into the soil in all directions, and in this way render it much more friable when it is broken up.

Next in adaptation, probably, come slough soils, even though covered with humus to a considerable depth, providing that clay lies under the humus. Enormous crops of hay or pasture can be grown on such soils, but the crops of seed are not usually so large as on the moist clays referred to above. On these also the hay is much more liable to lodge, unless supported by some kind of grass growing along with it.

After slough soils come those that have been deposited by the action of water, as in river beds and on lake bottoms, when the waters have subsided, providing the clay element so necessary to the successful growth of this clover is plentifully present. In some instances the very best crops of alsike can be grown on such lands, but in many other instances these deposit soils have in them too much sand to produce these.

Good crops can be grown on sandy loam soils, if well stored with vegetable matter, and at the same time fairly well impregnated with clay, but if one or both of these elements is lacking, adaptation in these soils will be correspondingly reduced.

On the average upland prairie soil, alsike clover

does not grow so vigorously as the medium red. The less of density that these possess under ordinary conditions, the less suitable are they to the needs of this plant, but when ample moisture is present, good crops may be grown on much of the soil in prairie areas.

Soils lowest in adaptation to the growth of alsike include infertile sands and gravels, and the vegetable soils of the prairie so light that when cultivated they lift more or less with the wind. On such soils the growth of alsike is short and feeble, and any lack of moisture renders it increasingly so.

This plant not only requires much moisture to insure the most vigorous growth, but it is also able to thrive under conditions of soil saturation such as some of the useful forage plants could not endure. When the weather is cool, it may be covered with shallow water for several days in succession without apparent injury. The possession of this characteristic makes it possible to grow alsike clover in sloughs not yet drained, but which are dry certain portions of the year.

Place in the Rotation.—Much of what has been said about the place for medium red clover in the rotation may also apply to alsike clover. (See page 70.) On upland soils its place in the rotation will be very similar to that of the other variety, but with the difference that the rotations will be longer, because of the perennial habit of growth in the alsike. It will be best sown, therefore, on clean land which has produced a crop that has been cultivated the previous year. Consequently, it may fol-

low such crops as corn, potatoes, field roots and beans in the North, and the same crops in the South, with the addition of cow peas, soy beans and the non-saccharine sorghums. But it may be sown after other crops when necessary, especially when it is to be pastured. One chief objection to sowing it thus for hay is that the hay will be less free from weeds.

On upland this crop may be followed with any kind of a crop requiring much nitrogen. No crops can be made to follow it with more advantage, however, than corn and the sorghums, or potatoes. Rape will feed ravenously on the overturned sod, and wheat and the other small grains will also feed similarly.

On low lands, especially when they partake of the nature of sloughs, the rotation is different. In some instances alsike may follow the natural grasses produced by the slough in the drained or undrained form, as the case may be, and may be made to supersede them without breaking the land, but more commonly on these it is sown after the natural sod has been broken and has decayed somewhat, by growing on it some such crop as rape or flax. On these lands it is usually grown in long rotations for pasture and also for hay, and when the sod is again plowed, it is followed by corn, potatoes, rape, and grains grown for soiling uses, since such land has naturally high adaptation for these. Flax also is a favorite crop to sow in such situations after alsike clover.

Preparing the Soil.—The preparation of the

land for alsike clover on ordinary soils is the same as for medium red clover. (See page 74.) Usually, that degree of fineness in the pulverization which best prepares the soil for the nurse crop with which alsike clover is sown, will also best prepare it for the alsike. But there may be some instances, as in strong clays, when a fine pulverization that would suffice for the needs of the nurse crop would be advantageous to the alsike. This finer pulverization can only be secured by the judicious use of the roller and the harrow. In loose-lying soils, more especially in areas where the precipitation in winter comes in the form of snow, and, therefore, does not wash the land as it does when it falls as rain, if the land on which alsike is to be sown is plowed in the fall, and only harrowed in the spring, or cultivated and harrowed when preparing it, the moisture will be better conserved than if it were plowed in the spring. When thus managed, strong clays in the area under consideration will usually have a much finer pulverization than can be obtained from spring plowing. When the preceding crop has been given clean cultivation, to plow land subsequently before sowing to alsike would bring up many weed seeds to the surface, where they would at once begin to grow. On slough lands, where water saturation is present during a portion of the year, even to the extent of appearing for a short interval over more or less of the surface, the seed may be sown without any previous preparation of the land, and in some instances successfully. In other instances it will fail should the following summer prove adverse. The

stand is rendered much more certain in such instances by first burning off the grass, sowing the seed upon it, covering it more or less with the harrow and running the mower over the ground, say, twice in the season, to let in sunlight to the young plants. The grass thus mown may be left as a mulch. Pasturing, but not too early in the season, will in some instances give results equally good. In such situations the sowing should be done, and also the harrowing, before the frost has left the ground, except for a short distance from the surface, or the horses may sink too deeply when doing the work. The success is dependent in no small degree on the denseness or want of denseness of the root growth of the grass plants already covering the soil. The more dense these are, the less easy is it to obtain a stand, and the more peaty the soil immediately underneath the surface, the greater is the danger that the young plants will perish in a time of drought.

When alsike seed is sown on drained sloughs, the aim should be to reduce the excess of coarse vegetable matter, if present, and to secure a smooth surface, such as will facilitate the easy mowing of the crop. More especially should this be the aim if the alsike is sown to produce hay. This can be most easily and speedily done by growing on it some reducing crop, as flax or rape, and then smoothing the surface by implements best suited to such work, as, for instance, some form of plow leveler.

Sowing—The time at which alsike clover may best be sown is the same as that for sowing the

medium red variety; that is to say, the early spring. (See page 75.) Since it is hardier than the medium red variety, the danger is less that spring frosts will destroy the plants after they begin to grow. As with medium red clover, it may also be sown at sundry times, from the opening of spring until the late summer when the opportunity offers, and when the conditions for growth are favorable. For instance, there may be seasons when alsike clover, and, indeed, any kind of clover, will succeed along with a catch crop sown for pasture or to provide soiling food. But it should not be sown in the autumn unless where the winters are mild, or the young plants will not survive their rigors.

Alsike clover is more commonly sown with a nurse crop. As with medium red, the crops with which it may be best sown are the small cereal grains, as winter rye, barley, wheat and oats, favorable in the order named. But it may also be sown with flax, with rape, and with grain crops that are to be cut for soiling or to be grazed down.

The method of sowing alsike clover is virtually the same as that followed in sowing medium red clover (see page 78); that is to say, it may be sown by hand machines, with a grass-seeder attachment to the grain drill, or with the ordinary tubes of the grain drill and along with the grain. The seed is very small, and, consequently, may not admit of being buried so deeply as medium red clover, but in the open soils of the prairie it will sometimes succeed as well sown along with the grain as when buried less deeply, but in many soils the roller will

provide a sufficient covering. Especially is this true in climates that are moist.

Alsike clover has special adaptation for being sown along with timothy and red top on slough soils, and soils made up of rich deposit. It matures about the same time as these grasses. They support the slender stems of the alsike, and in doing so prevent lodging more or less. This greatly improves the quality of the hay. The more numerous the plants in those mixtures, the finer also will be the quality of the hay. If but two varieties are wanted in the mixture, ordinarily these two should be alsike clover and timothy. Both furnish hay of excellent quality; hence, when the proportion of alsike is not too large, such hay sells readily to dairymen who have to purchase fodder.

Although this clover does not mature until three to four weeks later than the medium red, nevertheless, it may be well to add the latter to the timothy and alsike clover mixture. When these are thus sown in due balance, the first cutting will be mainly red clover, after which there will be but little of the red present. But the medium red clover will add much to the pasture after the first cutting for hay. Subsequently, the hay crop will usually consist of alsike and timothy. Alsike clover along with timothy may also be sown with mammoth clover, since the two mature about the same time. But the mammoth variety will monopolize the ground while the first hay crop is being produced. The advantage from sowing the seed thus lies chiefly in prolonging the period of clover production along with timothy grown

chiefly for hay. It is not wise, usually, to sow alsike clover alone for hay, owing to its tendency to lodge. In the South it is frequently sown with red top and orchard grass, especially the latter. It fills in the spaces between the plants in the orchard grass, and in so doing adds much to the hay or to the pasture.

There may be conditions in which it would be advisable to sow alsike clover alone, as when it is wanted for seed, and subsequently for pasture. But ordinarily to provide pasture, it is better to sow it along with some other grass or clover, or with a number of these. It greatly improves a timothy pasture in the upland or in the valley. It has also been used with much advantage in strengthening alfalfa pastures for horses in winter in certain of the Rocky Mountain valleys. It would probably be correct to say that with the area of adaptation for this plant, no kind of pasture can be grown on reasonably moist land that would not be benefited by having alsike in it. Among the clovers it has, relatively, high adaptation for permanent pastures, because of its enduring character.

The seeds of alsike clover are small. They are considered to be less than half the size of those of medium red clover, consequently, the amounts of seed are relatively much less. When alsike clover is sown alone and for seed, from 3 to 5 pounds of seed should suffice per acre, according to the soil conditions. Four pounds are frequently sown. In the various mixtures given above, the amounts of seed will vary with local and other conditions, but the following amounts may be given as averages:

Alsike and timothy, 4 and 6 pounds, respectively, per acre; alsike, timothy and red top, 3, 4 and 3 pounds; alsike, timothy and red clover, 3, 4 and 3 pounds; alsike, timothy and mammoth clover, 3, 4 and 3 pounds. When sown with other grasses for pasture, it would not be possible to give the amounts to sow that would best meet the needs of the grower under all conditions. But it may be said that 1 to 2 pounds of alsike seed per acre, sown under almost any circumstances in moist soils and within the alsike clover area, will be a good investment when laying down pastures of any considerable permanency.

This clover is also sometimes added to the seed sown in making lawns, more especially on farms where the lawn cannot be given that close attention which is necessary to keep it in the most presentable form. Because of its permanence, it is helpful in giving variety to the sward, and when mown but two or three times in the season, as is frequently the case with such lawns, it provides considerable bloom in the same, which is very attractive. The amount of seed to use on these lawns may vary to suit the desires of the owner. It is not usual, however, to sow in these more than maximum amounts for field crops. At the rate of 3 to 4 pounds of seed per acre should be ample.

Pasturing.—Alsike clover has by some authorities been assigned to a high place as a pasture plant. For such a use it has no little merit, but in the judgment of the author it is not nearly equal to medium red clover as a pasture plant, under average con-

ditions, since it does not grow so well, relatively, on average upland soils, and because the aftermath is usually light, after the crop has been cut for hay or for seed. Nor is it thought to be relished quite as highly by stock as the medium red clover. Nevertheless, domestic animals eat it freely, and under suitable conditions it will furnish for them a considerable amount of grazing. This feature has been finely illustrated by an experiment in grazing conducted at the Agricultural Experiment Station of Montana, on irrigated land, at Bozeman, in the Gallatin valley. Full particulars relating to this unique experiment are given in Bulletin No. 31, issued by the afore-mentioned station. In the summer of 1900, 18 cattle, one and two years old, were pastured on 5.04 acres of alsike clover for 102 days, beginning with June 9th. The increase in the weight obtained from the pasture in the time stated was 4560 pounds. This gain was valued at the very moderate price of 4 cents per pound live weight; hence, the net return per acre for the pasture for the season was \$36.19. It would scarcely be possible under any conditions, howsoever favorable, to obtain such results without irrigation.

Ordinarily, the results from pasturing alsike clover will be more satisfactory when one or two other plants are grown along with it, as, for instance, medium red clover or medium red clover and orchard grass, since both of these plants tend to prolong the period of grazing. In slough lands, red top and timothy add considerably to the value of the grazing. When grazing alsike clover, much more

pasture will be obtained if it can be allowed to make a good start in the spring, and if it is then kept grazed so short that the plants do not come into flower. Such treatment tends very much to prolong the period of grazing for the season. Should the grazing be so uneven as to admit of certain areas in the pasture pushing on into the flower stage, the mower may sometimes be profitably used to prevent such a result. Weeds should also be kept from going to seed in the pastures by using the mower or the scythe, or both. Nor should the fact be lost sight of that the tendency to produce bloat in alsike clover is much the same as in medium red clover.

Harvesting for Hay.—Alsike clover is ready to harvest for hay when the plants are just beginning to pass beyond the meridian of full bloom. Some of the first blossoms will then have turned brown and some of the smaller ones will still be deepening their tints, since the season of bloom is about the same as for timothy, and since alsike for hay is more commonly grown with timothy than with any other grass, both may be cut when at their best, especially when intended for cows and sheep. But when the hay is intended for horses, it should stand a few days longer than the stage indicated above, in order to have the timothy in the condition best suited to feeding horses. But the alsike, in the meantime, would lose something in digestibility.

If grown alone for hay, the process of harvesting would be much the same as in harvesting medium red clover. (See page 95.) But since the stems of alsike clover are finer than those of the medium

red, less time will suffice for curing it. It will also cure more quickly along with some other grass than if alone, since it does not then lie so closely in the winrow or in the cock. Grasses, as a rule, cure more quickly than clovers, and this also has a bearing on hastening curing in clover when the two are grown together, and also in lessening the degree of the fermentation after the crop has been stored. Ordinarily, when the weather is bright, alsike clover along with timothy may be cut in the forenoon, tedded once or twice soon after cutting, raked into small winrows the same evening and stored away the following afternoon. When thus managed, the hay loader may be used in lifting the hay from the winrows. Alsike clover growing alone could not be cured thus quickly. Nor would it be wise in showery weather to try and cure the crop without putting it into cocks, whether grown alone or with some other crop. When properly cured, the heads retain much of their bloom and the stems much of their greenness.

The yields of hay vary greatly with the soil. On dry, sandy uplands the yields of cured hay may not exceed $\frac{1}{2}$ ton, while on rich loam soils it may exceed 3 tons. Ordinarily, on good soils a combined crop of alsike clover should yield from $1\frac{1}{2}$ to 2 tons per acre of very excellent hay. Some authorities speak of getting two cuttings per year, but this is not usual. Under quite favorable conditions it would be possible to get two cuttings for soiling uses, providing the first was taken when the plants were coming into bloom. Usually, the growth of

the aftermath, when the hay has been removed, is very moderate.

Securing Seed.—Alsike is a great producer of seed. This arises in part from the relatively large number of the heads on the plants, and in part from the completeness of the pollinations, through the action of the honey bee. These are relatively much more numerous than the bumble bees, which alone among bees, it has been claimed, aid in the pollination of medium red and mammoth clover. Although the seeds are considerably less than half the size of those of medium red clover, as much as 8 bushels of seed have been secured from an acre. Frequently, however, the yields are less than 2 bushels. Good average yields may be stated as running from 3 to 4 bushels per acre. The best yields are usually obtained from the first crop, but under favorable conditions this clover may be cut for seed for two and even three years in succession. Better yields are usually obtained from crops of medium vigor than from those of excessive rankness. The latter lodge to such an extent as to reduce materially the yields of the seed, since the heads do not fill well. The cost of harvesting and threshing such crops is also greater, relatively, than of those of medium growth. To prevent such excessive growth in the seed crop, pasturing for a time is frequently resorted to. The grazing should begin reasonably early in the season before growth anywhere becomes so rank, that the animals do not eat it in certain portions of the field, whereas, at the same time, they graze other portions of the field too closely. Rather

close grazing, from the time that grazing begins, is preferable to grazing that leaves the crop uneven. When certain portions of the field are left ungrazed, or only partially grazed, the mower should be run over such portions about the time that the grazing ceases. If this is done a few days before the removal of the stock, they will eat much of the clover thus mown. Unless the mower is thus used, under such conditions the seed will ripen unevenly in the grazed and ungrazed portions of the same.

The duration of the grazing is much dependent on the soil and the season. The more moist and rich the soil and the more moist the season, the more prolonged should the grazing be. In Northern areas it seldom begins earlier than May 1st, and seldom extends beyond June 1st. If prolonged unduly and dry weather follows, the growth of the plants will not be enough to produce average crops of seed. Quite frequently on upland soils, the grazing should cease before the end of May.

Either cattle or sheep, or both, may be used in the grazing. Cattle do not graze quite so closely as sheep, which is so far favorable to subsequent growth. But sheep will glean weeds to a much greater extent than cattle. When the field is made to carry so much stock that the grazing is quickly and thoroughly done, the results are usually more satisfactory than when the opposite method is practiced.

It is important that weeds shall be prevented from maturing seeds in the clover. To prevent this, it may be necessary to run the mower over the whole

field at the close of the grazing season. In crops that are not grazed, it may be necessary to use the scythe in clipping back weeds and in cutting off any stray heads of timothy that may be pushing up toward maturity. In some instances it may even be found profitable to use the spud in destroying weeds of more dwarfish growth than those which can be clipped with the scythe. It is more important, relatively, that weeds shall be thus dealt with in growing alsike clover than in growing clover of the larger varieties, since, owing to the small size of the seeds of alsike, it is more difficult to remove foul seeds with the winnowing mill. No kind of seed, probably, is more difficult to separate from alsike seed than timothy; hence, when the former is grown for market, these plants should not be grown together. If, perchance, they should be so grown and the crop cut for seed, it would be well not to try to separate the seeds, but to sow them thus, as even when thus mixed the seed has a considerable market value.

The crop is ready for being harvested when nearly all the heads are fully matured. The bloom will then have left them and they will be characterized by a reddish cast. The earlier heads will have turned a dark color, almost black. Some bloom may yet linger on the later and smaller heads, but harvesting should not be delayed until these mature.

The seed crop can best be cut with the self-rake reaper, which throws off the sheaves unbound. If cut with the grain binder, the sheaves should not be bound. A sort of box attachment may be fastened

to the cutter-bar of the mower, which will enable the workmen to leave the hay in sheaves, but to do this an additional hand is wanted to rake or pitch off the sheaves. The sheaves should be laid off in rows, and by system, rather than at random, for convenience in storing.

Usually, the sheaves are not disturbed until ready for being stored, but in case of very heavy rain it may be necessary to turn the sheaves, to prevent the seeds which come in contact with the ground from sprouting. The sheaves should be carefully lifted, otherwise many of the heads will break off and be lost. Because of this, it may be wise, frequently, to refrain from lifting the sheaves for loading in the middle of the day. Large forks, which may be run under the bunches, are more suitable than ordinary forks.

When absolutely necessary, the seed crop may be harvested with the field mower, as ordinarily used, but when it is thus harvested, the crop should be cut with all promptness as soon as it is ready. It must then be raked into winrows and lifted as hay is usually lifted. All the work of harvesting should be done in those portions of the day when the heads will break off less freely, and when at the same time the dew is not resting on the seed plants in any considerable degree. When, however, a crop of alsike is thus harvested for seed, many heads will break off, howsoever careful the workmen may be.

The seed may be threshed at once or stored. Storing under a roof is preferable to storing in the stack, but the latter method will suffice, if the tops of the

stacks are well protected with a covering of marsh hay or of some other suitable material. When the seed is not threshed at once it is usual to defer threshing until cold weather, as with medium red clover, as then the seed is much more easily removed from the seed pod. Ordinarily, the work can best be done by clover hullers, the same as are used in threshing medium red and mammoth clover, but grain separators, with certain attachments, will now do this work in good form. Much care should be exercised in winnowing the seed. It ought to be so cleaned that it will grade as No. 1, and so bring the highest current price. Due care in this matter will make the major part of even ordinary seed bring the best price.

Renewing.—When the stand of the alsike is but partial, as, for instance, when young plants* have failed, or partially so, on the high land, and are sufficiently plentiful on the lower land, a full stand may sometimes be secured by simply scattering seed where it is needed so late* in the fall that it will not sprout before winter, covering with the harrow and then top dressing with farmyard manure well decomposed. But where the winters are so mild that the clover might be sprouted during some warm spell followed by severe weather, the seed should not be sown then.

On certain soils, as those naturally moist and porous, it may be possible so to renew alsike clover that it will produce hay or pasture crops almost indefinitely, by simply allowing some heads to seed every year and fall to the ground. In meadows,

this may be done by not grazing after the hay has been harvested until other heads have formed and ripened. A limited number of these will thus form after the crop has been mown for hay. If the crop has been cut for seed, many heads will in any event be left upon the ground. The same result will follow when grazing the crop, if grazing is made to cease at the right time, and for a period long enough to allow a considerable number of heads to mature. This method of renewal will not prove a complete success on all soils, as, for instance, on those very stiff and very light.

Natural meadows that lie low may be changed in whole or in part into alsike meadows or pastures in some of the States, as has been previously intimated, by sowing seed on them in the early spring. (See page 202.) In some instances such change has been effected by sowing seed but once, and at the rate of from 3 to 4 pounds per acre. In other instances it has been found preferable to sow a less quantity for two successive seasons, lest one of the two should prove adverse to successful growth in the plants. But on some slough soils a stand cannot be secured by this method of sowing, more especially when they are composed of raw peat.

CHAPTER VI

MAMMOTH CLOVER

Mammoth Clover (*Trifolium magnum*) was long ago named *Trifolium medium* by Linnæus. However appropriate the designation may have been at the time, it is not so now, at least under American conditions, as in this country there is no other variety of clover so large, unless sweet clover (*Melilotus alba*). To apply to it the distinguishing term medium, therefore, is positively misleading, since the smaller variety of red clover commonly grown occupies such middle ground, as the term medium would indicate. Because of this, the author has ventured to designate it *Trifolium magnum*. It has also been classified, and with no little appropriateness, *Trifolium pratense perenne*, which has reference to the mildly perennial habit of growth in this plant. In common phrase it is known by such names as Large, Tall, Saplin or Sapling, Giant, Meadow, Perennial Red, Red Perennial Meadow, Pea Vine, Zigzag, Wavy Stemmed, Soiling, and Cow clover or Cow grass. Each of these names has reference to some peculiarity of growth in the plant. For instance, the terms Large, Tall, Saplin and Giant have reference to the size of the plant; and the terms Pea Vine, Zigzag and Wavy Stemmed to the somewhat irreg-

ular and trailing habit of growth in the stems, and so of the others. The designation Cow grass is an English term.

Mammoth clover is a large variety of red clover; in fact, the largest variety of red clover in America. The plants are strong, stronger than those of the medium red variety, and the stems are much larger. They are softer than those of the medium red, which to some extent may account for the less erect habit of growth which characterizes it. The leaves are usually destitute of the white spot found on those of the other variety. The heads are also probably larger and somewhat more open, but there is no appreciable difference in the size of the seed. The plants, notwithstanding, bear so much resemblance to those of the common red variety that it is not easy to distinguish them unless by the large size of the plants of the former. The roots are larger and stronger than those of the medium red variety, and as a result have more power to gather plant food in the soil.

Mammoth clover is biennial under some conditions and under others it is perennial, although it is not usually a long-lived perennial. It has a stronger habit of growth than the medium red, and is, therefore, rather better fitted to thrive under adverse conditions, more especially when it has once obtained a hold upon the soil. It grows chiefly in the first half of the season, and makes but little growth, relatively, in the autumn, or, indeed, any time the same season after the crop has been harvested for hay. In the Northern States it comes

into flower about the middle of July, and in those of the South correspondingly earlier.

It is relished by all kinds of domestic animals kept upon the farm, but the hay is relatively better adapted to cows and other cattle than to horses and sheep. If cut too late, or much injured in the curing, it is too dusty for horses, and the growth is too coarse to make first-class hay for sheep. It makes excellent soiling food, because of the abundance of the growth and the considerable season during which it may be fed in the green form.

It is peculiarly valuable as a fertilizer and as an improver of soils. In addition to the nitrogen which it draws from the air and deposits in the soil, it brings up plant food from the subsoil and stores it in the leaves and stems, so that when fed it can be returned to the land. It also fills the soil with an abundance of roots and rootlets. These render stiff soils more friable, and sandy soils less porous; they increase the power of all soils to hold moisture, and in their decay yield up a supply of plant food already prepared for the crops that are next grown upon the ground.

Mammoth clover may also be utilized with advantage in lessening the numbers of certain noxious weeds, and in some instances of eradicating them altogether. This it does in some instances by smothering them, through the rankness of the growth. In other instances it is brought about through the setback which is given to the weeds by first pasturing the crop and then cutting it later for seed.

Distribution. —Mammoth clover has long been

grown in several of the countries of Europe and Western Asia. It is also grown in certain parts of Siberia. It was doubtless introduced into the United States from Europe by emigrants from that continent, but when exactly is not known. It has probably been many years since its introduction into America, but it is only within the more recent of the decades that it has attracted general notice. In some areas in this country it grows with great luxuriance, fully equaling, if not exceeding, the crops grown in any part of Europe.

Mammoth clover calls for climatic conditions about the same as those for medium red clover. (See page 61.) It flourishes best in moist climates of moderate temperature, and it will endure more drought than the medium red variety and possibly more cold.

The distribution of mammoth clover covers nearly all the States of the Union, but as with medium red clover the adaptation for it is relatively higher in the Northern than in the Southern States of the Union. The highest adaptation for mammoth clover is probably found in certain parts of Michigan, Wisconsin, Minnesota, the northern valleys of the Rocky Mountain States, the elevated portions of those further south and the country around Puget Sound. The adaptation is also high in much of New York, Ohio, Indiana, Illinois, Iowa, Missouri, Kansas and Nebraska. In the Southern States that lie northward, good crops may be grown in some locations, but not in all. As the semi-arid belt is approached, mammoth clover will grow further

west than the medium red, but in the greater portion of this region it will not succeed. The adaptation of the North Atlantic States, including those of New England, is not of a high order, but rather more so, probably, than for the medium red.

In Canada also the adaptation of medium and mammoth clover is much the same as for the medium red. In some parts of Ontario, especially Western Ontario, it grows remarkably well; but in the maritime provinces it does not grow so well; nor does it thrive in the provinces of the Canadian Northwest as it does in Ontario.

As with medium red clover, the distribution of this variety has not been fully determined in either the United States or Canada, more especially on soils of the prairie, where it does not succeed well at present. It is probable that under some conditions on these soils, and also in the South, the absence of the requisite bacteria in the soil may account, in part, at least, for failure in attempts made to grow it. With the introduction of these, the area of successful cultivation may be considerably extended.

Soils.—Mammoth clover may usually be successfully grown in soils well adapted to the growth of the medium red variety. (See page 65.) This means that it will usually grow with much luxuriance in all areas which produce hardwood timber, and are usually covered with a clay or muddy loam soil underlaid with clay. It will also grow with great luxuriance in the volcanic ash soils of the irrigated valley lands of the Rocky Mountain States,

and in the loam and light loam soils of the Puget Sound country. It has greater power than the common red variety to grow in stiff clays, in sandy soils underlaid with clay, and in areas where moisture is insufficient near the surface soil. In stiff clays the roots penetrate to a greater distance than those of the medium red variety and gather more food. Consequently, a stiff clay soil that would only furnish a light crop of the medium red variety in a dry season may furnish an excellent crop of the mammoth. The quality of the hay is likely to be superior to that grown on soils altogether congenial, since it is not likely to be over-rank or coarse.

On sandy soils underlaid with clay, and especially where the clay is some distance from the surface, this clover is more certain to make a stand, since the vigor of the plants enables them to gather food until the roots go down into the clay.

In areas where the moisture is more or less deficient, the other conditions being favorable, this clover can send its roots down into the subsoil, where moisture is more abundant than on the surface. Because of this power, it is better adapted than the medium red to much of the area of Southwestern Minnesota, Western Iowa, Western Kansas and Nebraska, and, in fact, much of the area bordering on the semi-arid country.

On clay soils that are so saturated with water that in the winter or spring the clover is much liable to heave, there is conflict in opinion as to whether the mammoth or the common red variety will heave the more readily, but the preponderance of the evidence

favors the view that the roots of the mammoth variety can better resist such influences than those of the common red.

This clover, like the common red, is not well adapted to hungry, sandy soils, to the blow soils of the prairie, to the muck soils of the watery slough, or to the peaty soils of the drained muskeg.

Place in the Rotation.—The place for mammoth clover in the rotation is much the same as for the medium red variety. (See page 70.) It may, therefore, be best sown on a clean soil; that is to say, on a soil which has grown a crop the previous season that has called for clean cultivation, as, for instance, corn, potatoes, sorghum, or one or the other of the non-saccharine sorghums, field beans, soy beans, cow peas and field roots. But it is not so necessary that it shall be made to follow either kind of beans or cow peas as the other crops named, since these have already gathered nitrogen, which is more needed by leguminous crops. This clover should rather be grown in rotations where more nitrogen is wanted, when the soil will profit by increased supplies of humus, and where strong plants are wanted, the root growth of which will have the effect of rendering the cultivated portion of the soil more friable when stiff and more retentive when sandy, and that will have the effect of opening up many little channels in the subsoil when the roots decay, through which an excess of surface water may percolate into the subsoil. It may precede such crops as revel in humus and that feed ravenously on nitrogen. These include all the small cereals, corn and all the sor-

ghums, rape, and all kinds of garden vegetables and strawberries. It is, of course, better adapted to short than to long rotations, because of the limited duration of the life of the plants.

The length of the rotation will, of course, depend upon various contingencies. Frequently, the clover is cropped or pastured but one season following the year on which the seed was sown, whatsoever the character of the crops that precede or follow it, but in more instances, probably, it is used as crop or pasture for two years. When timothy is sown along with this clover the pasturing or cropping may continue for one or more seasons longer before the ground is broken, but in such instances the timothy will have consumed much or all of the nitrogen put into the soil by the clover, save what has escaped in the drainage water. One of the best rotations in which to sow mammoth clover, as also the medium red, is the following: Sow in a nurse crop of rye, wheat, oats or barley, as the case may be, in order that it may be pastured or cut for hay the following season, and then follow with a crop of corn or potatoes. This in turn is followed by one or another of the small grains. This constitutes a three years' rotation, but in the case of mammoth clover it is frequently lengthened to four years. The year following the sowing of the clover, it is cut for hay or for seed, and the next year it is pastured with or without a top-dressing of farmyard manure. This rotation meets with considerable favor in certain areas of Wisconsin, well adapted to the growth of the plant.

Preparing the Soil.—The preparation of the soil called for by the mammoth clover is virtually the same as that required when preparing a seed-bed for the medium red variety. (See page 74.) Clay loam soils, whatsoever their color, cannot easily be made too fine and smooth, and the same is true of sandy loams. Stiff clays should be made so fine as to contain ample loose mold to germinate the seed readily, and yet they ought not to be made so fine that they will readily run together under the influence of a soaking rain. Usually, such soils are seldom made too fine, but sometimes they are. The aim should be to firm sandy soils, especially when light enough to lift with the wind, and to leave them more or less uneven on the surface when the seed is sown.

In many States the ground should be plowed in the fall for spring sowing, and in yet others it should be plowed in the spring. Conditions of soil and climate govern this feature of the work. Usually, however, the longer the soil is plowed and then properly worked on the surface before receiving the seed, the finer, cleaner, firmer and moister it is likely to be, and the larger the store of the available fertility to promote the growth of the young plants. Because of this, after cultivated crops, the ground is not usually plowed or otherwise stirred on the surface.

When the soil is low in fertility, it may be necessary to fertilize it before a crop of mammoth clover can be successfully grown. For such fertilization, farmyard manure is very suitable. When soils are low

in the content of humus, before a good crop of clover can be grown, it may be necessary to supply humus. But few soils are so deficient in fertility that they will not grow clover if supplied with humus. Farm-yard manure supplies both humus and fertility, but in its absence, a crop of rye buried in the soil will insure a stand of clover. In other instances it may be necessary to follow with some kind of a crop that has much power to gather plant food, as corn of some hardy variety, and to graze or otherwise feed it from the land.

Sowing.—Much of what has been said about the sowing of medium red clover will apply also to the sowing of mammoth clover. East of the Mississippi and north of the Potomac and Ohio rivers, mammoth clover is usually sown in the spring, and for the reason that the young plants are frequently killed by the severity of the winter weather when sown in the autumn. But when sown at that season, the seed being mixed with winter rye and being deposited by the drill as early as September 1st, the plants frequently survive the winter as far north as Marquette County in Wisconsin. The rye in the line of the drill marks provides a sufficient protection for the clover. But this only occurs where the conditions are eminently favorable to the growth of the clover. Around Puget Sound it may also be sown with advantage in the early autumn, as then it should produce a full crop the next season, and the same is true of nearly all the Rocky Mountain valley region, but in these areas it may also be sown in the spring. Between the Mississippi and the Rocky

Mountains and Oklahoma and Canada, spring sowing is usually preferable, and in much of the area is an absolute necessity to insure a stand. In the South the seed may be sown fall or spring; which season is to be preferred should be determined chiefly by the character of the soil. On soil much given to heaving in the winter it is usually preferable to sow in the spring. In all, or nearly all, parts of Canada spring sowing only is admissible.

When the seed is sown in the early spring, it should usually be sown quite early, as early, in fact, as the ground is in condition to receive the seed when the nurse crop has been sown the previous autumn. When the ground is smooth and impacted on the surface, it is considered preferable to defer sowing until the ground is dry enough to admit of covering the seed with the harrow. When deposited at the same time as spring-sown nurse crops, and with these, the time of sowing will be determined by the most suitable time for sowing the nurse crop. This plant may be sown under certain conditions as late in the spring as moisture exists in the soil sufficient to produce vigorous germination in the seed. This means that it may be sown as late as June, if sown alone, and even later. When sown thus late it should be on soil that has been well cleaned near the surface. When sown in the autumn, as with medium red clover, the aim should be to put the seed in as early as the arrival of the autumn rains, that the plants may be well rooted before the arrival of freezing weather.

Ordinarily, mammoth clover, like the medium red,

is sown with a nurse crop, whether sown fall or spring. (See page 84.) The nurse crops in the North include winter rye, winter wheat, barley, spring wheat and oats, suitable, probably, in the order named, also such pasture crops as rape, vetches, and various mixtures of grain sown on certain soils to provide pasture for cattle, sheep or swine. The best nurse crops in the South include winter rye, winter barley and winter oats, even though the seed should not be sown on them until the spring. On certain sandy loam soils a stand of mammoth clover is more assured if sown with a pasture crop than if sown with a grain crop which is to mature. (See page 82.) Under certain conditions of soil and climate, this crop may be sown on plowed or disked land in certain of the States, after a crop of grain, and in other instances by sowing amid the stubbles and covering with the harrow. But there is more of hazard in growing thus than by other methods. Sometimes this clover is sown amid standing corn, at the last cultivation, but too much shade or too little moisture may cause only partial success, or even failure, whereas at other times the plan may succeed.

The modes of sowing the clover are virtually the same as those to be followed in sowing medium red clover. (See page 78.) It will be sown by hand, by hand machines, and by the grain drill, with or without attachments. The seed of this variety, however, will, on the whole, be more frequently mixed in with the grain than the seed of the medium red clover, because of the stronger growth that it makes,

This will frequently be found the preferable mode of sowing it when sown in the autumn.

When sown to provide hay, mammoth clover and timothy make an excellent combination for the reasons, first, that they mature about the same time; second, that more of this clover is likely to survive the first year of cutting than of the common red; and third, that more food, it is believed, will be furnished to the timothy in the dead roots of this clover than of the medium red. The first year of cutting, the hay crop is likely to be nearly all clover; the second year, clover and timothy mixed, and the third year, timothy. But if alsike is sown in the mixture, though it may be little in evidence the first year, it will show itself the second year and probably the third year. When sown for pasture in short rotations, this clover may be sown alone or with other varieties of clover, timothy or tall oat grass being added. When sown for seed, it is probably better to sow it alone, but there is no very strong objection to sowing timothy alone with the clover, since the latter may aid in sustaining the clover, and it is not difficult to separate mammoth clover seed and timothy seed.

When mammoth clover is sown alone for hay or for seed, not fewer than 12 pounds per acre of seed should be used. When sown with timothy, 6 and 8 pounds, respectively, would be an average seeding. If alsike clover is added, the seed of the mammoth may be reduced by one pound, and the same amount of alsike added to the mixture. When sown with the medium red variety to provide short

rotation pastures, about 6 pounds of each may be sown. The pasture furnished will be more continuous than where only one kind is sown. If timothy or tall oat grass is added, a pound of one or the other of these should be added for every pound of the clover withheld from the mixture. For permanent pastures 6 pounds of the mammoth clover may be set down as the maximum to sow per acre, varying the quantity with varying conditions. And when the clover is sown with small grain to be plowed under in the fall or early in the spring, usually only very moderate amounts of seed ought to be used, especially where the hazard is considerable that the dry weather may cause failure in the catch of the seed.

Pasturing.—Mammoth clover furnishes much pasture when it is grazed, on into July and sometimes even into August, because of the vigorous character of the growth, but after that season the growth is usually light. Nor is there generally much growth after the crop has been cut for hay. The palatability of the pasture is much the same as that of the medium red variety. More grazing is furnished where the crop is fairly well grown before the pasturing begins, but it is not so palatable, and when unduly rank, to defer pasturing thus long would result in a considerable waste of pasture, which the stock would tread under foot. When the crop is wanted for hay, there may be instances in which it may be advantageous to pasture it for a time to prevent the growth from becoming overly luxuriant. There have been instances in which the

clover has grown so rankly that the lodged clover killed nearly all the plants by excluding the air from the roots. When grown on soils that in a normal season produce a rank growth, the quality of the hay will, in nearly all instances, be improved by grazing. This, however, should be done soon after the growth begins and should not be long continued, and it should be close, in order to promote evenness and uniformity in the growth of the hay crop.

When grown for seed, mammoth clover is quite frequently pastured. In fact, in a majority of instances it is either pastured or cut with the mower when a seed crop is wanted. The pasturing usually continues until June 1st, but in some instances it is prolonged far on into June. The duration of the pasturing season should be gauged largely by the character of the soil and weather. The better the conditions for growth in the plants, the longer may the pasturing be continued, and *vice versa*. There are also conditions in which such pasturing may not be necessary. But when the grazing is not close, the mower should be run over the field, otherwise the seeds will not ripen evenly.

There is the same danger from bloating that is present when pasturing medium red clover. (See page 94.) To avoid this danger, cattle that are being thus pastured are in some instances given access to cured clover hay. In other instances the haulm of the seed is left in the field so that the cattle have access to it. But the second season of grazing, the danger from bloat is not so great as

the first season, as usually more of other pasture plants grow amid the clover.

Horses, cattle, sheep or swine may be used in grazing off the clover for seed. All of these may be used at the same time. Horses bite the crowns of the plants so closely as to somewhat injure subsequent growth; sheep also crop rather closely; cattle do not crop the plants so closely; consequently, they are so far preferable to horses or sheep for such grazing. On the other hand, sheep will prove far more destructive to weed growth in the pasture.

Harvesting for Hay.—Ordinarily, the methods of making the hay crop are the same as those followed in curing medium red clover. The mammoth variety, however, frequently requires a longer season in which to cure, owing, first, to the heavier character of the growth, and second, to the larger stems of the latter. After it has been mown there is greater reason for using the tedder in getting it ready for being raked, and it calls for more curing before it is put into cocks. The larger the proportion of the timothy in the crop, the more easily it is cured. It is ready for cutting when in full bloom, and loses more than the medium red when cutting is too long deferred, because of the larger proportion of coarse stems in the crop. It is also relatively more injured by rain in the cocks, since it sheds rain even less readily than the medium red clover, and the same is true of it in the stack.

Some farmers cure mammoth clover in its green form in the mow as they also cure the medium red variety, but the same objections apply to curing it

thus that apply to the similar curing of the medium red. (See page 102.) Others cure it in the mow by storing good bright straw, preferably oat straw, in alternate layers along with the clover. From one-third to one-half the quantity of the straw as compared with the hay will suffice for such curing, varying with the degree of the wilting in the hay. Clover cut in the morning after the dew has lifted may be thus stored the same day. Where the facilities are present such a method of curing mammoth clover may be eminently wise in showery weather. The natural color of the hay and blossoms is thus preserved and the straw is eaten with avidity, because of what it has imbibed from the clover.

Securing Seed.—It has been already intimated more seed will be obtained when the clover has been pastured or cut back with the mower. (See page 233.) When the mower is used, it should not be set to cut quite low, or the subsequent growth will not be so vigorous as it would otherwise be. The state of growth at which the clover ought to be cut will be influenced by the luxuriance of the growth, but ordinarily clover seed should not be more than 6 to 8 inches high when the mower is used. What is thus cut by the mower is left on the ground as a mulch. Mowing the crop thus will also be helpful in destroying weeds, but some weeds will sprout again and mature seed as quickly as the clover.

When mammoth clover is neither pastured nor mown early in the season, when grown for seed some kinds of weeds may be prevented from going

to seed in it by cutting them off with the scythe. When not too plentiful they may be removed with the spud. Among the more troublesome weeds that infest mammoth clover are the Canada thistle (*Cirsium arvense*), the plantain (*Plantago lanceolata*), and in some instances the horse nettle (*Solanum Carolinense*) and spring nightshade (*Solanum*).

The yields of the clover seed will be much influenced by the character of the weather. Excessive rankness in the crop and excessive rainfall during the blossoming season are adverse to abundant seed production. But the seed crop is more injured by drought than by too much rain. When injured by drought the growth will not be sufficiently strong, or, if it is, the blossoms will be of a pale red tint. Warm winds while the seed is forming are also adverse to seed production, since they cause the crop to mature too quickly. Some experience will enable the capable observer to forecast with no little certainty the probable yield of the seed. If the indications point to a yield of seed less than 2 bushels per acre, it is deemed more profitable, as a rule, to cut the crop for hay. Large heads of a rich dark purple shade accompanied by vigor in the entire plant are indicative of abundant seed production.

The crop is ready for being harvested when a majority of the heads have ripened so far that the bloom on them is all gone and the shade of color in the head has not yet become brown. If left until a majority of the heads are brown many of them will break off while being harvested. The crop is usually cut with a self-rake reaper, but it may

be cut with a mower. When cut by either method the sheaves should be made small, so that they will dry out quickly.

It is important that the crop shall be threshed before it is rained on, as one thorough wetting will so far bedim the attractive brightness as compared with seed that has not been rained on that it will considerably discount the price that would otherwise be obtained for it. It is usually threshed with a huller, but may also be threshed like the medium red variety by a grain separator with a suitable attachment.

The yields of the seed vary much. Instances are on record where as much as 11 or 12 bushels per acre have been reaped, but ordinarily even on good producing soils the yields are not more than 4 to 5 bushels per acre, and under ordinary conditions for the production of mammoth clover they are even less than the amount named. Notwithstanding the greater strength of the plants, the seeds are apparently no larger than those of the medium red variety, nor can they be distinguished from them unless by an expert.

Renewing.—Much that has been said with reference to the renewing of medium red clover will apply equally to the renewing of the mammoth. (See page 109.) Where seed crops are much grown, the soil becomes so impregnated with the seed that more or less of the plants will appear any season. Renewal in the South is more important, relatively, than in the North, as under some conditions the plants survive for a longer period in Southern soils.

Compared with Medium Red Clover.—1. The mammoth is larger and coarser than the medium red and is considerably less erect in its habit of growth. It has larger and longer roots; hence, it goes down more deeply into the subsoil in search of food.

2. It is, on the whole, longer lived than the medium red variety and has greater power to grow in a sandy soil and under conditions in which moisture is not plentiful.

3. It provides more pasture than the medium red variety during the early part of the season, but not so much after harvest, the season of growth being less continuous than with the former.

4. The hay which it furnishes is usually considerably more bulky and coarse, and because of this it is not so highly prized by stock.

5. It blooms about three weeks later than the medium red variety and remains a little longer in bloom and seeds more freely, but can only be cut once in a season.

6. It furnishes more green food for plowing under than the medium red; hence, it is, on the whole, a better improver of the soil.

CHAPTER VII

CRIMSON CLOVER

Crimson Clover (*Trifolium incarnatum*) is also known by the names French, German, German Mammoth, Italian, Egyptian and Carnation clover. In America it is common in certain areas to speak of it as winter clover, from the greater powers of growth which it possesses at that season as compared with other clovers.

The plants have an erect habit of growth, and yet they are soft and hairy, and they have much power to stool. More than 100 stems have been produced by one plant, but under conditions the most favorable. The leaves are numerous. The heads are oblong, cylindrical, and considerably cone-shaped, and are from 1 to 2 inches long, and much larger than those of medium red clover. The bloom is scarlet or crimson and of the richest dye; hence, a more beautiful sight is seldom seen than that of a vigorous crop of crimson clover in full bloom. The average height of the plants may be put at about 18 inches, but they have been grown to the height of 3 and even 4 feet. The root growth is fully twice that of the stems. The roots are strong, go down straight into the soil, and are to some extent branched.

Crimson clover is an annual, although usually the growth covers a part of two years. Sown in the



Fig. 6. Crimson Clover (*Trifolium incarnatum*)

summer or early autumn, growth is completed by the advent of the following summer. It is, therefore, pre-eminently a catch crop, and because of this, when conditions admit of it, serves a purpose in American agriculture, which can be served by none of the other varieties of clover that are now grown. It has much power to grow in cool weather, when the clovers are practically dormant. It does not cease to grow until the ground has become frozen, and as soon as the frost leaves the soil growth begins at once; hence, the greater relative value this plant has for areas in which the winters are mild.

Crimson clover is much relished by farm animals, whether used as pasture, soiling food, silage or hay. Under some conditions it may be pastured autumn and spring, and even through much of the winter. As a soiling plant, its value is high, not only because it is a legume, but because it comes in season at a time when it may be fed with winter rye used as soiling. But the period is short during which it furnishes soiling food. Its value as hay will always be lessened by the difficulty in curing it so early in the season, and because of the danger from feeding it to horses when cut at a too advanced stage of growth. It is much in favor for furnishing chicken pasture in winter.

As a catch crop crimson clover may be made to do duty in seasons in which other clover crops may have failed. As a cover crop or a mulch for orchards, it is in high favor, as the growth which it produces protects the roots of the same. But its

greatest use lies in the beneficial influence which it exerts upon soils by enriching them and also improving their mechanical condition. It is likely, therefore, to be grown more for this purpose than for any other. While growing it in many instances will not render unnecessary the use of commercial fertilizers, it will greatly reduce the quantity of these that would otherwise be necessary. Owing to the season at which it is grown, it will be found quite helpful in destroying weeds.

The behavior of crimson clover has thus far been somewhat erratic, even in areas where the conditions are looked upon as generally favorable to its growth. The opinions of practical men differ much with reference to its value. There have been many instances of success and failure in the same locality, and even in the experience of the same individual. These varied experiences are doubtless due in a considerable degree to a difference in seasons, to want of acclimation in the seed sown, to a difference in varieties and to want of knowledge on the part of the growers, whose work, heretofore, has been largely tentative. Five different varieties have been grown, and these have not shown equal degrees of hardiness. But the rapidly increasing sales of seed point to the conclusion that larger areas are being sown every year. The increase referred to may be expected to grow greater for many years to come; since, when the needs of the plant are better understood, the failures will be fewer.

Distribution.—Crimson clover is probably indigenous to certain parts of Europe, especially to the

countries that lie southwest and south. It has been grown to a considerable extent in France, Germany and Italy. The name Egyptian would seem also to imply that it is grown in Egypt. It is not grown to any considerable extent north and west in Europe, owing, probably, to the too severe conditions of climate which characterize these. It is not indigenous to America, but was probably introduced from Europe two or three decades ago. Its late introduction accounts for the fact that its adaptation in some parts of the United States is as yet controverted.

This plant needs a climate rather mild and decidedly moist. It cannot withstand severe freezing when the ground is bare; hence, its uniformly successful growth cannot be relied on very far north of the Ohio and Potomac rivers. True, in certain winters of much snowfall it has come through in good form considerably north of the rivers mentioned, but in more instances it has failed. On the other hand, while it grows best in warm climates, the growth in these is made chiefly when the weather is cool, as in the autumn and spring, and in some instances in the winter. It would be about correct to say that the climatic adaptation of this plant is nearly the same as that of the peach. Climates too cold for fruitage in the latter would be too cold for the uniformly safe wintering of crimson clover. It would also seem correct to state that on suitable soils and with sufficient precipitation, this clover will do best in the United States when the climate is too warm for the medium red

clover to grow at its best. In the United States, soil and climatic conditions taken together, would probably give Delaware, New Jersey, Maryland, Virginia and Tennessee highest adaptation for the growth of this plant. Taking in a wide area, highest adaptation would lie in the States south of the Potomac and Ohio rivers and east of the Mississippi. Washington and Oregon, west to the Cascade Mountains, would probably furnish exceptions, but in these the necessity for growing crimson clover is not likely to be so great as in the area just referred to, owing to the ease with which other varieties of clover may be grown. In some parts of New York, Pennsylvania, Ohio and Michigan many farmers have succeeded well in growing crimson clover, but a larger number have failed. The failures have arisen largely through dry weather in the autumn, want of plant food in the soil and the severity of the winter weather. Westward from these States to the Mississippi, the adaptation is still lower, and the same is true of the New England States. In fact, it is so low in these that it is far more likely that it will fail than that it will succeed. Between the Mississippi and the Cascade Mountains, crimson clover is not likely to be much grown. It will not grow well in any part of the semi-arid belt. In the mountain valleys it would probably succeed, but in these alfalfa and some other varieties of clover will give far better returns.

Crimson clover will not grow well in any part of Canada, except in that narrow strip of land between the Rocky Mountains and the Pacific. The

winter climate is too cold for it. Some crops have been grown successfully in the peach-producing areas of Ontario contiguous to Lakes Erie and Ontario, but even in these it is an uncertain crop. The attempt has been made to grow it in some of the provinces of Canada, and in several of the States, by sowing the seed in the spring. Some fairly good crops have been thus obtained, but usually not so good as can be grown by sowing certain other varieties of clover at the same season. It is but reasonable to expect, however, that adaptation in growing crimson clover will widen with the acclimation of the plant, and with increasing knowledge as to its needs on the part of those who grow it.

Soils.—Crimson clover though usually grown for the enrichment of soils will not, as a rule, make satisfactory growth on soils very low in the elements of fertility, whatsoever may be their composition or texture. On orchard lands liberally fertilized, in the Middle Atlantic States, excellent crops have been obtained, whereas on adjacent soils precisely similar they have failed. In the Southern States, however, better results, relatively, will be obtained from sowing this clover on comparatively infertile lands, owing to the longer season which it has for continuous growth. Where the winters are possessed of considerable severity and when the protection of snow is more or less wanting, unless the plants are strong when they enter the winter, they are almost certain to perish. Loam soils with reasonably porous subsoils are best adapted to its growth. Of these, sandy loams have a higher adap-

tation than clay loams, when equal to the former in fertility, as in the latter the plants can more quickly gather the needed food supplies, since the roots and rootlets can penetrate them more readily. Such soils are well adapted to the growth of orchards, especially peach orchards, and it is in such areas that crimson clover has been grown with highest success. In the alfalfa soils of the Rocky Mountain valleys it should also grow well, but on these it would be less profitable to grow than alfalfa, because of the permanency of the alfalfa. Even on sandy soils a good growth will be obtained when these have been fertilized and sufficient moisture is present. On stiff clays the growth is too slow to produce crops highly satisfactory either North or South, and in dry weather it is also difficult to obtain a stand of the plants. The alluvial soils of river bottoms in the South produce good crops. The vegetable soils of the prairie do not grow the plants very well, and the adaptation in slough or swamp soils is even lower. Good crops will not be obtained on soils underlaid with hardpan which comes up near the surface, whatsoever the nature of the top soil may be, since the roots cannot penetrate these.

Place in the Rotation.—It cannot be said of crimson clover, in the ordinary usage of the word, that it is a rotation plant. It has probably no fixed place in any regular rotation, and yet it can be used almost anywhere in the rotation that may be desired, and in any rotation whether long or short, regular or irregular. As previously intimated, it is usually grown as a catch crop, and primarily to fertilize

the land; and since its growth is chiefly or entirely made in the late summer, autumn, winter and early spring, that is to say, when the land is not otherwise occupied, the only hindrances to using it anywhere in the rotation are such as arise from the nature of the weather, the mechanical condition of the land and the needs of the crops that are to follow. For instance, at the usual season for sowing it, the weather may be so dry as to preclude the hope of successful germination in the seed. This influence may also make it impossible to bring the land into that mechanical condition which makes a good seed-bed without undue labor, and ordinarily it would not be necessary to have crimson clover precede another leguminous crop; since the latter, under many conditions, can secure its own supply of nitrogen. To this there may be some exceptions. There may be instances, as on light, porous and leechy soils, when it might be proper to grow crimson clover as an aid in securing a stand of the medium red variety, or in growing a crop of peas for the summer market. Ordinarily, however, this crop is grown to increase the supply of plant food in the soil for crops which require nitrogen, and to give soils more or less porous, increased power to hold moisture and applied fertilizers. It is probably seldom grown to improve the mechanical condition of stiff soils, since on these it grows slowly. Some other plants can do this more effectively. It is pre-eminently the catch crop for the orchardist and the market gardener, and yet it may be made the catch crop also of the farmer, under certain conditions.

Crimson clover may be made to follow any crop, but it is seldom necessary to have it follow another leguminous crop which has brought nitrogen to the soil. Nor is it usually sown after a grass crop which has brought humus to the land. It is frequently sown after small cereal grain crops that have been harvested. It may be made to follow any of these. Sometimes it is sown in standing corn. But oftener than anywhere else probably, it is sown in orchards and on soils from which early potatoes and garden vegetables have been removed.

It is peculiarly fitted for being grown in orchards. In these it may be grown from year to year. It may be thus grown not only to gather nitrogen for the trees, but to make them more clean than they would otherwise be when the fruit is being gathered, to protect the roots of the trees in winter and to aid in the retention of moisture when plowed under. But this plant may also, with peculiar fitness, be made to precede late garden crops. It may be plowed under sufficiently early to admit of this, and when so buried it aids in making a fine seed-bed, since the roots promote friability in the land. When grown under what may be termed strictly farm conditions, it usually precedes a cultivated crop, as potatoes, corn, or one of the sorghums. It is equally suitable in fitting the soil for the growth of vine crops, such as melons, squashes and pumpkins.

But in some localities this crop may be grown so as to break down the lines of old-time rotations, since in some instances it may be successfully grown from year to year for several years without change.

Potatoes and sweet corn, for instance, may be thus grown.

Preparing the Soil.—In preparing the seed-bed for crimson clover, the aim should be to secure fineness of pulverization near the surface and moistness in the same. The former is greatly important, because of the aid which it renders in securing the latter at a season when moisture is often lacking in the soil. As it is rather grown on soils deficient in humus than on those plentifully supplied with the same, fineness in the seed-bed is not so important as it is with some classes of prairie soils.

In starting the seed, drought is the chief hindrance to be overcome in the North, owing to the season at which the seed must be sown; hence, the aim should be to begin preparing the seed-bed as long as possible before the sowing of the seed. The preparation called for will be influenced by the kind of soil, the crop last grown upon it and also the weather; hence, the process of preparing the seed-bed will vary. The judgment must determine whether the land should be plowed, or disked and pulverized, or simply harrowed. After potatoes and other garden crops, harrowing may suffice; after certain grain crops on soils not too stiff, disking may suffice; but where much trash is to be buried, plowing would be necessary, and when the ground is at all cloddy, the roller should be freely used. In corn fields the last cultivation will make a suitable seed-bed, and the same is sometimes true in cotton fields.

To grow good crops of crimson clover, it is neces-

sary that there shall be a considerable amount of plant food in the soil that is readily available. Farm-yard manure when it can be spared or secured will supply the need. But the results will probably be more satisfactory where the manure has been applied to the previous crop, as, for instance, to potatoes or corn, and for the reason, probably, that in the relatively dry season at which the seed of this plant is sown, the residue of the manure still in the soil is more readily available than freshly applied manure would be. Good crops have been grown on land thus manured, when at the same time seed sown on land under similar conditions and similar in other respects failed to give satisfactory yields.

In a majority of instances farmyard manure cannot be spared for such a use. When it cannot, if necessary, commercial fertilizers may be applied. Those rich in phosphoric acid and potash are usually most needed, but sometimes nitrogen also is necessary. When nitrogen is used, it may be best applied on the growing crop and while it is young. Phosphoric acid and potash may be fitly applied when the land is being prepared, and in a way that will incorporate them with the surface soil. These may be used in the form of wood ashes, bone meal, Thomas' slag, Kainit, sulphate or muriate of potash, South Carolina rock and acid phosphate. Acid phosphate and muriate of potash stand high in favor with some growers when applied in the proportions of 9 and 1 parts and at the rate of, say, 200 pounds more or less per acre.

Sowing.—The date for sowing crimson clover would seem to depend more upon latitude than upon any other influence. North of the Ohio River it should seldom be sown later than September 1st, lest the growth of the plants should not be strong enough to endure the winter weather. Nor should it be sown earlier than July 1st, lest the plants should reach the blooming stage without having made a sufficient growth, an objection which applies to sowing earlier than July 1st in any part of the United States. All things considered, August is the most favorable month for sowing the seed north of the Ohio and Potomac rivers. In the South, sowing at a later period is preferable. In the latitude of Tennessee, September would usually prove more suitable for sowing than an earlier date, and near the Gulf, October. But it may be sown earlier and later in these respective latitudes. It is a good time to sow the seed in much of the South when the autumn rains begin to come, and the same is true of the Puget Sound country.

The seed may be sown by hand, by the aid of hand machines, by some makes of grain drills in the same way as grain is sown, and by others with a grass-seeder attachment. When sown by the latter, the seed should usually be allowed to fall before the grain tubes to aid in securing a covering for it; the covering thus provided should be supplemented by additional harrowing and in some instances rolling. When sown by hand or by hand machines on soils East and South, the roller should in many instances follow and then the harrow, but on cloddy

surfaces the harrow should be used first and then the roller. No method of sowing the seed is more satisfactory than that which sows it by grain drills, which can deposit it in the soil as grain is sown, as it is then buried at an even depth. Sowing to a medium depth, say, $\frac{1}{2}$ to $1\frac{1}{2}$ inches, is preferable to either extreme.

Whether it is advisable to sow a nurse crop will depend upon conditions. When the seed is sown early, in hot weather the young plants are helped by more or less of shade. Such shade is usually provided by the other factor or factors of the mixture. But when shade only is wanted from the nurse crop, a thin seeding of buckwheat has been found to answer. Melons and tomatoes have in some instances furnished shade satisfactorily, and in others upright growing varieties of cow peas or soy beans. The less complete the preparation of the seed-bed, the greater also is the necessity for shade. In orchards the shade of the trees is usually ample, and in some instances excessive. The same is true of vigorous corn and cotton crops.

Whether this clover should be sown alone or in mixtures will also depend upon conditions. If the crop is wanted solely for the enrichment of the land, it will usually be better to sow it alone, as crops other than legumes do not bring as much fertility to the land. As a rule, therefore, it should be sown alone in orchards. It should also, usually, be sown alone for soiling crops and for hay, but in some instances for both uses it may be sown with such crops as winter oats or winter vetches. On

some soils, however, these will too much crowd the clover plants. On others the reverse will be true. For seed the crop should, of course, always be sown alone.

For pasture, crimson clover is sometimes sown with rape, winter rye, winter oats, the common vetch or the sand vetch. When sown with rape, the date of the sowing should be early. With the other crops named the most suitable date for sowing the clover will usually prove the most suitable also for sowing these.

When sown alone, from 10 to 20 pounds of seed are used per acre. With all the conditions favorable, 12 to 15 pounds should suffice. When sown with rape for pasture, 3 pounds of rape and 10 of the clover, or even a less quantity, should be enough. When sown with winter rye or winter oats, about 1 bushel of each and 10 pounds of clover should suffice, and when sown with the common or the sand vetch, $\frac{1}{2}$ bushel of either and 10 pounds of the clover should be enough. When sown in the chaff, from 2 to 3 bushels ought to suffice, but the amount required will be much affected by the character of the seed crop.

Pasturing.—Crimson clover may be pastured in the autumn or in the spring or at both seasons, either when sown alone, or in conjunction with some other pasture crops, as winter rye, oats, barley or vetches. But it is not probable that it will ever become so popular as some other pasture plants that grow during the same seasons of the year; since, first, when it is grown, it is usually wanted for green

manure; second, it does not under some conditions grow satisfactorily with other crops; and third, when grazed down in the autumn the covering thus removed renders the plants much more liable to perish in the winter. When, however, it is sown early in the season, as in July, along with Dwarf Essex rape, or even alone, much grazing may be furnished, even though the clover should not survive the winter.

It may be grazed by horses, mules, cattle, sheep or swine, but when grazed with cattle and sheep, it is probable that some danger from hoven or bloat will be present, as when grazing other kinds of clover. (See page 94.) This danger, however, will be lessened, if not entirely removed, when nurse crops are grown with the clover, except in the case of rape. The grazing should not begin when the plants are small, lest the growth should be too much hindered at a season when growth is critical.

Harvesting for Hay.—Crimson clover is ready to be cut for hay when coming into, and a little before it is in, fullest bloom. Some authorities claim that it should be harvested when the blooms begin to appear. It should certainly not be allowed to pass the stage of full bloom, lest the hay when cured should prove hurtful to horses and possibly to other live stock, because of the presence of hair balls, which are then liable to form from the hairs so numerous found on this plant. These balls produce death by forming an impermeable wedge in the intestines of horses, thereby impeding and in some instances totally arresting the process of digestion. These balls, almost circular in form, are

composed of minute and rather stiff hairs, and several have been found in one animal. These hairs, numerous on the heads, do not stiffen sooner than the period of full bloom; hence, until that stage is reached in the growth of the plants, the danger from feeding cured hay made from them does not occur.

In New Jersey and the neighboring States, crimson clover is ready for being cut sometimes in May earlier or later, as the season is early or late. Further South it is fit to harvest earlier. At that season it is not easily cured, since then rains are more frequent than in the ordinary harvest season and the weather is less drying. Consequently, hay caps may frequently be used with much advantage by the growers of this hay. (See page 98.)

It is harvested as other clover; that is, it is cut with the field mower, raked when wilted, put up into cocks, and left to stand in these until it has gone through the sweating process, when the cocks are opened out again on a bright day for a few hours prior to drawing them. The tedder should be used freely in getting the hay ready to rake, as at that season of the year it dries slowly.

Securing Seed.—Crimson clover does not ripen quite so quickly after flowering as common red clover, owing, in part, at least, to the less intense character of the heat and drying influences at the season when it matures. Nevertheless, when it is ripe, unless it is cut with much promptness, the seed will shed much from the heads, and the heads will break off much during the curing process. If cut even two or three days too soon, the seeds will not be large

and plump. Moreover, showery or muggy weather will soon greatly injure the crop. One or two days of such weather after the crop has been cut will stain the seed; two or three days of the same will cause much of the seed to sprout, and three or four days will practically ruin the crop.

Because of the ease with which the seed sheds off the heads, it is better to cut the seed crop while it is a little damp, or at least to refrain from cutting during the greatest heat of the day. In some instances it is cut with the mower and raked early or late in the day, put up in small cocks and threshed from these in four or five days after being cut. But this method of harvesting, however carefully done, is attended with much loss of seed. It is better to harvest with the self-rake reaper, the rakes being so adjusted that the hay will be dropped off in small gavels or sheaves, so small that in two or three days they may be lifted without being turned over. Much care should be exercised in lifting the sheaves to avoid shedding in the seed, and it should be drawn on wagons with tight racks.

While it is not absolutely necessary to thresh the seed crop at once, the work can usually be done at that time with less outlay and with less loss of seed. It is threshed with a huller or with a grain separator with suitable attachments. Some attention must be given to the arrangement of the teeth used in the machine, lest many of the seeds, which are large, should be split; and as it is not easy to separate the seeds from the haulms, specially made riddles and sieves must needs be used.

The seed crop is usually harvested in June north of the Ohio and Potomac rivers, and southward from these in the month of May. The yield of seed runs all the way from 10 bushels per acre downwards. The average crop is 4 to 5 bushels.

Renewing.—Since crimson clover is an annual, but little can be done in the sense of renewing it on the same land without breaking the ground. But in orchards, it is sometimes grown from year to year by what may be termed a process of self-seeding. When the seed is not quite ripe in the heads, or even somewhat earlier, the orchard is plowed so as to leave some of the heads standing up along the line of the furrow. When these have matured, the land is harrowed, which scatters the seeds in the chaff, and from these another crop is produced. But to this plan there is the objection that it allows the clover to draw too heavily on the moisture in the soil before it is plowed under.

Facts Regarding Crimson Clover.—1. When crimson clover is sown so early in the season that it has at least three to four months in which to grow before winter sets in, the benefits to the land from sowing the seed will usually more than pay for the seed and labor, even though it should not survive the winter.

2. Prominent among the causes of failure where crimson clover does not succeed are: (*a*) The seed fails to germinate because of the want of moisture, or having germinated the young plants are killed by heat or drought; (*b*) they perish in the winter from exposure to cold winds or frosts, or by alter-

nate freezing and thawing in the soil; or (c) the land is too low in fertility to produce a sufficiently vigorous growth in the plants.

3. The mechanical effects upon the soil from growing crimson clover on it are very marked, especially when it inclines to stiffness, owing to the strong development of the root growth.

4. When crimson clover has been sown in the spring, a reasonably good growth is usually obtained before midsummer, even as far north as the Canadian boundary line, but since hot weather checks further growth and frequently causes wilting in the plants, this variety is not equal to some of the other varieties of clover for being sown at that season.

5. In the Southern States, crimson clover has been found to render considerable service by aiding in preventing land from washing in the winter season.

6. When plowed under in orchards, the work should be done at an early rather than a late stage in the growth of the plants, lest it should rob the trees of their rightful share of the moisture. Because of this, in some instances, if not in all, the plants should be buried before the season of full bloom and sometimes before the blooms begin to open.

7. The seed is more certain to germinate while yet enclosed in the chaff scales, and because of this, where home-grown seed is used, it may be worth while to secure it in this form by flailing out the seed or treading it out with horses.

CHAPTER VIII

WHITE CLOVER

White Clover (*Trifolium repens*) is also called Dutch, White Dutch, White Trefoil, Creeping Trifolium and Honeysuckle clover. The name Dutch clover has doubtless been applied to it because of the extent to which it is in evidence in the pastures and meadows of Holland; the name Creeping Trifolium, because of the creeping character of the stems, which, under favorable conditions, send roots down into the soil; and Honeysuckle clover, because of the honey supplies which it furnishes for bees. It is one of the plants known as Shamrock, the national emblem of Ireland.

White clover is perennial, the stems of which creep along the ground and, as above intimated, root at the joints; so that from this source plants are indefinitely multiplied. They also come from the seed. The leaves are small and very numerous, and with the exception of the flower stems and flowers, furnish all the forage obtained. The flowers are very numerous, especially when showery weather precedes and accompanies the flowering season. They are large for the size of the plant, are supported by a leafless stem of considerable length, and are white or tinted with a delicate rose color. The



Fig. 7. White Clover (*Trifolium repens*)

roots are numerous and fibrous. They cannot go down into the soil so deeply as the larger clovers; hence, the dwarfing effect of dry seasons upon the growth.

This plant is exceedingly hardy. It comes out from under the snow with a green tint, and the leaves are not easily injured by the frosts of autumn. The growth is not rapid until the general late rains of spring fall freely. It then pushes on rapidly, and, sending up innumerable flower stems, turns the pastures in which it abounds into immense flower gardens in the months of May and June, according to the latitude of the locality. The bloom remains out for a considerable time, and free grazing has the effect of prolonging the period of bloom. Under such conditions, blossoms continue to form and mature seeds during much of the summer. When these escape being grazed, they fall down upon the land and aid in forming additional plants. Hence it is that when white clover has once possessed a soil, it so stores the land with seed possessed of so much vitality that subsequently white clover plants grow, as it were, spontaneously on these lands when they have been thus grazed even for a limited term of years.

The power of this useful plant to travel and possess the land is only equalled by that of blue grass. When timber lands are cleared, white clover plants soon appear, and in a few years will spread over the whole surface of the land. But the amount of grazing furnished by it varies greatly with the character of the season. Some seasons its bloom

is scarcely in evidence; other seasons it overspreads the pastures.

While it is an excellent pasture plant for stock, they do not relish it so highly as some other pasture plants; when forming seed, it is least valuable for horses, owing to the extent to which it salivates them. Its diminutive habit of growth unfits it for making meadows, unless in conjunction with other hay plants. In nutritive properties, it is placed ahead of medium red clover. Some growers have spoken highly of it as a pasture plant for swine.

Being a legume, it has the power of enriching soils with nitrogen, but probably not to so great an extent as the larger varieties of clover. Its rootlets, however, have a beneficent influence on the texture of soils, because of their number, and because of the power of the stems to produce fresh plants, which occupy the soil when other plants die. The latter furnish a continued source of food to other grasses, which grow along with white clover in permanent pastures.

Along with blue grass, white clover plants aid in choking out weeds. This result follows largely as the outcome of the close sod formed by the two. But in some soils, plants of large growth and bushes and young trees will not thus be crowded out.

Distribution.—White clover is certainly indigenous to Europe and to the Northern States, and probably Western Asia. It grows in every country in Europe, but with greatest luxuriance in those countries which border on the North Sea, the climates of which are very humid, and more especially

in the Netherlands and Great Britain. It stands in high favor in Holland, but is not regarded so highly in England, owing, probably, to the great variety of grasses grown there in permanent pastures. It is generally thought that it was not indigenous to the Southern States, but has reached these from those farther north. It would seem to be capable of growing in all countries well adapted to the keeping of cattle; hence, it follows in the wake of successful live-stock husbandry.

White clover seems able to adapt itself to a great variety of climatic conditions. Nevertheless, it is certainly better adapted to a moderately cool climate than to one that is hot, and to a moist, humid climate than to one that is dry. It has much power to live through dry seasons, but it will not thrive in a climate in which the rainfall is too little for the successful growth of small cereal grains. Where snow covers it in winter, this clover will grow on timber soils as far north as any kind of cereal can be made to mature; and it will also grow as far south as the Mexican boundary on the higher grounds, when there is enough moisture present to sustain it.

It would probably be correct to say that this plant is found in every State in the Union, and that it succeeds well in nearly all the Northern States, from sea to sea. Although it grows well in certain parts of the Southern States, especially in those that lie northward, the general adaptation in these is not so high as in those further north. The highest adaptation in the United States is probably found in the Puget Sound region and in the hardwood

timber producing areas of the States which lie south from the Great Lakes and in proximity to them, as Northeastern Minnesota, Northern Wisconsin, Michigan, Ohio and New York. But the adaptation is also high in the more elevated of the mountain valleys of the Northwestern States when irrigated waters may be led on to these lands. The areas lowest in adaptation are those that lie within the semi-arid belt. The low-lying lands of the South, where hot weather is prolonged in summer, are likewise low in their adaptation, but not so low as the former. The prairie areas of the Northern Mississippi basin have an adaptation for growing white clover that may be termed intermediate, but where hardwood forests grow naturally on these the adaptation is high. In New England the climatic conditions are very favorable, much more so than the soil conditions.

In Canada, conditions are found highly favorable to the growth of this plant in the country lying eastward from Lake Huron, north of Lakes Erie and Ontario and also on both sides of the St. Lawrence River. Adaptation is also high along the Pacific and in the mountain valleys not distant from the Pacific. In all the areas of Canada, which once produced forests, this plant will grow well. But north from Lakes Huron and Superior, the soil conditions are against it, because of their rocky character. Certain forest areas west from Lake Superior, and also in other parts, the sandy soils of which sustain a growth of Jack Pine (*Pinus murrayana*) trees, do not grow white clover with much vigor.

The prairie areas of Canada, westward from Lake Superior to the mountains, do not grow white clover with much success, and the adaptation for its growth would seem to lessen gradually until the Rocky Mountains are approached.

Soils.—Small white clover will grow on almost any kind of soil, but by no means equally well. Highest, probably, in adaptation, especially when climatic conditions are considered along with those of soil, are the clay loams west of the Cascade Mountains and northward from California to Alaska. During the moist months of early summer, this plant turns the pastures in these areas into a flower garden. Almost equally high in adaptation are the volcanic ash soils of the Rocky Mountain valleys. When amply supplied with water, the finest crops of white clover can be grown even superior to those grown on the lands described above. Almost the same may be said of what are termed the hardwood timber soils, which are usually made up of clay loam lying upon clay. Such areas abound in Minnesota, Wisconsin, Michigan, Ontario and some States further south. In these soils it grows with much luxuriance, more especially when lime and potash are abundant. Similar luxuriance may be looked for in the deposit soils of river basins in which the clay element predominates, but not in those that are largely made up of sand. It will also grow well on the stiffest clays, whether white or red, when moisture is present. On prairie soils, the success attending it is dependent largely on their texture, composition and the moisture which they

contain under normal conditions. The more firm these soils are, the better will the clover grow in them, and *vice versa*. This is equivalent to saying that the more clay they contain, the better will the white clover grow in them.

Where the humus soils of the prairies are deep and are underlaid with clay, white clover will grow much better in the subsoil, if laid bare, than in the surface soil. Prairie soils which lift with the wind are ill adapted to the growth of this plant, whatsoever may be their composition. Much of the soil in the semi-arid belt would grow this plant in fine form, but want of moisture, where irrigation is absent makes its growth prohibitory in a large portion of this area. On ordinary slough soils, this clover finds a congenial home, but it will not grow quite so well, relatively, in these as alsike clover. On sandy soils, such as those on which Jack pine and Norway pine (*Pinus resinosa*) grow, this plant will maintain itself, and in wet seasons will make considerable showing on these; but in very dry seasons the plants will die, the growth the following season coming from seeds already in the soil. In the soils of the extreme South, the inability of white clover to make a good showing is probably more the result of summer heat than of want of power in the plants to gather food. In those of the Southwest, want of moisture and excessive heat render its growth, in a sense, prohibitory.

Place in the Rotation.—Since white clover is usually not sown for meadow, but is rather sown for pasture, it can scarcely be called a rotation plant

in the strict sense of the term; and yet, because of the extent to which it grows when it has once obtained a footing in soils, it is more or less frequent in all rotations in which grass or clover is one of the factors. As it usually comes into the grass pastures, when these have become established, it will occupy about the same place as blue grass in rotations; that is to say, whatever would be proper to sow after the blue grass would be proper to sow after this plant; since the two usually unite in making the same sod. It will, therefore, be in order to follow this plant with corn to feed upon the nitrogen furnished by the clover. The same will be true of any small cereal that has special adaptation for being grown on overturned sod, as for instance, flax or oats, or of any crop that revels in the decay of vegetable matter, more especially in the early stages of such decay, as, for instance, potatoes and rape. When white clover is sown on land that is cultivated, though only sown as a factor in a pasture crop, as with all other clovers it may best be sown on land that is clean; that is, on land on which the preceding crop has been cultivated to the extent of securing a clean surface on the same. If, however, this crop must needs be sown on land that has not been thus cleaned, its great inherent hardihood will enable it to establish itself where some clovers and grasses would fail.

It is common to sow white clover on land from which the forest has recently been removed, also on natural prairie, where it has not previously grown. In these instances it simply follows the

crop of forest in the one case and of native prairie in the other. But it will not take possession of the land in either case to the exclusion of other grasses.

Preparing the Soil.—The preparation of the soil for growing this plant is much the same as for growing other plants of the clover or grass family. Fineness, firmness, cleanness and moistness are the chief essentials to be looked for in making the seed-bed. For the same reason that it has much power to grow among weeds for so small a plant, it has also much power to grow on surfaces not in the best condition of preparation for receiving so small a seed. But when sown to provide a seed crop, it is specially necessary to make the land thoroughly clean before sowing the seed. This is necessary for the reason, first, that small white clover, because of its tardiness in growing in the spring, and because of its comparatively small growth has not much power to crowd weeds; and second, because of the labor involved in preventing weed seeds from maturing in a crop that ripens its seeds somewhat late in the season. While it is advantageous to burn off the grass from a natural meadow where white clover is to be sown, it is not so essential, nevertheless, as when preparing such land for being sown with some other varieties of grass or clover. The young plants will endure under conditions which would cause those of many other varieties to fail.

Sowing.—White clover is sown by much the same methods as the medium red variety. (See page 75.) But it will stand more hardship than the other variety; hence, it may be sown earlier. This

means that it may be sown in northerly latitudes any time, from the melting of the winter snows until early summer, and in southern latitudes almost any season, except during the hot summer months. In either latitude, however, the early spring is usually the most suitable season for sowing.

The seed may be sown by hand, by hand machines, or by the seeder attachment of grain drills. It is more commonly sown along with other clovers and grasses, and the methods of sowing these will also be suitable for the sowing of white clover. (See page 18.) But when the seed is sown alone, as for producing seed crops, the nurse crop need not of necessity be sown thinly, from the fear that the young plants should be smothered by an undue density of shade.

There is no mixture of clovers and grasses grown for pasture to which this plant may not be added with profit, providing the seed is not already in the land in sufficient supply. But it is seldom sown with either clovers or grasses, or with these combined, for the production of hay. It is the judgment of the author, however, that in localities which have special adaptation for the growth of this plant, it should render excellent service in providing hay for sheep, if sown along with alsike clover, and a little timothy; the latter being sown mainly to support the clovers so that they will not lodge. The white clover would furnish hay considerably finer even than the alsike; hence, such hay should be peculiarly adapted to the needs of sheep. Some authorities object to the presence of white clover in

hay intended for horses or cattle, lest it should induce in them more or less salivation. The author leans to the opinion that in cured hay injury from the source named will in no instance prove serious, owing to the small amount, relatively, of white clover in average hay crops.

The amount of seed to sow will vary with such conditions as soil, climate and the nature of the pasture, but in any event it need not be large. The seeds of white clover are small, considerably smaller than those of alsike. For ordinary grazing along with other grasses, or grasses and clovers, it will seldom be necessary to sow more than 1 pound of seed per acre. Sometimes a less quantity will suffice, as when there is more or less of seed in the land, and, as already intimated, because of the store of seed in the land in many instances, it is not necessary to sow it at all. Especially is this true of sections which have been tilled for some time. When sown with alsike clover to provide hay, 2 pounds of seed per acre would be a maximum amount, and 4 pounds when sown alone to provide seed.

When sown in newly cleared forest lands or on prairie sod, the methods to be followed will depend upon circumstances. More commonly when thus sown the seed is not covered artificially; consequently, much of it in dry seasons may not grow. The plan, therefore, of sowing small amounts of the seed on such lands two years in succession would be safer than to sow twice the amount of the same in one year. In time this clover would find its way into such areas. It comes through such

agencies as birds, hay fed to teams engaged in lumbering, and the overflow of streams; and as soon as it gets a foothold its distribution is further accelerated by the droppings of cattle which contain the seeds, and by the winds.

The power of this plant to increase is simply wonderful. This is owing to: 1. The relatively large number of seedheads produced from the plants. 2. The power which these have to multiply by means of rootlets from the incumbent stems, which fasten into the soil. 3. The prolonged season during which the heads form. 4. The habit of growth in many of the heads, because of which they are not grazed off. 5. The strong vitality of the seed. And 6. The great hardihood of the plants.

Pasturing.—White clover ranks next to blue grass as a pasture plant within the area of its adaptation (see page 261), when its productiveness, continuity in growth, ability to remain in the land, palatability and nutritive properties are considered together. In palatability it ranks as medium only. In the early part of the season while it is still tender and juicy, it will be eaten by stock with avidity, but as the seed-maturing season is approached, it is not so highly relished. In nutrition it ranks higher than medium red clover. It does not make much of a showing in the early part of the season, but in favorable seasons, about the time that blue grass begins to fail, it grows rapidly and furnishes much pasture.

It is pre-eminently the complement of a blue-grass pasture. When these grow together, the two will

furnish grazing in a moist year through all the season of grazing. Both have the property of retaining their hold indefinitely in many soils and of soon making a sward on the same without being re-sown, when the cultivation of the ground ceases. The blue grass grows quickly quite early and late in the season, and the clover grows likewise during much of the summer. As the older plants of the clover fail, fresh ones appear, and the blue grass feeds on the former in their decay. They thus furnish humus and nitrogen for the sustenance of the blue grass.

But much moisture is necessary in order to insure good blue grass pastures, and they are more luxuriant when the moisture comes early in the season, rather than when the plants are nearing the season of bloom. To such an extent is white clover influenced in growth by such weather, that in some seasons it will abound in certain pastures, while in others it will scarcely appear in the same. Those favorable seasons are frequently spoken of as being "white-clover years."

While this plant furnishes good grazing for all kinds of domestic animals kept upon the farm, as a pasture for horses and mules, there is the objection to it that it will in a considerable degree so salivate them that much "slobbering" follows. This is sometimes produced to such an extent as to be seriously harmful. The trouble from this cause increases as the seed-forming season is approached. It has been known thus to salivate cattle, but the danger of injury to them from this source is slight.

These injurious results to horses will be obviated in proportion as the other grasses are allowed to grow up amid the clover; in other words, in proportion as the pasture is not grazed closely early in the season. The animals which then graze on these pastures must take other food with the clover.

Harvesting for Hay.—Since white clover is seldom grown alone for hay, and since it seldom forms the most bulky factor in a hay crop, the methods of harvesting will be similar to those practiced in harvesting the more bulky factor or factors of the crop. The want of bulk in this clover is against it as a hay crop, owing to the smallness of the yields, compared with the other hay crops that may be usually grown on the same land. As a factor of a hay crop, however, this little plant will add much to its weight and also to its palatability, especially for sheep and dairy cows.

When it is grown for hay in mixtures in which the large clovers or timothy predominates, the white clover should, of course, be cut at the most suitable season for cutting these clovers or the timothy, as one is present in excess. When the larger clovers predominate, the method of curing will be the same as for curing these (see page 234), that is to say, it can best be cured in cocks. When timothy predominates, the method of curing will be the same as for timothy; that is to say, it may be cured in the cock or in the winrow, according to circumstances. Owing to the fineness of the stems, it may be cured more quickly than red clover; hence, its presence in a crop of timothy will not delay much the curing

of the latter unless when present in great abundance.

Under some conditions it would be easily possible to grow white clover for hay alone, and in some instances with profit, more especially in providing what would be a matchless fodder for young lambs and young calves. It might be so grown in the clover lands that lie immediately southward from Lakes Superior and Huron, in the northern Rocky Mountain valleys and on the valley lands around Puget Sound. On these lands in a favorable season, it would be quite possible to cut not less than 2 tons per acre, while on average land white clover alone would not yield more, probably, than $\frac{1}{2}$ ton per acre. But even when grown for the purpose named, some alsike clover sown along with the white clover would add to the yield of hay, and without in any considerable degree lessening its value for the use named.

Securing Seed.—White clover is a great seed-producing plant. The season for bloom covers a period relatively long, and the number of blossoms produced under favorable conditions on a given area is very large. But when seed crops are to be produced with regularity, it is necessary that moisture can be depended upon in sufficient supply in the spring months to produce a vigorous growth in the plants. Such a climate is found in the Puget Sound country and in a less degree for some distance south from Lakes Huron and Superior. In areas which can be irrigated, it is not imperative that the climate shall be thus moist. Such areas, therefore,

may be looked upon as possessed of superior adaptation for the growth of seed crops of white clover.

The areas are limited, however, in which seed crops are grown in the United States; so limited are they that it has been found very difficult to locate them. Wood County in Central Wisconsin grows a considerable quantity, and some counties northward in the same State, and probably also some parts of Northern Michigan, will grow seed equally well.

Where a seed crop is grown every care should be exercised to have it free from foul weeds. The aim should be to grow it on clean land. Sometimes, however, the seed is self-sown; that is, it comes into the land without being sown, but even in such areas it is safer to sow 3 pounds of seed per acre in the early spring along with a nurse crop. The best seed crops in Wisconsin and Michigan are grown on a reasonably stiff clay soil. To get a full crop of seed, it should be pastured for a time in the spring, or the crop should be run over with the mower about June 1st, setting the mower bar so as to cut 3 or 4 inches high. No harm will follow if some of the tops of the clover should be cut off. The grass and weeds thus cut are usually left on the ground, but sometimes it may be necessary to remove them. In a short time the field should be one mass of bloom.

The crop is ready for being harvested when the bulk of the heads have turned a dark brown and when the bulk of them have assumed a reddish brown tint, notwithstanding that some of the later

heads may still be in full flower. Vigorous crops may be cut with the self-rake reaper set to cut low, otherwise many of the heads will not be gathered. To facilitate this process, the ground should be made quite smooth even before sowing the seed. But the seed crop is more commonly cut with the field mower, to the cutter bar of which a galvanized platform is bolted, the sides of which are about 6 inches high. From this the clover is raked off into bunches with a rake. These bunches should not be large, and since nearly all the heads in them will point upward, they should not be turned over if rained on, but simply lifted up with a suitable fork and moved on to other ground.

The seed crop cures quickly. It may be drawn and threshed at once, or it may be stacked and threshed when convenient. If stacked, a goodly supply of old hay or straw should be put next the ground, and much care should be taken to protect the clover by finishing off the stack carefully with some kind of grass or hay that will shed the rain easily. Since the heads are very small and numerous, and since, as with all clovers, they break off easily when ripe, much promptness and care should be exercised in harvesting the seed crop. The best machine for threshing a seed so small is the clover huller.

The yields of seed will run all the way from less than 3 bushels per acre to 5 bushels, and some crops have been harvested in Wisconsin which gave 7 bushels per acre. Four bushels would probably be about an average yield. As the price is usually

relatively high compared with other clovers, the seed from white clover would be quite remunerative were it not that in a dry season the yield is disappointing. In some instances two crops are grown in succession; in others, one crop is reaped. The land is then sown to barley the next year, and the following year clover seed may be reaped again without sowing a second time. Usually, after two successive crops of seed have been cut, blue grass crowds the clover.

It should be possible to grow prodigious crops of white clover in certain of the northern Rocky Mountain valleys, as, for instance, in Montana and Washington, where the conditions for the application of water to grow the plants and of withholding the same when ripening the seed are completely under the control of the husbandman. The soils in these valleys, as previously intimated, have high adaptation for growing white clover.

Renewing.—White clover is probably more easily renewed than any plant of the clover family. In fact, it seldom requires renewal in a pasture in which it has obtained a footing as long as it remains a pasture. This arises from the abundance of the seed production and from the power of the same to retain germinating properties for a long period. Nevertheless, there may be instances when it may be wise to scatter more seed in the early spring in a pasture in which white clover may not be sufficiently abundant. It is also renewed, in a sense, when suitable fertilizer is applied on the pastures. A dressing of potash will greatly stimulate the

growth of any kind of clover on nearly all soils; hence, the marked increase in the growth of the clover that usually follows the application of a dressing of wood ashes, especially in the unleached form. Top-dressings of farmyard manure are also quite helpful to such growth.

The conclusion must not be reached that because white clover is not much in evidence in a permanent pasture for one or two, or even three dry seasons, if these should follow each other, that it will not come again and with great vigor and in much abundance when a wet season arrives again.

For Lawns.—No other plant of the clover family is so frequently sown when making lawns. For such a use it is not sown alone, but is always the complement of Kentucky blue grass or of a mixture of grasses. No two plants can be singled out that are more suitable for lawn making than white clover and Kentucky blue grass. Both are fine in their habit of growth. The two in conjunction usually make a more dense sward than either alone, and the clover will grow and produce many flowers, if not kept clipped too closely when the blue grass is resting in midsummer.

As lawns are usually small, and a dense sward is desired as quickly as it can be obtained, the seed should be sown thickly on lawns, at the rate of not less than 5 pounds of seed to the acre. The early spring is the best time for sowing the seed, but in mild climates it may be sown at almost any season that may be convenient, providing the ground is moist enough to germinate the seed. In cold cli-

mates, the seed should be sown not later than August, unless when sown too late for autumn germination. This in some instances may not only be proper, but commendable.

As a Honey Plant.—White clover is proverbial for its ability to furnish honey. There is probably no single plant which furnishes more or better honey. But its value for such a use varies greatly in different years. In seasons that are quite dry in the spring, it makes but little growth and produces but few blossoms; hence, in such seasons bees can obtain but little honey, relatively, from such a source. It would doubtless be good policy, therefore, for the growers to encourage the sowing of alsike clover where bees are much kept, since the growth of this clover is less hindered by dry weather at the season named. Less close pasturing than is commonly practiced would favorably influence the production of honey from white clover, and would also result in considerably greater yields of pasture.

CHAPTER IX

JAPAN CLOVER

Japan Clover (*Lespedeza striata*) was introduced from China or Japan, or from both countries, into South Carolina in 1849, under the name Japan clover. It is thought the seed came in connection with the tea trade with these countries. According to Phares, the generic term *Lespedeza*, borne by the one-seeded pods of the plants of this family, was assigned to them in honor of Lespedez, a governor of Florida under Spanish rule. It is sometimes called Bush clover, from the bush-shaped habit of growth in the plants when grown on good soils, but is to be carefully distinguished from the Bush clovers proper, which are of little value as food plants.

Japan clover is an annual, but owing to its remarkable power to retain its hold upon the soil, through the shedding of the seed and the growing of the same, it has equal ability with many perennials to retain its hold upon the soil. It does not start until late in the spring, nor can it endure much frost; but its ability to grow in and retain its hold upon poor soils is remarkable, while its powers of self-propagation in the South would seem to be nearly equal to those of small white clover (*Trifolium repens*) in the North. It is, therefore, one of the hardiest plants of the clover family. Where it

has once obtained a foothold, in some soils, at least, it has been known to crowd out Bermuda grass and even broom sage.

The form of the plants is much affected by the character of the soil in which they grow. On poor soils, the habit of growth is low and spreading; on good soils, it is more upright. But it is always more or less branched, and the stems are relatively stiffer than those of other clovers. They rise but a few inches above the ground in poor soils, not more than 2 to 4; but in good rich soils it will attain to the height of 2 feet. About 1 foot may be named as the average height. The leaves are trifoliate. The flower produced in the axils of the leaves are numerous, but quite small. They appear from July onward, according to locality, but are probably more numerous in September, and vary from a pink to a rose-colored or purplish tint. The seed pods are small, flattish oval in shape and contain but one seed. The tap roots are strong in proportion to the size of the plant and are relatively deep feeding; hence, the ability of the plant to survive severe drought. The roots have much power to penetrate stiff sub-soils.

Japan clover is not usually relished by stock at first, but they soon come to like it, and are then fond of it. Close grazing does not readily injure it; it also furnishes a good quality of hay, but except on reasonably good soils, the yields of the hay are not very large. The chemical analysis compares well with that of red clover.

Japan clover is also an excellent soil renovator.



Fig. 8. Japan Clover (*Lespedeza striata*)

In the Southern States, it is credited with the renovation of soils so poor that the return was not worth the labor of tillage. Throughout much of the South, it has rendered much service in thus improving soils. It also grows so thickly on many soils as to lessen and, in many instances, entirely prevent washing, that great bane of Southern soils. It will even grow and produce some pasture under the shade of grass or Southern pines.

Distribution. —Japan clover is said to be native to China and other countries in Eastern Asia. When introduced into Japan, the soil and climatic conditions proved so favorable that before long it spread out over the whole island. Since its introduction into the United States it has spread very rapidly.

Since it does not grow early in the season, it needs a warm climate. It grows much better in moist weather than in a time of drought, but it will also continue to grow in the absence of rain until the drought becomes excessive. It will then wilt down on poor soils, but grows again as soon as rain falls.

Since the introduction of Japan clover into the United States in 1849, or, as some think, somewhat earlier, it has spread over the entire South, from the Ohio River to the Gulf, from the Atlantic to the Mississippi, and also to the States of Arkansas, Louisiana and Texas beyond the Mississippi. It was early introduced into Georgia, and came into much favor there. It reached Tennessee in 1870, and soon spread over many counties. It came later into Louisiana, but soon became very popular there, largely through the efforts of Colonel J. Burgess

McGhee of West Feliciana, who gave much attention to cultivating it and placing it before the public. While it will grow readily in any part of the South, it renders better service in the Gulf States than in those farther north, owing to the longer season for growth. North of the Ohio River it is not likely to be cultivated, since in the Northern States it is not needed, because of the abundance of the red clovers and also the small white. It is a less abundant producer than the red clovers, and is also less palatable. Moreover, the season for growing it is much shorter in these States than in those south; a fact which greatly lessens its adaptation to northern conditions.

Japan clover has no mission for any of the provinces of Canada, and for the reason that it has no mission for the Northern States.

Soils.—Japan clover is adapted to a wide range of soils. There would seem to be a concensus of opinion in the Southern States that it will grow on almost any kind of soil. It has grown well on hard, stiff clays, both white and red; on sandy levels; on gravelly undulations and slopes; on the banks and in the bottom of gullies; on soils too poor to produce other crops, as on denuded hills and also in groves. But it will grow much better, of course, on good, rich land, as on moist loams and rich alluvial soils. While it prefers moist situations, it is not well adapted to saturated lands. There is no useful pasture plant in the South that would seem so well able to fight its own battle unaided on poor soils as Japan clover, nor is there any which has brought

so much of renovation to these for the labor involved.

Place in the Rotation.—Japan clover can scarcely be classed as a rotation plant in the strict sense of the term, since it more frequently comes into the fields, as it were, spontaneously, and owing to the uncommon degree to which it has the power of re-seeding itself, it is frequently grown and grazed for successive years on the land upon which it has been allowed thus to grow. Nevertheless, since it is a nitrogen gatherer, when it has fertilized the land sufficiently by bringing to it a supply of nitrogen and by putting humus into it, crops should follow such as require much of growth to grow them in best form. Such are cotton, corn and the small cereal grains. Owing to its power to grow on worn and even on abandoned soils, and to crowd weeds that grow on them, on such soils it comes in between the cessation of cultivation and the resumption of the same. It frequently grows as a volunteer crop along with Johnson grass, and where it comes, it tends to crowd grasses of but little value, as brown sage.

Where pasture is desired winter and summer, it should be quite possible in some localities to obtain it by sowing such crops annually, as winter oats and sand vetches (*Vicia villosa*) every autumn, and the seed of Japan clover on the same. The crops first named would provide winter and spring grazing, and the clover, summer and autumn grazing. The clovers and the vetches would both aid in fertilizing the land.

Preparing the Soil.—While careful preparation of the land will result in more certain and uniform germination in the seed, and more rapid growth in the plants, careful preparation of the seed is not so necessary with Japan clover as with many other pasture and hay plants. The seeds are strong in germinating power and the plants are much able to grow, even under adverse conditions, when they do germinate. Usually, the preparation which is suited to nurse crops, amid which this clover is sown, will be suited also to the clover when it is sown thus.

In many instances, however, it is allowed to re-seed itself where it has been once sown, or even where it may have come into the soil without sowing. In this way successive pasture crops have been obtained. But usually where hay crops are wanted, it will prove more satisfactory, all things considered, to sow the seed.

In many instances, simply scarifying the ground has been found a sufficient preparation for the seed. Any implement that will pulverize the surface for a few inches downward will answer for such work. In very many instances, seed, of course, self-sown has become rooted and grown vigorously on unplowed land.

Sowing.—Japan clover is more commonly sown in the spring, but it is sometimes sown in the autumn. There is more or less of hazard in sowing it in the autumn north of the Gulf States, since when the plants are young they will not stand much frost. For the same reason, there is the element of hazard in sowing it too early in the spring. Spring sowing

stands highest in favor, taking the whole area into account, in which the clover is grown. While it is possible to sow the seed too early in the spring, it will be readily apparent that the earlier it may be sown without hazard to the young plants, the better will be the returns, because of the growth secured before the advent of dry weather.

The seed may be sown by any of the methods adopted when sowing medium red clover. (See page 78.) The method which is most labor-saving, however, when sown with a nurse crop, is that which sows it with an attachment to the grain drill used in sowing the nurse crop. If allowed to fall in front of the drill tubes, it will not usually need any other covering than that furnished by the drill tubes followed by the roller.

It may be sown with any of the small cereals, whether these are grown for pasture, for hay, or for grain. When these are fall sown and the clover seed is not sown until the spring, it will be well worth while, when the weather and soil will admit of it, to cover the seed with the harrow. It may also be advisable to sow the seed in pastures, as, for instance, along with orchard grass, or with tall oat grass, as it would tend to fill the vacancies in the land.

When sown alone, 10 pounds of seed per acre will usually suffice. But where there is much seed in the land that has been self-sown, a less quantity will suffice. Where hay crops are wanted from year to year on the same land, it may be obtained by simply disking the land and re-sowing. If the

hay is allowed to approach maturity before being cut, sufficient seed will fall to re-sow the land for the next year's crop, but the quality of hay so ripe is not so good as if cut earlier. In pastures, the grazing must not be too close when self-seeding is wanted.

Pasturing.—Japan clover is much used in providing grazing in the South. Some writers have spoken of it as being the most valuable grazing plant that grows in the South. Viewed from the standpoint of productiveness, this would be assigning it too high a place, since Bermuda grass produces more grazing, but taking productiveness and the probable influence exerted on soil fertility together, the estimate may be correct. The ease with which Japan clover may be propagated is also a strong point in its favor.

Since it starts late in the spring, it only provides grazing during the summer and autumn months, from May, June or July onward, according to the locality, and it fails with the appearance of the first heavy frosts. In moist situations, it will furnish grazing during all the summer and autumn, if not allowed to seed, but in time of drought, it may wither on dry, thin soils and come on again when the rains of autumn begin to fall. In order to keep the grazing tender and palatable, it should be reasonably close. If allowed to mature much seed before grazing begins, the plants will then die, to the great injury of the grazing.

That stock do not take kindly to it at first, as they do to alfalfa and some other plants, cannot be

doubted. But they can soon learn to relish it. It has been praised both for milk and meat production; hence, the aim should be to have it in all permanent pastures. In some of these it may be necessary to sow a few pounds of seed per acre at the first. If the grazing is not too close, the plants thereafter will sufficiently re-seed the land. It has been found quite possible in short rotations to secure pasture from Japan clover without sowing it on land on which it has once grown. But to accomplish this effectively, the grazing must not be so close as to preclude a self-seeding. By growing such plants for winter and spring grazing, as turf oats and sand vetches, and then grazing the Japan clover, which will grow later on lands thus managed, grazing may be furnished indefinitely from year to year.

Harvesting for Hay.—Japan clover is a good hay plant when grown on strong soils. The quality is good also when grown under adverse conditions, but the quantity is deficient. On good soils, the yield is from 1 to 2 tons per acre, the average being about $1\frac{1}{4}$ to $1\frac{1}{2}$ tons. The hay is also quite merchantable in Southern markets. It is considered superior to baled timothy—timothy brought in from the North—especially when fed to cows producing milk. Japan clover is best cut when the plants are in full bloom. But harvesting is frequently deferred to a period somewhat later where self-seeding of the land is desirable. Late cutting, however, lowers the quality of the hay, both as regards palatability and digestibility. Much that has been said as to the

curing of medium red clover will also apply to Japan clover.

Successive crops of hay may be grown from year to year on the same land, as already intimated. (See page 285.) But where other crops are wanted on the same farm, it would be wiser to grow these in some sort of alternation or succession with the clover crops, so that the former could feed upon the nitrogen brought to the land by the clover.

Securing Seed. — Japan clover is ready for being harvested when the major portion of the seeds are ripe. This is late in the season. The seed crop is more easily gathered when grown on good land, owing to the more upright habit of growth. The self-rake reaper is probably the best implement for cutting, since it lays it off in loose sheaves, and on well-prepared land it may be made to cut so low as to gather the bulk of the seed. But it may also be cut with the field mower as small white clover is frequently cut. (See page 275.) Owing to the lateness of the season at which the seed matures, careful and prompt attention may be necessary to secure the seed crop without loss, owing to the moistness which characterizes the weather at that season.

When Japan clover is to be harvested for seed, care should be taken to prevent weeds from ripening their seeds in the same. With a view to prevent this, it will be found helpful in many instances to run the mower over the field some time after the clover has begun to grow freely in the late spring or early summer. Such clipping will also have the effect of

securing more uniformity in the ripening of the seed.

The seed may be threshed in much the same way as other clover seed. (See page 107.) The yields per acre should run from 3 to 8 bushels. It weighs 20 pounds per bushel.

Renewing.—Since Japan clover is an annual, it is not necessary to renew it, in the sense in which more long-lived clovers are renewed, as, for instance, the alsike variety. (See page 216.) About the only renewal practicable is that which insures successive crops of pasture, hay or seed from the same land where the crop has once been grown. (See page 285.) But the growth may, of course, be stimulated by the application of dressings of fertilizer, such as gypsum, or those that may be termed potassic in character.

CHAPTER X

BURR CLOVER

Burr Clover (*Medicago maculata*) is sometimes called Spotted Medick and sometimes California clover, also Yellow clover. The name burr clover has doubtless arisen from the closely coiled seed pod, which, being covered with curved prickles, adhere to wool more or less as burrs do. The name Spotted Medick has been given because of the dark spot found in the middle of the leaflets, in conjunction with the family of plants to which it belongs. The name California clover is given because of the claim that it was much grown in California after having been introduced there from Chili, and the name yellow clover, from the color of the blossoms. After its introduction into the United States, seedsmen sell California and Southern burr clover as two varieties, but the correctness of the distinction thus made has been questioned. Many persons were wont to confuse it with alfalfa, or, as it is frequently called, lucerne, but the latter is much more upright in its habit of growth, grows to a greater height, has more blossoms, blue in color, and seed pods more loosely coiled. It is also to be distinguished from a variety (*Medicago denticulata*) which bears much resemblance to it, and which, growing wild over portions of the plains and foothills of the West, affords considerable pasture.

Burr clover may properly be termed a winter annual, since the seed comes up in the autumn, furnishes grazing in the winter and spring, and dies with the advent of summer. It is procumbent or spreading and branched. On good soil some of the plants radiate to the distance of several feet from the parent root. They have been known to overlap, and thus accumulate until the ground was covered 2 feet deep with this clover, thus making it very difficult to plow them under. It is only under the most favorable conditions, however, that the plants produce such a mass of foliage. The leaves are composed of three somewhat large leaflets. The flowers, as previously intimated, are yellow, and there are but two or three in each cluster, but the clusters are numerous; hence, also the pods are numerous. They are about $\frac{1}{4}$ of an inch broad, and when mature are possessed of considerable food value.

Burr clover grows chiefly during the winter, and is at its best for pasture during the months of March and April, and in the Gulf States dies down after having produced seed in May. Though it is frequently sown, it has the power of self-propagation to a marked degree, which makes it possible to grow many crops in succession without re-seeding by hand.

It is not considered a good hay plant, but its value for pasture is considerable, although, as a rule, animals do not take kindly to it at first, as they do to alfalfa or medium red clover, but later they become fond of it, but less so, probably, in the case

of horses than of other animals. Being a legume, it is helpful in enriching the land, and being a free grower, it improves the soil mechanically through its root growth, and also through the stems and leaves, when these are plowed under.

Distribution.—Burr clover is said to be native to Europe and North Africa, but not to North America, although it has shown high adaptation in adapting itself to conditions as found in the latter.

Although this plant is hardy in the South, and, as previously stated, makes most of its growth in the winter, it is not sufficiently hardy to endure the winters far northward. Its highest adaptation is found in States around the Gulf of Mexico. It also grows with more or less vigor as far north as North Carolina, Tennessee and Arkansas. For these States its adaptation is, on the whole, higher than crimson clover, although where the latter will grow readily it is considered the valuable plant of the two.

For Canada, burr clover has no mission, owing to the sternness of the winter climate in that country.

Soils.—While burr clover will grow with more or less success on almost any kind of soil possessed of a reasonable amount of fertility and moisture, it is much better adapted to soils alluvial in character and moist, as, for instance, the deposit soils in the bottom of rivers. Its power to fight the battle of existence on poor lands is much less than that of Japan clover, but on soils that grow crops, such as corn or cotton, it may be made to render a service

which the other cannot, since it grows chiefly in winter and early spring, whereas Japan clover grows in the summer and early autumn, when cultivated crops occupy the land.

Place in the Rotation.—Burr clover is grown more in the sense of a catch crop and for pasture than in that of a crop to be marketed directly. Since it is grown in the winter and spring, it may be made to come in between various crops. On good producing lands of the South it has given satisfaction as a pasture plant for winter for many successive years without re-sowing by hand, when sown in conjunction with crab grass (*Panicum sanguinale*) for hay. Dr. Phares grew it thus in Mississippi for about 20 years. In June crab grass sprang up on the ground, and being cut when in blossom, produced a good crop of hay in August. A lighter cutting was again taken in October. The clover then took possession of the land and was grazed until spring, but not so closely as to prevent re-seeding in May, after which the plants died down.

By thus allowing the plants to mature seed, any crop may follow that can be grown after May. By following burr clover with cow peas, land may be much fertilized in one year. By reversing the process on land low in fertility, that is, sowing the peas first and the clover later, a much better growth of the clover will be secured. The seed may also be sown in corn and cotton crops, with a view to enriching the land. But it is only in the Gulf States that much attention is given to growing burr clover thus, and for the reason, probably, that the winters

are too cold to admit of the plants furnishing a sufficiency of grazing at that season.

Burr clover is sometimes grown with Bermuda grass. The latter furnishes summer grazing. There is some merit in the plan, if the seed of the burr clover were sown from year to year. When the re-seeding of the plants is depended on from season to season there is difficulty in adjusting the grazing so as to admit of the plants properly re-seeding for the growth that is to follow. If the Bermuda grass is not closely grazed many of the burrs which contain the seeds may not reach the ground in time to germinate.

Preparing the Soil.—Since burr clover has much power to re-seed the land without preparation, it is more commonly reproduced thus. But, as with all other plants, it will grow more quickly and more luxuriantly on a well-prepared seed-bed, where it may be thought worth while to thus prepare the land. The cultivation given to such crops as corn, cotton or cow peas makes an excellent preparation of the soil on which to sow burr clover.

Sowing.—Usually, burr clover is allowed to re-seed itself after it has once become established in the soil. In this respect it is not unlike small white clover and Japan clover, but it does not grow so well as these on poor soil. Where not yet established, it must, of course, be sown where it is desired to grow it.

The seed is commonly sown in September or early October, but some growers recommend sowing in the burrs as early as June or July, that the tough

surrounding which encloses the seed may have time to decay. When seed separate from the burr is used, it is sown in the months named. When sown on well-prepared soil, grazing should be plentiful from February onward.

Burr clover is more commonly sown in the burr. The burrs are usually scattered by hand and on land that has been pulverized, but it is easily possible, when the conditions are favorable, to obtain a stand on land that has not been plowed. Where seed is scarce, the burrs are sometimes planted in squares 3 feet apart each way, a limited number of burrs being dropped at one time. When thus planted, 1 bushel of burrs will plant several acres. The plants will soon possess all the ground, but to enable them to do so, pasturing must be deferred for one season. Whether sown in the burr or otherwise, it is better to cover the seed with the harrow.

One bushel of burrs weighs from 10 to 12 pounds. It has been stated 1 bushel of clean seed weighs 60 pounds. When sown in the burr, it is usual to sow 3 to 5 bushels per acre, but in some instances less is sown and in some more. When seed apart from the burr is sown 12 pounds per acre should suffice. In some instances it is sown on Bermuda sod, but the attempts to grow it thus have not always proved satisfactory. At the Louisiana Experiment Station it was found that the burr clover remained long enough and grew large enough to injure the Bermuda. Possibly closer grazing would have prevented such injury. When sown on Bermuda grass,

June, July or August are the months chosen for scattering the seed.

Burr clover is also sometimes sown in corn and cotton to provide winter grazing, but when thus sown the object more frequently sought is to enrich the land. Both ends may be accomplished in some degree.

Pasturing.—Opinions differ as to the palatability of this grass. All are agreed that stock do not take kindly to it at first, but that they come to relish it at least reasonably well when accustomed to it. It is said to be relished less by horses and mules than by other domestic animals. It has been praised as a pasture for swine. It is more palatable in the early stages of its growth, and will bear close grazing, and also severe tramping. It will provide pasture for six months, but not so bountifully in the first months of growing as later.

Harvesting for Hay.—Burr clover is not a good hay plant. Owing to the recumbent character of the growth it is not easily mowed, nor has it much palatability in the cured form. The yield is said to be from $\frac{1}{2}$ to 1 ton per acre.

Securing Seed.—In the Gulf States the seed matures in April and May. The plants grow seed profusely. Sown in October, stock may usually be allowed free access to it until March, and if then removed, it will spring up quickly and mature seed so profusely that when the plants die and partially decay seed may sometimes be collected in hollows, into which it has been driven by the wind. It is more commonly sown in the burr form, the form

in which it is usually gathered. The more common method of saving the seed, as given by Mr. A. H. Beattie of Starkville, Mississippi, is to first rake off the dead vines so as to leave the burrs on the ground and then sweep them together with a suitable wire or street broom. It is then lifted and run through two sets of sifters of suitable mesh by hand to remove the trash swept up in gathering the seed. It is probable that other methods more economical of labor are yet to be devised when harvesting the seed crop. As much as 100 bushels of burrs have been obtained from an acre, but that is considerably more than the average yield of seed.

Renewing.—Since this plant is an annual, it cannot be renewed in the sense in which renewal is possible with a perennial. But as has been shown above (see page 294), it may be grown annually for an indefinite period in the same land and without re-sowing by hand. It has also been shown that by sowing the seed in certain crops at the proper season, from year to year, it may be made to grow from year to year where the rotation will admit of this. (See page 295.) When the ground is well stored with seed, the plants will continue to come up freely in the soil for at least two or three years, even without any re-seeding of the land.

As a Fertilizer.—The growing of burr clover exercises a beneficial influence on the land. Its value for this purpose, since it can be grown as a catch crop, is probably greater than its value in providing food for stock. Like all plants that are more or less creeping in their habit of growth, it shades

the soil and keeps it moist, which, in conjunction with the influence of the roots, puts it in a friable condition. When the plants grow rankly, it is not easy to bury them properly with the ordinary plow, but in such instances, if cut up with a disk harrow, the work is facilitated. The plants quickly die down so as to make plowing easily possible, but the aim should be to have such decay take place within the soil rather than above it.

CHAPTER XI

SWEET CLOVER

Sweet clover is so named from the sweet odor which emanates from the living plants. It is of two species. These are designated, respectively, *Melilotus alba* and *Melilotus officinalis*. The former is also called Bokhara clover, White Melilot and Tree clover. It is possibly more widely known by the name Bokhara than by any other designation. The latter is sometimes called Yellow clover. The difference between these in appearance and habits of growth does not seem to be very marked, except that the blossoms of the former are white and those of the latter are yellow.

Sweet clover is upright and branched in its habit of growth. It attains to a height of from 2 to 8 feet, according to the soil in which the plants grow. The somewhat small and truncate leaves are not so numerous, relatively, as with some other varieties of clover, and the stems are woody in character, especially as they grow older. The blossoms are small and white or yellow, according to the variety, and the seed pods are black when ripe. The roots are large and more or less branched, and go down to a great depth in the soil; especially is this true of the main, or tap root.

The plants, according to Beale, are annual or bi-



Fig. 9. Sweet Clover (*Melilotus alba*)

ennial, but more commonly they are biennial. They do not usually blossom the year that they are sown, but may blossom within a year from the date of sowing. For instance, when sown in the early autumn, they may bloom the following summer. They are exceedingly hardy, having much power to endure extremes of heat and cold, and to grow in poor soils and under adverse conditions. In some soils they take possession of road sides and vacant lands, and continue to grow in these for successive years. The impaction of such soils by stock treading on them seems rather to advance than to hinder the growth. They start growing early in the spring and grow quickly, especially the second year. They come into bloom in June; early or later, according to the latitude, and ordinarily only in the year following that in which they were sown. Because of the fragrant odor which is emitted from the plants as they grow, they are sometimes introduced into gardens and ornamental grounds.

The uses of the plants are at least three. It has some value as a food for live stock. It has much value as a fertilizer. It has probably even more value as a food for bees. It has also been used in binding soils. Its value as a food for stock has probably been overestimated. It is bitter, notwithstanding the fragrant odor that emanates from it; hence, it is not relished by stock, insomuch that they will not eat it when they can get other food that is more palatable. As hay, it is hard to cure and of doubtful palatability when cured. As a fertilizer, its value does not seem to have been sufficiently recog-

nized, and the same is probably true of it as bee pasture, although many bee-keepers are alive to its great merit for such a use.

This plant does not seem to find much favor with many. The United States Department of Agriculture has spoken of it as a "weedy biennial, concerning which extravagant claims have been made." The laws of some States proscribe it as a weed, and impose penalties directed against any who allow it to grow. Legislatures should be slow to class a legume as a weed, especially one that has much power to enrich soils. The author cherishes the opinion that this plant has a mission in the economy of agriculture and of considerable importance to farmers, especially in soils that are poor and worn, as soon as they come to understand it properly.

Distribution. —Sweet clover is probably indigenous to the semi-arid regions of Asia. The name Bokhara would seem to indicate as much, but it is also found in many parts of Europe, and if the facts were known, was doubtless brought from Europe to North America by the first settlers. For many decades it has been represented in many flower gardens in all parts of the country.

The plant will endure almost any amount of cold when it is once established. It has stood well the winters of Manitoba. It can also endure extreme summer heat, since it thrives well in some parts of Texas. It grows most vigorously where the rainfall is abundant, as in Western Oregon, and it makes a strong growth in the dry areas of Western Kansas and Nebraska.

Sweet clover will grow vigorously in some part or parts of every State in the Union. Of course, it has higher adaptation for some conditions than others. In some of the Central and Southern States, it has multiplied to such an extent without cultivation as to have assumed the character of a weed; hence, the legislation against it. When it is called to mind that this plant is a legume, and when the further fact is recognized that it may be used not only in enriching soils, but at the same time improving them mechanically, in addition to other benefits that it may be made to render, surely the enactments which prohibit its growth should be repealed in any State where these exist. In the Northern States, with a normal rainfall, the mission of this plant is likely to be circumscribed, for the reason that other legumes possessed of a much higher food value may be grown in these. In the Southern States, its mission will be more important, since it may be used in some of these with decided advantage in binding soils and in renovating them, even when too poor to produce a vigorous growth of cow peas. It is likely also that it may yet be made to render good service in the semi-arid country west of the Mississippi River, where other clovers cannot be grown.

Sweet clover will grow in all the provinces of Canada. For economic uses, however, it is not likely to grow to any great extent east of Lake Superior, or west of the Rocky Mountains. Other legumes more useful may be grown in these areas. But in the intervening wheat-growing region it is possible

that it may come to be used for purposes of soil renovation.

Soils.—But little can be gleaned from American sources on this subject. Notwithstanding, it may be said with safety that it has greater power to grow on poor, worn and hard soils than any forage plant that has yet been introduced into America for economic uses.

It will probably be found true of it, as of other clovers, that it will thrive best on soils that have produced timber, and more especially timber of the hardwood varieties. This means, therefore, that it will grow well in probably all kinds of clay soils and also in loam soils underlaid with clay. It has high adaptation for soils abounding in lime. It can be made to succeed on hard clay subsoils from which the surface soil has been removed. But it will also grow well on sandy soils and even on gravels when a reasonable amount of moisture is present. The author succeeded in growing it in good form in 1897 and 1898 in a vacant lot in St. Paul, from which 6 to 8 feet of surface soil had been removed a short time previously. The subsoil was so sandy that it would almost have answered for building uses.

This clover will probably grow with least success on soils of the prairie so light in texture as to lift with the winds, and in which the underlying clay is several feet from the surface, also in slough soils that are much saturated with water.

Since it grows vigorously on road sides, in rocky waste places and even in brick yards when sown

without a covering, the idea has gained currency that the harder the soil, the better the plants will grow, and the more surely will they be established in the soil; but this view does not seem to be in accord with the principles which usually govern plant growth. It will, however, send its roots down into hard subsoils so deeply that in certain seasons the plants could not be dug up without the aid of a pick.

Place in the Rotation.—Since sweet clover seed is more commonly scattered in byplaces, or is self-sown from plants that have run wild, it can scarcely be said that it has ever been grown as a regular crop and in a regular rotation. Nor is it ever likely to become a factor in such a rotation unless its properties shall be so modified that it can be grown acceptably as a pasture plant. In such an event it would have the same place in the rotation as other clovers; that is, it would naturally follow a cultivated, that is, a cleaning crop, and precede some crop or a succession of crops that would profit from the nitrogen and humus which it had brought to the soil, and also from the influence which the roots would exercise mechanically upon the same. But the necessity for sowing it on clean ground would not be so great as with the other clovers, since it has greater power than these to overshadow weeds when the two grow together.

In the meantime, this plant will probably continue to be grown as in the past; that is, if sown, it will be sown: 1, In byplaces to provide pasture for bees,

in which case in time it will be superseded by other plants. 2. On worn lands so poor that they refuse to grow valuable food products sown, partly, at least, with a view to renovate them. And 3. In cuttings made by railroads and in gullies that have been made in fields, with a view to prevent soil movement. It may also come to be sown in grain crops in localities where other varieties of clover will not grow, to be plowed under the following spring.

Preparing the Soil.—Since sweet clover will grow on the firmest and most forbidding soils, even when self-sown, it would not seem necessary, ordinarily, to spend much time in specially preparing a seed-bed for it. The fact stated is proof of its ability to grow on a firm surface. It does not follow, however, that such a condition of the seed-bed will give a better stand of the plants than a pulverized condition of the same, as some have contended. It may be that on soils that are quite loose near the surface, and under conditions that incline to dry a seed-bed firm and even hard, may be more conducive to growth in the plants than one in which the conditions are the opposite. Much rolling of loose soils has been recommended when preparing the seed-bed with a view to firm them.

When the seed is sown along with grain, the preparation of the soil needed for grain would be ample preparation also for the clover. When sown on stubble land, in many instances no preparation by way of stirring the soil would seem necessary. And when sown on railroad embankments, road

sides, rocky situations and byplaces generally no preparation of the soil would be possible.

Sowing.—In the North sweet clover is best sown in the spring. In fact, it can only be sown then with the assurance that it will survive the winter north of a certain limit. That limit will vary with altitude, but it will probably run irregularly across the Middle States, from the Atlantic westward to the Cascade Mountains, beyond which it will veer away to the North. In the Southern States, it may be sown fall or spring, but if sown late in the fall the young plants will in some instances succumb to the frost of winter. Early fall sowing, therefore, is much to be preferred to sowing late.

The method of sowing may be the same as in sowing medium red clover (see page 78); that is, when the seed is sown with grain crops. When sown in byplaces, it will ordinarily be sown by hand. In such places it will re-seed itself and will likely grow in these for successive seasons. On railroad embankments, the seed is scattered more commonly on the upper portion, and from the plants which grow there the seeds produced scatter downward. The plants not only lessen washing in the soil, but they prepare the same for the growth of grasses. They also aid thus in the introduction of grasses into rocky and very hard soils.

Sweet clover may be sown with almost any kind of a nurse crop desired, which does not destroy it with an over-abundant shade. Or it may be sown alone where such a necessity exists. But the instances are not numerous in which it would be de-

sirable or necessary to sow it alone on arable soils. There may be conditions when it could be sown successfully at the time of the last cultivation given to corn and with a view to soil enrichment.

Since sweet clover is seldom sown for the purpose of providing food for live stock, it is not sown in mixtures, nor is it well adapted for being sown thus, because of the large and luxuriant character of the growth, which would tend to smother other plants sown along with it.

The amount of seed to sow has been variously stated at from 15 to 20 pounds per acre. The smaller amount should be enough for almost any purpose, and a much smaller amount should suffice for sowing in byplaces and along road sides, where the plants retain possession of the ground through self-feeding.

Pasturing.—Because of the bitter aromatic principle which it contains, known as commarin, stock dislike it, especially at the first. And it is questionable if they can be educated to like it in areas where other food, which is more palatable, grows abundantly. In an experiment directed by the author at the Minnesota University Experiment Station, sheep pastured upon it, and did not take kindly to it; but by turning them in to graze upon it in the morning, they cropped it down. In localities where good grazing is not plentiful, if live stock have access to it, especially when the plants are young, they will so crop it down that in a few years it will entirely disappear. But where other pastures are abundant, it will continue to grow indefinitely. It would not

seem wise to sow it for the purpose of providing grazing, unless where the conditions for growing other and better grazing are unfavorable.

Some have spoken favorably of sweet clover for soiling uses. It makes a very rapid growth quite early in the season, and when cut and wilted more or less before being fed, the palatability is thereby considerably increased. Small plots of this plant near the outbuildings may in this way be utilized with some advantage in the absence of better soiling plants.

Harvesting for Hay. — Sweet clover is not a really good hay plant under any conditions, and if not cut until it becomes woody, is practically valueless for hay. It ought to be cut for hay a little before the stage of bloom. If cutting is longer deferred, the plants become woody. Such early cutting, however, adds much to the difficulty of curing the crop, since, while naturally succulent, its succulence is then, of course, considerably more than at a later period. It should be cured like medium red clover. (See page 96.) If not cut sufficiently early, and cured with as much care as is exercised in curing alfalfa, there will be considerable loss from the shedding of the leaves.

More commonly the plants are not cut for hay the year that they are sown, but some seasons such harvesting is entirely practicable in certain situations. The hay crop or crops are usually taken the second year. Sometimes the crop is cut twice. It is entirely practicable to obtain two cuttings under ordinary conditions, because of the vigor in the

growth, and because of the early season at which it must be harvested for hay. From 3 to 4 or 5 tons may thus be obtained in many instances from the two cuttings.

Securing Seed. —Nearly all of the seed sown in this country is imported. The author has not been able to obtain information with reference to growing seed within the United States; hence, the inference is fair that but little of it has been grown for that purpose up to the present time. Since, however, it seeds freely, and since the price of seed is high, seed crops, more especially when the plants are also utilized as bee pasture, ought to prove remunerative in the hands of judicious growers.

The seed crop is obtained usually, if not always, the second year after the sowing. If cut for hay before coming into bloom, it will grow up again and bear seed profusely. This would seem preferable on strong soils, as it would prevent that rankness in growth which would militate against abundant seed production, and which would add much to the labor of handling the crop.

The seed crop may be cut and handled in substantially the same way as medium red clover when grown for seed. It may also be cured and thrashed essentially in the same way. (See page 105.) The author has not been able to obtain information with reference to the average yield of the seed crop under American conditions. The seed, like that of the medium red variety, should weigh 60 pounds per bushel.

Renewing. —In the sense of a pasture or hay

crop, it would not seem necessary to try to renew this crop, because of the relatively low value which it possesses for these uses. When grown for bee pasture, it will renew itself for an indefinite period when the plants are not cut for seed and where the conditions are favorable to growth. When grown to keep soils from washing or railroad embankments from breaking down, it will, of course, renew itself in the same way. In time, however, it is usually superseded by some kind of grass, for which it has prepared the way by the ameliorating and renewing influence which it exerts upon the soil.

Value for Bee Pasture. —All authorities are agreed as to the high value of this plant as a honey producer. The claim has been made for it that for such a use it is more valuable acre for acre than any ordinary grain crop. By cutting a part of the crop before it comes into bloom, the season of honey production may be prolonged from, say, July 1st until some time in the autumn, as the part thus cut will come into bloom after the blooms have left the plants that were cut. When not disturbed, sweet clover yields honey in the interval between the blooming of the basswood and the golden rod. The honey is of excellent quality. There should be no good reasons, therefore, why bee-keepers should not sow the seed in by and waste places. But the wisdom of growing it as a honey-producing crop on valuable land where other honey crops, as alsike and white clover, can be grown in good form may be questioned.

Value as a Fertilizer.—The high value of this plant as a fertilizer and soil improver cannot be questioned. But whether it should ever be sown for such a use will depend on the capacity of the soil to produce other crops valuable for fertilizing and also more valuable for producing forage or fodder. Where other clovers more useful can be grown, also cow peas, soy beans and other legumes valuable for food uses, it would seem unwise to sow sweet clover. This would restrict its use, therefore, as a soil renovator; first, to soils too poor to grow those useful legumes; second, to areas where the climate conditions will not admit of the growth of these; and third, to areas from which the surface soil has been removed, and which it is desirable to so ameliorate and improve the soil thus laid bare that it could later be covered with some more valuable cover crop. Under present conditions this would restrict its growth for the purpose named to sandy and gravelly soils, to certain areas in the semi-arid region east of the Rocky Mountains, and to such small areas as the surface soil had been removed from.

In the semi-arid region where crops of grain and also some varieties of field corn can be grown successfully, but where the clovers are not successful, it would seem practicable to sow a few pounds of sweet clover seed per acre at the same time as the grains, and to plow under the plants produced some time in the month of May the next season. The clover thus buried could be at once followed by corn or potatoes, or, indeed, by any kind of a

cleaning crop. The high price of seed at present practically forbids growing clover thus.

Whether sweet clover grown for renovating uses should be turned under the season in which it has been sown will depend largely on the growth that has been made. In many instances, the growth made is so rank as to justify plowing it under the following autumn. In other instances, better results will follow plowing it under the next season. It frequently happens that the growth made is so rank that a strong plow and also a strong team are necessary to do the work properly.

Value on Alkali soils. —This plant has been grown to some extent to aid in removing alkali from soils superabundantly impregnated with the same. It will grow, it is claimed, under certain conditions on such soils so surcharged with alkali as to prohibit almost every other form of vegetable growth. The extent to which it may be thus used profitably had not yet been fully demonstrated. But where it can be grown on such soils, the fact that it takes up and removes relatively large quantities of alkali would appear to be well established.

Destroying the Plants.—Should the conditions be found so favorable to the growth of the plant that it persists in growing where it is not wanted, it will soon cease to appear, if prevented from going to seed. Ordinarily, the blossoms appear only during the second year of growth. If, therefore, the plants are cut off when in bloom, seed forming will

not only be prevented, but since sweet clover is a biennial, the plants will die. When thus dealt with, the only source from which other plants may come while extermination is being thus sought is from seed lodged in the soil and still capable of germinating.

CHAPTER XII

MISCELLANEOUS VARIETIES OF CLOVER

In addition to the varieties of clover that have been discussed at some length in previous chapters are a number the value of which may be considerable to areas more or less local and limited. These include Sainfoin, Egyptian clover, Yellow clover, Sand lucerne, Japanese clover, Beggarweed and Seaside clover. Some of these, as Sainfoin and Buffalo clover, have been in the country for several years, and yet but little is known as to their behavior, except in very limited areas. Others, as Buffalo clover, native to the country are thought to have merit, and yet the degree of such merit does not appear to have been yet proved under cultivation. The three varieties but recently introduced are thought to have considerable promise for certain soils and climates to which they have special adaptation, but sufficient trial has not been given them to determine even approximately the measure of their worth to this country. These varieties will now be discussed, but for the reasons stated above it will be manifest that the discussion will of necessity be imperfect and fragmentary in character.

SAINFOIN

Sainfoin (*Onobrychis sativa*) is a perennial, leguminous, clover-like forage plant of the bean family.

The word Sainfoin is equivalent to the French words for sound or wholesome hay. It is also frequently called Esparcette or Asperset, more especially in Germany. It is further known in England by the name Cock's Head, French Grass and Medick Vetchling. In some parts of France and Switzerland the name has been and probably is yet applied to lucerne (*Medicago sativa*).

In its habit of growth it is more woody in the rootstock than clover and more branched. It also grows to a greater average height. The stems, which are covered with fine hairs, bear numerous leaves long and pinnate. The blossoms are numerous and of an attractive, pinkish color, brightening into a crimson tint. The seed pods are flattened from side to side and wrinkled, and are also sickle-shaped. They bear but one seed. The roots are strong and more or less branched.

Sainfoin, as already intimated, is perennial in its habit of growth. When a field is once well set with the plants, it should continue to produce crops for a decade, but will eventually be crowded out with weeds or other grasses. It grows very early in the season, quite as early, if not earlier, than alfalfa, and continues to grow until autumn.

The feeding value of sainfoin is much the same as that of alfalfa. It is much esteemed where it can be grown for the production of pasture, of soiling food, and also hay, valuable for enriching the land, through the medium of the roots, and also when the tops are plowed under as green manure.

Sainfoin is native throughout the whole of Cen-



Fig. 10. Sainfoin (*Onobrychis sativa*)

tral Europe and over much of Siberia. Although native to the southern counties of England, it does not appear to have been cultivated there before the year 1651, at which time it is said to have been introduced from Flanders. From what has been said with reference to the distribution of sainfoin in Europe and Asia, it will be apparent that it is a hardy plant, which has highest adaptation for climates temperate and mild to moderately cool. Its hardihood has been shown by its surviving the winters in the latitude of the St. Lawrence River, but the abundant snow covering then provided should not be lost sight of.

Its adaptation to the United States does not appear to have been proved yet, except in limited areas. In some of the Montana valleys good crops have been grown with much success in many of those western valleys, and even on the bench lands at the base of foothills. Nor would there seem to be any good reasons for supposing that good crops could not be grown in various parts of the United States where the soil is suitable.

In Canada, sainfoin has succeeded in Quebec. In trials made by the author at the Ontario Agricultural College at Guelph success was only partial, but the trials were limited. There would seem to be no good reasons why this plant should not succeed in many places in Canada where limestone soils prevail.

This plant is best adapted to dry soils calcareous in their composition and somewhat porous in character. This explains its great affinity for the chalk

soils which abound in the south of England. On the dry, limestone soils of this country it ought to succeed. It has shown much adaptation for the volcanic soils of the Western mountain region, where it has been tried. On stiff clays it grows too slowly to be entirely satisfactory. It ought not to be sown on soils wet or swampy in character.

Since sainfoin is perennial in its habit of growth, and since, when once well set, it will retain its hold upon the soil for several years, it is not in the strict sense of the term a rotation plant. When it is grown, however, it should be followed by crops which require large quantities of nitrogen easily accessible, to enable them to complete their growth. If this plant should ever be grown to any considerable extent in the mountain States, much that has been said with reference to the place for alfalfa in the rotation will also apply to sainfoin. (See page 135.)

It has been found more difficult to get a good stand of sainfoin plants than of other varieties of the clover family. This is owing to the low germinating power frequently found in the seed. The stand of plants is frequently found to be too thin and scattering. Weeds, therefore, and sometimes grasses are much liable to come into the soil occupied by the sainfoin and to crowd the same. Because of this it is specially important that sainfoin shall be sown on a clean seed-bed.

The seed is very frequently sown in the hull, and usually in the early spring. But there would seem to be no reasons why the seed should not be sown

in the early autumn in localities where alfalfa can be sown thus. (See page 145.) In the rough form, it is usually broadcasted by hand, but would probably also feed through a seed drill. When sown apart from the hull, the seed may be sown by the same methods as alfalfa. (See page 147.) In the rough form, from 3 to 5 bushels per acre are sown. In the clean form, it is claimed that 40 pounds of seed should be sown, but that amount of clean and good seed would seem to be excessive on well-prepared land. The seed in the hull weighs 26 pounds per bushel. The plan of sowing 2 to 3 pounds per acre of the seed of alsike clover along with the sainfoin would doubtless be found helpful under some conditions, as it would tend to thicken the crop, more especially the first season.

Sainfoin is a good pasture plant when properly grazed. It does not produce bloat in cattle or sheep as alfalfa does. In this fact is found one of the strongest reasons why it should be grown in areas where alfalfa is wanted for pasture. It will furnish grazing about as early as alfalfa, and considerably earlier than medium red clover.

This plant is more frequently grown for soiling food than for hay. For the former use it has high adaptation, since it will furnish several cuttings of soiling food per season. It will also furnish two cuttings of hay, or one of hay and one of seed, and under some conditions more than two cuttings can be obtained. In the latitude of Montreal it is ready to be cut for hay during the early days of June. It is ready for being cut when the blossoms begin

to expand. Much care is necessary in curing the hay, in order to prevent the too free shedding of the leaves. The methods for making alfalfa hay will apply also to sainfoin.

Seed may be obtained from the first or second cutting of the crop. It is usually obtained from the second cutting, as the yield is much larger than that obtained from the first cutting. The author has not been able to obtain any facts based on experience regarding the harvesting of the seed crop under American field conditions. But the methods followed in obtaining seed from alfalfa would probably also answer equally well for sainfoin. Great care is necessary in handling the seed crop, owing to the ease with which the seed shatters. Special pains are also necessary to keep the germinating power of the seed from injury from overheating. Nor does the seed seem able to retain germinating power as long as the seeds of some other varieties of clover. In experiments conducted by Professor C. A. Zavitz at the Ontario Experiment Station at Guelph in 1902 and 1903, the average yield per acre was 426.1 pounds.

EGYPTIAN CLOVER

Egyptian clover (*Trifolium Alexandrianum*) is more commonly known in the Nile valley as Berseem. It is of at least three varieties. These are the Muscowi, Fachl and Saida, all of which are more or less closely related to medium red clover. The term *Alexandrianum* as applied above is somewhat misleading, as its growth is not specially identified with

Alexandria, nor is its growth in Egypt supposed to be of great antiquity, since no trace of it is found upon the ancient monuments.

The Muscovi variety, which is commonly grown more especially in lower Egypt, sometimes grows to the height of 5 feet and over, but usually it is not more than half the height named. In its habit of growth it is rather upright, like alfalfa, but the hollow stems are softer and more succulent, and the blossoms occur on heads resembling those of clover, but not so compactly formed, and they are white in color. The seeds bear a close resemblance to those of crimson clover. The roots are much shorter, but more spreading in their habit of growth than those of alfalfa, and in Egyptian soils they bear small tubercles abundantly. This variety, which is usually grown on land that can be irrigated at any season, produces in some instances 5 cuttings in a season. The Fachl variety is usually grown on land irrigated by the basin system; that is, the system which covers the land with water but once a year, and for a period more or less prolonged. But one crop a year is taken from such land. The hay from this variety is heavier for the bulk than that of the Muscovi. The Saida variety is of a lower habit of growth than the Muscovi and has a longer tap root, which enables it to stand drought better than the Muscovi. It is more commonly sown in Egypt southward from Cairo.

All these varieties are annual. The period of growth covered by any one of them is never more than 9 months, and usually not more than 6 months;

that is to say, from October to March. The Muscowi variety especially grows very rapidly.

Egyptian clover in all its varieties is pre-eminently a soiling plant. It is sometimes pastured and is also made into hay. It is practically the one fodder crop of Egypt, and is more commonly fed in the green form. All kinds of stock are fond of it, and it is fed freely to horses, donkeys and camels at labor, to cows in milk, and to cattle that are being fattened. It also serves to keep Egyptian soils supplied with nitrogen, for the support of crops grown on them in summer, especially cotton, and various kinds of grain. Moreover, because of the frequency of the cuttings, with the Muscowi variety, its growth tends very much to check the growth of weeds.

Egyptian clover is not native to Egypt, but was introduced from some country outside of Egypt, yet bordering on the Mediterranean. This, at least, is the view presented in Bulletin No. 23, issued by the Bureau of Plant Industry, United States Department of Agriculture, from which source much of what is written with reference to this plant has been obtained. In Egypt more than 1,000,000 acres are grown annually. It is also being tried, with much promise, in other portions of Northern Africa, as Tunis and Algiers. It is also now being experimented with in various parts of the Southern and Southwestern States.

Egyptian clover is only adapted to a warm climate. In those parts of the United States which have a climate not unlike that of Egypt, in many

respects, as Florida, Southern Texas, New Mexico and Arizona, it may have an important mission. It may yet be grown in these areas, or some of them, where irrigation is practiced in conjunction with cotton, or with certain of the cereals. If it can be thus grown, it will prove of much value, as it would only occupy the land when not occupied by the crops usually grown in summer, and it would bring much fertility to the same, in addition to the forage provided. Since in Tunis it has been found that the plants have not been killed by cold 2° below zero and in Algiers 9° below that point, the hope would seem to be justifiable that this clover may yet be grown much further north than the States named. If grown thus, however, it should not be as a substitute for alfalfa, but rather to occupy the ground in winter when not producing otherwise. It may yet be found that the Saida variety may have adaptation for some localities in the West where irrigation cannot be practiced. This clover is not likely to render any considerable service to any part of Canada, because of the lack of adaptation in the climate.

Egyptian clover has highest adaptation for deposit soils, such as are made by the settling of silt held in solution by waters that overflow. In these it will grow with vigor, though they rest upon coarse sand or even upon gravel not too near the surface. Irrigating waters to some extent are necessary to grow the plants in best form, although, as previously intimated, the Saida variety may yet be grown without the aid of such waters. It is the first crop

sown on reclaimed alkaline lands, and growing it on these tends to remove the alkali and to sweeten and otherwise improve the soils.

The place for this plant in the rotation is readily apparent. Like crimson clover, it is clearly a catch crop, as it were, and a winter plant, but with the difference that it grows much more rapidly under suitable conditions and furnishes much more food. The advantage of growing it northward in the Western mountain valleys when sown in spring, as intimated by the writer of the bulletin already referred to, would seem to be at least problematical, since it could not be sown early enough in the spring to produce a crop as early as alfalfa already established. It would then be grown also as the crop of the season, rather than as a catch crop. The place for Egyptian clover in the rotation is clearly that of a winter crop, to provide soiling food for stock and plant food for the land, which may be utilized by the summer crop that follows.

In Egypt the seed is frequently sown on the silt deposited by the waters that have subsided and before it would be dry enough to plow. At other times, it is sowed on land stirred on the surface to a greater or less depth, and sprouted through the aid of irrigating waters. In the valleys of the West that preparation of the soil found suitable for alfalfa would also, doubtless, be found suitable for this clover.

The seed is sown in the autumn in Egypt, usually in October, but the season of sowing lasts from September to January, and some crops have been

obtained sown as late as April 1st, but when sown late, the number of the cuttings is reduced and the occupancy of the soil by the clover interferes with the growing of other crops. Under American conditions, it will doubtless be found that the best season for sowing Egyptian clover will be just after the removal of the crop that occupied the land in summer. The seed is usually sowed by hand and without admixture, but the Fachl variety is sown in some instances with wheat or barley when seed is wanted. The methods of sowing found suitable for alfalfa would also seem to be proper for sowing Egyptian clover. (See page 78.) As much as one bushel of seed is sown per acre, but it is thought that a less amount will suffice under good methods of tillage.

Egyptian clover is sometimes pastured, but it has higher adaptation to soiling, because of the softness of the stems. When pastured reasonably close, cropping would probably be preferable, as there would then be less waste from the treading of the plants. Nevertheless, in Egypt considerable quantities of the hay are stored for feeding in the summer months when green fodder is scarce.

Egyptian clover is sometimes made into hay, but it is not essentially a hay plant. Much care is necessary when it is being cured to prevent loss in the leaves, and when cured the stems are so brittle that it is difficult to prevent waste in handling the hay. It is pre-eminently a soiling crop, and the greater portion is fed in the green form. From 4 cuttings of the Muscovi variety as much as 25 to 30 tons

of green fodder are harvested, and about 10 tons are produced by 2 cuttings of the Saida variety.

Egyptian clover has not been grown sufficiently long in this country to justify giving information based upon American experience that could be taken as authoritative, with reference to the best methods of harvesting the seed crop. There would seem to be no reasons, however, to suppose that the methods followed in harvesting alfalfa could not be followed with equal advantage in harvesting Egyptian clover. Nor can anything be said as yet with reference to which cutting of the series will furnish the best seed crop.

The best service, probably, which this crop can render to the United States is the enrichment of the soils on which the plants are grown. As the same bacteria which inoculate alfalfa soils will not answer for Egyptian clover, and as the requisite bacteria may not be found in soils where it is desirable to grow this clover, the conclusion that it will not grow sufficiently well in certain soils on which it is being tried should not be reached until the question relating to the presence or absence of the proper bacteria has been settled. If necessary to introduce bacteria from Egypt, the obstacles in the way of such introduction would not be at all serious, if undertaken by the Department of Agriculture.

YELLOW CLOVER

Yellow clover (*Medicago lupulina*) is to be carefully distinguished from Hop clover (*Medicago procumbens*), which it resembles so closely in the

form of the leaves and the color of the bloom as to have given rise in some instances to the interchangeable use of the names. The latter is so named from the resemblance of the withered head when ripe to a bunch of hops. Its growth has been almost entirely superseded by *Medicago lupulina*, since the other variety was low in production and also in nutrition. *Medicago lupulina* is also called Black Medick, Nonesuch, Black Nonesuch and Hop Trefoil. In both England and Germany it is now more commonly grown than white clover. It is more or less recumbent in its habit of growth, but the stems do not root as do the runners in the small white variety. The stems, though tender in the early spring, become woody as the season advances. The flowers, as the name would indicate, are yellow, and the plants produce seed numerously. The roots, like those of the small white variety, are more fibrous than in some of the larger varieties.

Yellow clover is perennial. Owing to the power which the plants have to multiply through rooting and re-seeding, they can stay indefinitely in congenial soils. The growth is vigorous in the early part of the season, but less so later, and with the advance of the season the herbage produced becomes more woody in character.

This plant furnishes considerable pasture during the spring months, but in the summer and autumn it makes but little growth. Though palatable early in the season, it is less so later. Nevertheless, it may be made to add materially to the produce of pastures in which it grows.

It also aids in fertilizing the soil, though probably not quite to the same extent as white clover.

Yellow clover is indigenous to Europe. It is grown to a considerable extent in pastures in certain areas in Great Britain, France, Germany and other countries. It has highest adaptation for climates that are moist and temperate. Although this plant is not extensively grown in the United States, it would seem probable that it will grow at least reasonably well in a majority of the States. The exceptions will be those lacking in moisture in the absence of irrigation. It will grow best in those that more properly lie within the clover belt; that is, in those that lie northward. It grows with much vigor in Oregon and Washington west of the Cascade Mountains. In Canada, yellow clover will grow with much vigor in all areas susceptible of cultivation, unless on certain of the western prairies.

Yellow clover has highest adaptation for calcareous soils. In certain parts of England it has grown so vigorously on soils rich in lime as almost to assume the character of a troublesome weed. It will grow well on all clay loam soils, and reasonably well on stiff clays, the climatic conditions being suitable. It has greater power to grow on dry soils than the small white variety.

Since yellow clover is usually grown as an adjunct to permanent pastures, it can scarcely be called a rotation plant. But, like other clovers, it enriches the soil, and, therefore, should be followed by crops,

that are specially benefited by such enrichment, as, for instance, the small cereal grains.

Yellow clover when sown is usually sown with other grass mixtures, and along with grain as a nurse crop; hence, that preparation of the soil suitable for the nurse crop will also be found suitable for the clover. It is, moreover, a hardy plant, inasmuch that in some instances, if the seed is scattered over unplowed surfaces, as those of pastures, in the early spring, a sufficient number of plants will be obtained to eventually establish the clover through self-seeding.

The seed is usually sown in the early spring, but in mild latitudes it may also be sown in the early autumn. It may be sown by the same methods as other clovers. (See page 267.) It is usually sown to provide pasture, the seed being mixed with that of other pasture plants before being sown. As the plants, like those of the small white variety, have much power to increase rather than decrease in pastures, it is not necessary to sow large quantities of seed, not more usually than 1 pound to the acre. But should the crops be wanted for seed, then not fewer than 3 to 5 pounds per acre should be sown and without admixture with other grasses or clovers. When the plants once obtain a footing on congenial soils, there is usually enough of seed in the soil to make a sufficient stand of the plants in pastures without sowing any seed, but since the seed is usually relatively cheap, where an insufficient supply in the soil is suspected, more or less seed should be sown.

Since the stems of yellow clover plants become tough as the season of growth becomes considerably advanced, where it forms a considerable proportion of the pasture the aim should be to graze most heavily during the early part of the season. The plants do not make much growth during the autumn. It would probably be correct to say that it can grow under conditions more dry than are suitable for white clover, and, consequently, it is more uniformly prominent in evidence in permanent pastures when it has become established.

Yellow clover is not a really good hay plant, owing to its lack of bulkiness. But in some soils its presence may add considerably to the weight of a crop of hay, of which it is a factor.

This plant produces seed freely. The seeds are dark in color and weigh 60 pounds to the bushel. The seed matures early, usually in June or July, according to locality. The methods of harvesting, threshing and preparing the seed for market are substantially the same as those adapted in handling small white clover. (See page 272.)

While yellow clover is not the equal of the small white clover in adaptation to our conditions, it would seem that there are no reasons why it should not be sown to a greater extent than it is sown under American conditions. A plant that is so hardy, that provides a considerable quantity of reasonably good pasture, that stores nitrogen in the soil, and that, moreover, does not stay in the soil to the extent of injuring crops that follow the breaking up of the pastures, should certainly be encouraged to grow.

SAND LUCERNE

Sand Lucerne (*Medicago media*), sometimes designated *Medicago falcata*, is probably simply a variety of the common alfalfa (*Medicago sativa*). Some botanists, however, look upon these as two distinct species. Others believe that *Medicago sativa*, with blossoms ranging from blue to violet purple, and *Medicago falcata*, with yellow blossoms, are two distinct species, while *Medicago media*, with blossoms ranging from bluish and purple to lemon yellow, is a hybrid between these. The name Sand Lucerne has doubtless been given to this plant because of the power which it has to grow in sandy soils.

Sand lucerne is so nearly like common alfalfa in appearance and habits of growth, that until the blossoming season, careless observers cannot distinguish between the plants. (See page 114.) Sand lucerne, however, has a more spreading habit of growth than common alfalfa, the seed-pods are less coiled and the seeds are lighter. The root system is strong and the roots are probably more branched than those of ordinary alfalfa. Under Michigan experience, given in Bulletin No. 198 of the Michigan Experiment Station, it has shown considerably higher adaptation to light, sandy and gravelly soils than the former. The feeding properties of sand lucerne would not seem to be far different from those of common alfalfa (see page 119), but it is claimed that the former is considerably less liable to produce bloat in cattle and sheep than the latter.

• Sand lucerne is probably native to Europe and

Asia. Some attention is given to growing it in Germany, the principal source from which comes supplies of seed at the present time. It was introduced into Michigan by the experiment station of that State in 1897, and its behavior in several trials made to grow it on sandy and gravelly soils in various places, has, on the whole, been encouraging.

Since this variety, like the Turkestan, being considerably hardier than common alfalfa, can undoubtedly be grown further north than the latter, there would seem to be no reasons at the same time why sand lucerne would not grow satisfactorily on sandy soils that lie far south, but this does not seem as yet to have been proved by actual demonstration. It is possible, therefore, that this plant may render considerable service to areas scattered over considerable portions of the United States and Canada, in which the soil is light.

While sand lucerne has higher adaptation than common alfalfa for sandy and gravelly soils, it does not follow that it has equal adaptation for being grown on ordinary alfalfa soils. No advantage, however, would result from growing sand lucerne where common alfalfa will grow equally well, as it is not superior to the latter as a food, if, indeed, it is equal to the same, and there would be a distinct disadvantage in the greater cost of the seed of sand lucerne.

Sand lucerne is not any more a rotation plant than the common variety. In fact, it is even less so, since it would not be practicable to introduce it into short rotations when grown in northerly lati-

tudes, as it does not reach a maximum growth for several years after the seed has been sown. But in mild latitudes, it may be found practicable to introduce it into short rotations, like other alfalfa (see page 135), and on land that is too sandy to grow the common variety in the best form.

Much of what has been said about the preparation of the soil for common alfalfa will equally apply to the preparation of the same for sand lucerne. (See page 137.) But when the latter is sown on sandy or gravelly land, a moist condition of the seed-bed at the time of sowing is even more important than when sowing common alfalfa under ordinary conditions.

The same methods of sowing the seed will be in order as are suitable for sowing common alfalfa in any particular locality. (See page 147.) This will mean that in Northern areas sand lucerne can best be sown in the spring and as early as the danger from frost is over, that the plants may get as much benefit as possible from the moisture in the soil before dry weather begins. It will also mean that if sown southward in the autumn, it may in some instances be necessary to wait longer for the sandy soils on which the seed is sown to become sufficiently moist to sprout the seed than for such a condition in soils on which common alfalfa is usually sown. The amounts of seed to sow will also be practically the same. (See page 152.)

The adaptation of sand lucerne for providing pasture is as high, if not, indeed, higher, than that of common alfalfa, since it is said that it has less

tendency to produce bloat in cattle and sheep, and it is not so easily destroyed, at least in Northern areas, by grazing. In providing pasture, its higher adaptation is in furnishing the same for cattle, swine and horses.

With ample moisture, even as far north as Lansing, Michigan, three crops of hay may ordinarily be looked for. At the Michigan Experiment Station, sand lucerne sown in 1897 yielded cured: In 1898, at the rate of 6800 pounds per acre; in 1899, 10,580 pounds; in 1900, 12,310 pounds; and in 1901, 13,839 pounds. The methods of cutting and curing are the same as for other varieties of alfalfa. (See page 170.) The quality of the hay is not far different from that of common alfalfa. If there is a difference, it would, perhaps, be a little against the sand lucerne, owing to the nature of the land producing it. For soiling food, it may be handled in the same way as common alfalfa. (See page 166.)

No further information would seem to be available with reference to the production of seed in the United States than the statement that the efforts to grow it in Michigan had not been altogether successful. The question thus raised has an important bearing on the future growth of the plant, as, if seed is to be imported from Europe when sand lucerne is to be sown, the expense of securing seed is likely to militate against extending its growth. It is probable, however, that this difficulty will be overcome through the more perfect acclimation of the plants in the North, or by growing seed from the

same in Western areas which have shown higher adaptation to the production of alfalfa seed.

The value of sand lucerne in fertilizing sandy and gravelly soils in this country may yet be very considerable. Its value in putting humus into the same may prove equally high. This value will arise chiefly from its greater ability to grow on such soils than various other legumes. When sown primarily for such a use, heavy seeding would seem to be preferable to ordinary seeding.

JAPANESE CLOVER

The United States Department of Agriculture has quite recently introduced a variety of clover known botanically as *Lespedeza bicolor*. In 1902 small lots of seed were distributed to ascertain the value of the plant grown under American conditions. Sufficient time has not yet elapsed to prove its value, but the indications encourage the belief that it will be of some agricultural value under certain conditions.

This variety of clover is more erect and less branched in its habit of growth than the Japanese variety *Lespedeza striata*. Under Michigan conditions it was found to grow to the height of 3 feet on sandy soil and to about half that height on clay soil, the seed having been sown about the middle of May. The stalks are about the same in structure as those of alfalfa, and like alfalfa they do not lodge readily. The leaves are ovate in form and of a pea-green tint. The seed is formed in pods resembling those of lentils, only smaller. The seeds are larger

than those of crimson clover and are oblong in shape. In color they are mottled brown, yellow and green. The roots in the Michigan test produced nodules freely and without inoculating the soil by any artificial means. The plants in the same tests were killed to the ground by early October frosts.

This variety, like that grown so freely in the Southern States, is an annual. In the absence of experience in growing it under varied conditions, it would be premature to dwell upon its value. If it should grow readily on sandy land, as the Michigan test would seem to indicate, it would render substantial service in fertilizing such soils. In the grass garden of the Department of Agriculture at Washington, D. C., its behavior has been such as to encourage making further tests.

FLORIDA CLOVER

Florida clover (*Desmodium tortuosum*) is sometimes grown both for hay and pasture, more especially in the Gulf States. It has been designated botanically *Desmodium molle*, and is also known by the common names Beggar Weed, Giant Beggar Weed, Beggar Ticks and Tickweed. The name Florida Clover has been given to it because of its prevalence on the light soils of Florida. The name "beggar" has probably been applied to this plant because of its relation to poverty in soils, in which it is more commonly grown, and the name "ticks" from the clinging habit of the seed-pods to surfaces with which they come in contact.

Beggar Weed is an erect and branching plant,



Fig. 11. Beggar Weed or Florida Clover (*Desmodium tortuosum*)
(Flower and Seed Stems)

which grows from 2 to 10 feet high. The branches are woody in character, especially in the lower parts, which prevents close cropping by animals grazing on the plants. The trifoliate leaves are numerous, especially on the upper portions. The panicle is erect and is considerably branched. The pods are prickly and have many joints. These break asunder when matured, and are frequently distributed by adhering to the covering of animals and the clothing of men. The strong, spreading roots have much power to gather food in the soil and also to enrich the same by means of the tubercles formed on the roots.

This plant grows only in warm weather, and it is able to withstand much drought. Its value for pasture and hay would seem to depend considerably on the stage of growth at which it is grazed or harvested for hay. When nearing maturity, stock do not relish it much, either as pasture or hay. It is frequently classed as a weed, but in certain poor soils it has been deemed worthy of cultivation.

Beggar weed is native to the West India Islands and also, it is thought, to Southern Florida. In 1879 seeds were distributed by the Department of Agriculture. It is now grown more or less in the wild or cultivated form in all the Gulf States. While it may be successfully grown as far north as the Ohio River, it is not probable that it will be sown far north of any of the Gulf States, since other fodder plants more valuable in producing food can be grown to supply the wants of live stock. At the Minnesota University Experiment Farm, the author



Fig. 12. Beggar Weed (*Desmodium tortuosum*)
(Root System)

(341)

North Carolina Experiment Station

sowed seed in May. The plants came into bloom in September, but did not mature any seed.

Beggar weed will grow on almost any kind of soil reasonably free from an excess of ground moisture. Its power to grow on poor and light soils, even light enough to lift with the wind, is very considerable. Its highest use will probably be found on soils so light and sterile that better forms of useful vegetation are not easily grown on them.

It can scarcely be called a rotation plant, since it more commonly grows in the wild form, and on lands so poor as to be considered unprofitable for regular cropping. But when cultivated, it should be followed by some crop that can make a good use of the nitrogen left in the soil in the tubercles formed on the roots of the beggar weed plants.

The soil does not, as a rule, require deep stirring when preparing it for beggar weed. This fact finds demonstration in the ability of the plants to re-seed the ground when grown for grazing.

The seed is usually sown in the Gulf States late in March or early in April. It germinates slowly, and the plants make the most vigorous growth after the weather becomes warm. The seed is more commonly scattered broadcast, but may be drilled in, and at distances that will or will not admit of cultivation as may be desired. Thick seeding is preferable to prevent coarseness and woodiness in the growth of the plants. Not less than 10 pounds of hulled seed per acre should be sown in the broadcast form when sown for hay. When sown in drills, less

seed is required, but usually the seed is sown broadcast. In the hulled form, in which the seed is more commonly sold, according to Professor H. H. Hume, the measured bushel weighs 60 to 64 pounds, and with the hulls on, from 10 to 40 pounds, the average weight, as purchased by dealers, being about 20 pounds. The cleaned seed bears considerable resemblance to clover seed.

All kinds of farm stock, as cattle, horses, mules, sheep and even swine, are said to do well when grazing on beggar-weed pastures in the summer and autumn. They do not usually graze it closely after it has been well started, owing to the woody character of the stems. When thus cropped back, it starts out afresh, and thus continues to produce grazing until the arrival of frost. It is said that the pasture is of but little value in winter. One strong point, however, in favor of such pastures, is the ability of the plants to re-seed the land when not grazed too closely, and thus to perpetuate the grazing from year to year.

No little diversity of opinion exists as to the value of this plant for producing hay. Some growers speak highly of its palatability and nutrition. Others speak of it as being of very little value as a hay plant. This difference in opinion is doubtless due largely to cutting the crop at different stages of growth. If allowed to become too advanced before it is cut, the woody character of the hay would doubtless make it unpalatable, whereas, if cut early, at least as early as the showing of the first blooms, if not, indeed, earlier, it would be eaten

with a much greater relish. The yields of hay are said to usually exceed 2 tons per acre.

The seed matures in September and October. The methods of saving the seed have usually been of a somewhat primitive character, as by hand when saved in small quantities. But there would seem to be no reason why the seed crop could not be harvested by the binder.

Where alfalfa or cow peas can be successfully grown, either crop would be preferable. But on some soils these are not a success, especially when the first attempts are made to grow crops. The choice of hay may be one between a crop of beggar weed and no crop at all. All are agreed as to the renovation which it brings to soils; hence, when grown or allowed to grow on unproductive soil for a few years and then plowed under, the soil becomes productive. Since it grows late rather than early in the season where the seed is in the land, it will not interfere with the growth of the corn, but will come on later, and thus exert a beneficial influence on the soil. But the fact should not be overlooked that beggar weed once in the land has considerable power to stay there. In other words, like sweet clover, it has some of the characteristics of a weed.

BUFFALO CLOVER

Buffalo clover (*Trifolium stoloniferum*) is a native species procumbent in its habit of growth. The leaves are most abundant at the base of the plants. The flower heads, about an inch in

diameter, are rose colored, and rise to the height of about one foot from the ground.

This variety, said to be perennial in its habit of growth, is probably the same as *Trifolium reflexum*, said to be biennial in Kansas. Plants are found growing wild in prairies, between forests, and in open woodlands, from Kentucky on the east, to Kansas on the west. It is thought that this clover would repay cultivation, but the author has not been able to get any information bearing upon its behavior under cultivation.

SEASIDE CLOVER

Seaside clover (*Trifolium involneratum*) has rendered some service to agriculture in what is known as the "Great Basin," which includes parts of Oregon and Nevada. In Bulletin No. 15, Bureau of Plant Industry, issued by the United States Department of Agriculture, it is referred to as one of the most promising species for cultivation in that area. Under the influence of irrigation it has spread, in one instance cited, into sage brush soil, and there, along with timothy and red top, has aided in producing fine crops. In low, swampy, non-alkaline areas, it often yields from $\frac{1}{2}$ to $1\frac{1}{4}$ tons of hay per acre. It has been estimated that with correct conditions it would be found about equal in producing power and feeding value to alsike clover. It is at least questionable, however, if it is likely to supersede to any considerable degree the varieties already under general cultivation.

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