LETTER OF TRANSMITTAL

U. S. DEPARTMENT *or* AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., September 4, 1908.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin, to supersede Farmers' Bulletin No. 215, entitled "Alfalfa Growing," the manuscript of an article entitled "Alfalfa," prepared by Mr. J. M. Westgate, Assistant Agrostologist, in Charge of Alfalfa and Clover Investigations in the Office of Forage Crop Investigations of this Bureau, under the direction of the Agrostologist in Charge.

The rapid extension of the alfalfa area in almost every State of the Union has been stimulated by the publications of the Department of Agriculture and those of the State agricultural experiment stations, as well as by the agricultural press. This condition has led to an increasing demand for full information concerning the best means of producing this crop, especially in sections where it is not already well established. The conditions outside of the recognized alfalfa districts are usually unfavorable to the successful production of alfalfa until the natural drawbacks are all overcome. These unfavorable conditions are generally those incident to the humid climate of the East or the lack of sufficient rainfall in the West. A large proportion of the alfalfa seed sown in sections where alfalfa is not a staple crop has been practically wasted owing to the lack of proper understanding of the special requirements of the young plants. This bulletin has been prepared quite as much to point out where and under what conditions alfalfa will probably fail as to indicate the sections and conditions under which success may be expected.

Besides drawing freely upon the publications of the State agricultural experiment stations and the experience of prominent alfalfa growers, there have also been available a considerable number of data derived from the cooperative experiments of the Bureau of Plant Industry carried on with farmers in all parts of the country during the last three years.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

Issued December 11, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 339.

ALFALFA.

by

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ALFALFA

HISTORY AND PRESENT DISTRIBUTION OF ALFALFA.

The original home of alfalfa appears to have been southwest of central Asia, but from there it has been carried to practically every part of the world where agricultural pursuits are important. It is now one of the staple forage crops of every continent of the Old World and easily takes front rank as the most important leguminous forage crop of the Western Hemisphere. The name " alfalfa " is of Arabic origin and means " the best fodder." The southern European name of " lucern " was formerly applied to the plant in the eastern part of the United States and in Utah, but this name has practically given way to the name " alfalfa," under which it was introduced by the Spaniards.

The Persians were apparently the first nation which grew this plant. They took it with them when they invaded Greece about 490 B. C. The object of this introduction appears to have been to provide forage for the horses and cattle upon which their armies depended. Alfalfa was introduced into Italy during the first century A. D. Such early Roman writers as Virgil and Pliny give what may still be regarded as excellent instructions regarding the handling of alfalfa fields. The introduction of alfalfa into Spain was probably during the Moorish invasion in the eighth century A. D. The Spaniards introduced it into Mexico and South America during the sixteenth century. It is reported to have been carried northward from Old Mexico into what is now the southern portion of the United States, but it was not until 1854, when it was taken to San Francisco from Chile, that its rapid extension over the irrigated sections of the Western States commenced. Its culture has since been extended to many of the non-irrigated sections of the West. The more humid sections of the Great Plains area have proved especially adapted to its production. Eastward of the ninety-sixth meridian its culture has been less successful owing to the presence of less favorable conditions of soil and climate.

The history of alfalfa in the Eastern States runs back for at least two centuries, as the colonists made repeated attempts to establish it.

Under the name of " lucern " it had been introduced into England about 1650. The attempts on the part of the American colonists to establish it were unsuccessful. The limestone region of central New York probably constitutes the area of its longest continued culture in any section of the East. In South Carolina there is a field reported to be seventy-five years old. Alfalfa has also been grown locally in most of the Eastern States for many years. The black prairie soils of Alabama and Mississippi are proving especially adapted to alfalfa. The successful districts have usually been the somewhat limited area of limestone soils where the conditions are especially suited to the plant. The recent efforts looking to its further extension throughout the East and South indicate that the chances of success increase greatly as the special requirements for its production are understood and provided for.

ALFALFA IN THE UNITED STATES.

Alfalfa is the staple leguminous forage crop throughout the western half of the country. Its distribution, as compiled from the census of 1899, is indicated in the accompanying map (fig. 1). Each dot represents 1,000 acres in the region where the dot is located. For

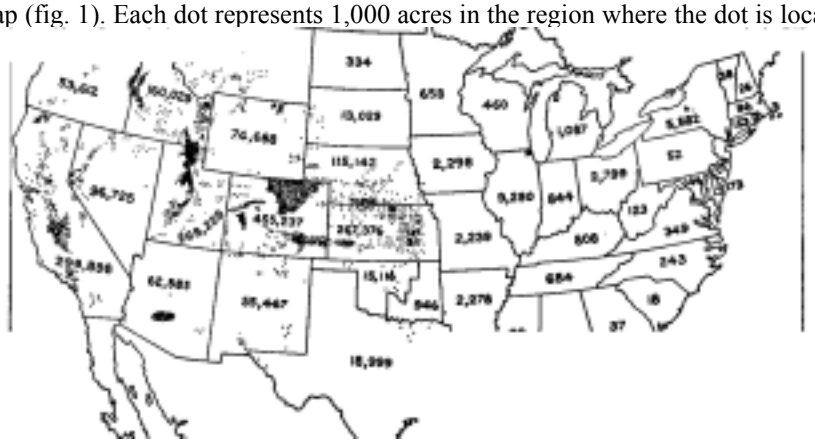


FIG. 1.-Map of the United States showing the distribution of alfalfa in 1899. The numerals indicate the acreage in each State. The dots show the location of the alfalfa sections.

this reason only the sections of rather extensive alfalfa production are shown, as counties having less than 1,000 acres are not dotted. The acreage east of the one-hundredth meridian has probably more than doubled since the last census was taken. Its rapid extension in

parts of the West is indicated by the fact that in Kansas the assessors' reports in 1891, when alfalfa was first listed separately, showed 34,384 acres, while in 1907 743,050 acres were reported. In the and sections on the areas which have been brought tinder cultivation in the past ten years alfalfa has been extensively planted.

DESCRIPTION OF ALFALFA.

The accompanying illustration (fig. 2) indicates the general appearance of the plant. It may briefly be described as being a deep rooted, long-lived herbaceous forage plant belonging to the botanical family Leguminosae, or pod-bearing plants. Its flowers are violet, clover shaped, and borne in compact oblong racemes, or clusters. The pods are small, slightly hairy, and spirally coiled in two or three turns. The kidney-shaped seeds are about one-twelfth of an inch long, and several are contained in each pod.

One of the most important characteristics of alfalfa is its long taproot, often extending 15 or more feet into the soil. This enables the plant to reach stores of plant food in the soil which can not be secured by the ordinary shallow-rooted field crops. This long taproot is also of great importance in sections of limited rainfall, as by this means the plant is enabled to withstand extremes of drought which would otherwise be fatal.

Fig. 2 Alfalfa plant in early bloom

ADAPTABILITY OF ALFALFA TO VARIOUS CONDITIONS.

The wide distribution of alfalfa throughout the world indicates a remarkable adaptability to various climates and conditions. So far as climate is concerned alfalfa can be grown in every State in the Union. It is, however, very exacting in the humid sections as to soil and treatment. It is grown below the sea level in southern California and at altitudes exceeding 8,000 feet in Colorado. Under proper irrigation it yields abundant crops in the deserts of Arizona, which

are among the hottest in the world. The hardy strains are able to withstand the severe winters of the North Central States. It is raised without irrigation in semiarid sections where the rainfall is only 14 inches a year, and also in the Gulf States where the annual rainfall may amount to 65 inches. A rainfall of 36 inches a year is ample for this crop, and an amount in excess of this is usually a detriment. In moist climates the soil is frequently sour, and the clay soils especially are apt to be too poorly drained. In such a climate weeds and fungous diseases prove much more injurious than under less humid conditions. Although the adaptability of alfalfa is great, yet in the areas not perfectly suited to its successful production care is necessary to provide the very favorable conditions required by the young plants in order to overcome the natural drawbacks.

REQUIREMENTS FOR SECURING AND MAINTAINING A STAND OF ALFALFA.

A deep, fertile, well-drained soil rich in lime and reasonably free from weeds is necessary for alfalfa. The lack of any one of these essentials is very apt to be the cause of failure, especially in the Eastern and the Southern States, where alfalfa is at best produced with some difficulty.

A DEEP SOIL USUALLY NECESSARY FOR ALFALFA.

A deep, permeable soil should be chosen if possible, as alfalfa is naturally a deep-feeding plant that usually sends its roots down many feet to obtain the plant food materials and moisture which are out of reach of the shallow -rooted crops. If the soil lacks depth the alfalfa plant is unable to utilize its deep-feeding root system and is less likely to withstand the inroads made by the surface-feeding weeds. The roots can, however, penetrate rather stiff clay soils, and even some of the soils -underlain with hardpan. Instances have also been observed in the limestone sections of the Eastern and Southern States -where alfalfa was growing successfully on soils underlain at a depth of but 18 inches with limestone ledges.

IMPORTANCE OF A FERTILE SOIL FOR ALFALFA.

Alfalfa, being a leguminous plant, is able through the nodule forming bacteria within its roots to add nitrates to the soil and in this way increase its fertility to that extent. Since large yields of alfalfa draw on the soil rather heavily for the other elements of soil fertility, it usually requires the richest and best,-drained soil the farm affords, and if successful will bring returns to justify the use of this land. There is risk, however, in selecting bottom lands for alfalfa, both on account of their failure to drain promptly and owing to the

danger from weeds on such soils. In the East it is usually best to develop the fertility of some of the higher rolling land and seed this to alfalfa.

West of the Mississippi River the soils are usually fertile enough for alfalfa without the use of any fertilizer. In the East, and South, however, they usually require some artificial treatment to bring them up to the proper degree of fertility before alfalfa can be safely planted. This result may be brought about by the plowing under Of some green-manure crop, the application of commercial fertilizers, or the, spreading of barnyard manure.

Barnyard Manure for Alfalfa.

Well-rotted barnyard manure [a] is usually the most satisfactory fertilizer for alfalfa. Fresh manure is apt to carry large numbers of weed seeds; therefore, if necessary to use it, the application should be made to the preceding crop. This will give time for the germinating weed seeds to be destroyed by the cultivation of the preceding crop or by the stirring of the ground incident to the preparation of the seed bed for the alfalfa.

Green-Manure Crops for the Prospective Alfalfa Field.

Green-manure crops [b] are especially efficient in increasing the humus content of the soil, and this is exactly what many soils require if alfalfa is to be raised upon them. In the South cowpeas, crimson clover, vetches, and even bur clover are successfully used. In the States farther north crimson clover, cowpeas, soybeans, and vetches may be utilized. It is usually best to follow the green-manure crop with some clean-culture crop before seeding the land to alfalfa, as the decaying vines induce acid conditions in the soil that are unfavorable to the alfalfa plants.

Commercial Fertilizers for Alfalfa.

If barnyard manure is not available and if there is not time for the utilization of green-manure crops, it is necessary to apply commercial fertilizer liberally to any soil that may be lacking in fertilitv. This fertilizer should be reasonably rich in phosphoric acid ad potash, but may be poor in nitrogen. However, the kind and amount of fertilizer necessary vary greatly with the soil and section, and exact recommendations can not be made. The State agricultural experiment stations of most of the Eastern and Southern States have made experiments with various fertilizers for alfalfa. It is suggested that

a See Farmers' Bulletin 192, entitled " Barnyard Manure." *b* See Farmers' Bulletin 278. entitled " Leguminous Crops for Green Manure." 58749-Bul. 339-08-2

the methods outlined under the heading " Need of experimenting at first " be used to determine the best formula for any particular case.

NECESSITY FOR A WELL-DRAINED SOIL FOR ALFALFA.

In the humid sections of the country it is especially important to provide a well-drained soil for alfalfa. In the irrigated districts the problem of drainage to prevent or reduce the accumulation of alkali is often serious. In the regions of heavy rainfall natural drainage must be provided. It has been found that alfalfa requires much more complete drainage of the soil than do other field crops. Where the underdrains are unable to carry off the rainfall rapidly enough for prompt drainage, it is sometimes the practice to backfurrow, leaving the dead furrows at intervals of a rod or less. This permits the water to run off quickly in the event of heavy rains. [a]

Alfalfa is often killed by overflows from streams. During its growing period it will not usually withstand more than twenty-four hours of complete submergence or more than forty-eight hours of partial overflow. During the dormant period of winter, however, fields have been known to remain under flowing water for two weeks without serious injury.

A WELL-LIMED SOIL ESSENTIAL FOR ALFALFA.

No other forage crop requires so much lime in the soil as does alfalfa. It is apparently necessary that the soil acidity be neutralized by the lime and that there be also an excess for the actual use of the plant. In one test an analysis was made of the mineral constitutents of certain crops. The percentage of lime in the alfalfa ash was 34.9, while red clover had but 20.6 per cent, and timothy had only 4.7 per cent. Throughout the East and South alfalfa is most easily produced on the limestone soils. Even these soils often require liming for the best success of the alfalfa, as the rains tend to leach the lime out of the surface layers of the soil.

Liming Soils.

It may be safely assumed that if a soil ever requires liming it will require it for alfalfa. The litmus test for acidity of the soil may be used, but this is not always satisfactory. The most reliable method is the one outlined under the heading " Need of experimenting at first," page 20. The only drawback to this method is that it requires a year's time. It is usually best to apply the lime the season previous to sowing the alfalfa, as this allows time for the lime to become thoroughly incorporated into the soil. There are several different forms of lime on the market. As a general rule it is best

a **See Farmers' Bulletin 187, entitled "Drainage of Farm Lands."**

to purchase that form which will mean the most actual lime for the money outlay. Ground unburned limestone is proving satisfactory in many sections. Nearly twice as much of this as of the freshburned lime is required. Under normal conditions a ton of ordinary lump or ground lime is usually applied to an acre.

IMPORTANCE OF A WEED-FREE SOIL FOR ALFALFA.

Young alfalfa plants are very tender and are apt to be killed by weeds during their early stages of growth. For this reason it is essential that the land be as free from weeds as possible. This condition can be brought about by raising some cultivated crop for two or three seasons previous to planting alfalfa. The same result can also be secured by seeding the land successively to crops, such as cowpeas, which naturally prevent the growth of weeds. If a weedy soil must be used, the land should be plowed several months before the, alfalfa is seeded and the successive crops of germinating weeds destroyed by frequent harrowing. Weeds are especially harmful to spring-seeded alfalfa, and for this reason spring seeding should be avoided and late summer or early autumn seeding practiced in all sections where this can be done.

CROPS WHICH MAY PRECEDE ALFALFA.

The time of year that any given crop may be harvested and the land prepared for alfalfa is an important factor in choosing the crop to precede alfalfa, which usually requires seeding at a certain definite time in any given locality. In sections where late summer seeding of alfalfa is possible the early-maturing truck crops, such as early potatoes, enable one crop to be secured that season and still allow time for the preparation of the land for alfalfa. In addition to this the clean culture given the truck crop will tend to rid the field of weeds and will make plowing unnecessary. The residual effect of the heavy fertilizer applications which must be made for the truck crop will usually suffice for the alfalfa. Except in the extreme North small-grain stubble can usually be worked tip in time for late summer seeding. This is especially true of oats.

Clean-culture crops, such as corn in the North and cotton or tobacco in the South, are useful in ridding the land of weeds. As in the case of truck crops, a heavy application of manure may be given these crops and the culture given them will destroy any weeds that mav have been introduced with the manure. It is usuallv impossible in the sections indicated to get such a crop as corn off' the land in time for the late summer seeding of alfalfa. In such cases a green-manure crop, such as hairy vetch or common clover, may be seeded

in the fall, cut for hay the following spring, and the stubble plowed in preparation for alfalfa.

In the North Central States where spring or early summer seeding is necessary, it is sufficient that corn-stubble land be disked and harrowed for alfalfa. A small-grain crop may also follow the clean-culture crop and immediately precede the alfalfa in sections where the can be plowed under in time for the seeding of the alfalfa. Sod or pasture land may usually be plowed in the spring and fitted for alfalfa by late summer seeding in the Eastern States. In the Great Plains area it is sometimes the practice to break the sod in the fall and by repeated diskings bring the land into condition for seeding the alfalfa by spring.

PREPARING THE SEED BED.

The tender nature of the young alfalfa plants requires that the soil be in excellent tilth at planting time. The seed bed should be fine on top but thoroughly settled. The young taproot of the alfalfa plant strikes down immediately and is apt to be seriously injured if it encounters a layer of loose dry soil at the bottom of the old furrow. As a general rule about six weeks are required for plowed land to settle enough for alfalfa seeding. It is sufficient, however, with many soils that they be disked instead of plowed. Less time is required for the disked land to settle and the operation is much less expensive than plowing.

It is important that the preparation be uniformly good, as the poorly prepared spots are apt to fail. These bare places form the centers from which weeds may spread and ultimately destroy the whole stand. Summer fallowing is often practiced in the semiarid regions to conserve sufficient moisture for the germination of the seed at planting time. This method is also effective in any section for ridding the ground of weeds.

Preparation of Sandy Ground.

It is often difficult to establish alfalfa on soils that are so sandy that they drift when bare. The young unprotected alfalfa plants are very apt to be cut off by the drifting sand unless special precautions are taken. This danger may be avoided by applying a light top-dressing of straw or coarse manure just after seeding. Another method is to drill the alfalfa into the high-cut stubble of cane, kafir, or millet; or the alfalfa may be seeded in a thin young stand of small grain, such as oats, which makes a rapid early growth and thus protects the seedling alfalfa plants.

SELECTION OF SEED.

The selection of the seed is an important matter. The original source of the seed, its vitality, and its impurities should each receive consideration. Experiments indicate that it is not harmful to sow northern-grown seed in the South, but southern-grown seed should not be seeded in the Northern States on account of danger from winterkilling. It is usually desirable to secure samples from more than one source and test them as to germination and purity before purchasing. [a] It is not a difficult undertaking to make a home test of the seed as illustrated in figure 3.

Since the demand for alfalfa seed in this country has for some time exceeded the supply, there is very little old seed on the market. The securing of perfectly fresh seed is not so important, as tests have shown that samples 5 to 7 years old lose very little of their germinating power. The loss of vitality due to age is generally indicated by the seed turning a reddish brown. The greatest care should be taken to get seed free from dangerous weeds. (See fig. 4.)

It is generally advisable to order the samples the winter before the seed is to be sown. It is often impossible in the rush season just before seeding to purchase seed from the same lot after the delay incident to having the germination and purity tests made. Some seed firms will book orders for certain lots of seed " subject to satisfactory germination and purity tests." This practice should be much more common, however, than it is at present, and will doubtless become general when there is a sufficient demand for it on the part of the farmer.

FIG. 3-Homemade seed tester. A, closed; B, open.

TIME OF SEEDING.

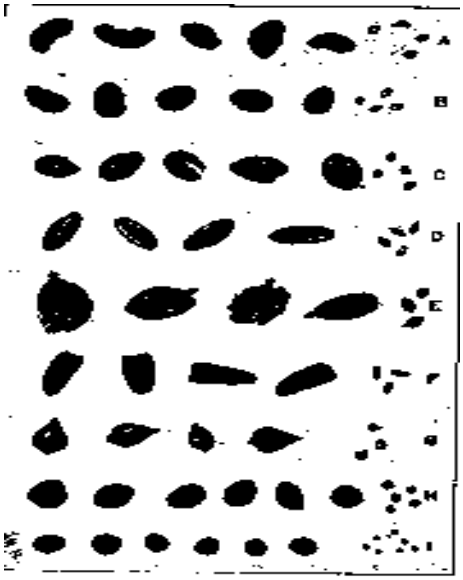
The time of seeding alfalfa varies in the different sections of the country, but late summer seeding is usually best in the East and

a See Farmers' Bulletin 194, entitled "Alfalfa Seed," where a full discussion of the impurities and adulterants of alfalfa seed is given. The United States Department of Agriculture and many of the state agricultural experiment stations stand ready to make examinations of seed for purity and germination free of charge.

South. The general principle underlying the time of seeding is to' sow as far in advance as possible of what promises to be the most trying season for the young plants. Spring seeding is the rule in the irrigated and semiarid sections of the West. It is also preferable in Minnesota, Wisconsin, and the Dakotas, where any but spring or early summer seeded stands are very apt to winterkill Fall seeding Southwest, and late spring seeding may be necessary at times in the Southern States when drought or other unfavorable conditions have prevented fall seeding.

The weeds of midsummer constitute the worst danger to the young stands of alfalfa in the humid sections of the country, except the extreme north, where this danger is exceeded by the danger of winterkilling. Wherever possible in the humid sections of the country late summer seeding should be practiced. The advantage of this time of seeding over that of either spring or fall is that an early-maturing crop may be removed in time for seeding, the weeds of midsummer are avoided, and ample time is given for the making of a strong growth to resist winterkilling and the heaving of the ground in the spring. The large growth of the plants possible during the early fall also enables them to make a rapid early growth the following spring. On this account the alfalfa is able to resist much better the inroads of weeds than if it had been seeded the previous fall or during the same spring. (See fig. 5.) A fair yield of hay is secured the season after seeding, and in this way there is not the loss of the use of the land for a year, as is likely to be the case with spring or fall seeding.

FIG. 4.-Seeds of alfalfa and common impurities. (Enlarged; natural size at the right.) A, alfalfa; 13, yellow trefoil; C, sweet clover; D buckhorn; E. wild carrot; P. wild chicory! G, curled dock; 11, large-seeded dodder;



I: small-seeded dodder.

METHODS OF SEEDING.

The manner of seeding varies considerably in the different sectionsi but the various methods agree in that it is necessary for the seed to be covered and not sown on the surface of the ground, as is sometimes done with grasses and clovers. Alfalfa may be planted with a drill - or seeded broadcast with a hand seeder or wheelbarrow seeder, or by hand. It is usually best to sow half the seed
one way across the field and the other half at right. angles to the line of the first sowing.

The depth of planting depends on the soil conditions. Covering f r o in t h r e e -fourths to 1 inch deep is usually sufficient on clay soils, but an inch and a half is necessary on sandy soils or in the semiarid sections, where deep covering is required to insure sufficient moisture for the germination of the seed. When seeded

FiG. 5.-Alfalfa seedlings at t1i beginning of winter. 1, Seeded August 15, 13 inches high; 2, seeded September 1, 51 inches high; 3, seeded September 15, 2.1 inches high. The larger, early-seeded plants are much better able to withstand the winter than are the small, late-seeded ones.

broadcast, a light harrow, weeder, or brush is used to cover the seed. In case the soil is light it may be rolled, but this is not usually advisable, as the soil is more apt to become dried out before the plants can become established. A smaller quantity of seed is used when it is drilled. If a grain drill is used, the amount seeded may be regulated by the use of leather thongs to reduce the, feed.

RATE OF SEEDING.

The quantity of seed required per acre is much greater in the humid sections than in the semiarid and irrigated sections of the country. In the West fair stands have been secured with as little as I to 5 pounds of seed per acre, but this has been under perfectly ideal conditions. Good stands from 5 pounds of seed to the acre are not unusual in the West. Twenty pounds per acre is the amount usually recommended, however, and even this must be increased where the danger from weeds is serious and it is necessary that the alfalfa plants cover the ground from the start to prevent the weeds from becoming established. A pound of ordinary alfalfa contains about 220, 000 seeds. As there are 43 560 square feet in an acre, each pound seeded would give about 5 seeds to the square foot. At the rate of 20 pounds per acre each square foot would receive 100 seeds. Many of these fail to grow, and the young plants meet with many accidents. Counts in old alfalfa fields have shown from I to 6 plants per square foot, practically equal yields being secured from all. A year-old field in Virginia was found to contain 20 plants to the square foot.

The following recommendations as to the rate of seeding are made for the different sections of the country: Atlantic and Southern States, 24 to 28 pounds per acre; States east of the ninety-eighth meridian and west of the Appalachian Mountains, 20 to 24 pounds; semi-arid sections of the Great Plains, from 5 to 15 pounds, depending on the average rainfall; 15 pounds is commonly seeded in the irrigated sections by experienced growers.

USE OF A NURSE CROP.

In the East and the South and in the semiarid sections of the West P. nurse crop usually proves disastrous to alfalfa, of ten resulting in the complete destruction of the stand. In sections where it can be used alfalfa usually succeeds in spite of the nurse crop rather than by reason of it. In the irrigated sections of the West a nurse crop is often used, the two crops being seeded together in the spring.

In the extreme Southwest barley is sometimes seeded with alfalfa in the fall. In the States bordering on Lake Michigan a half seeding of beardless barley is often a success as a nurse crop for alfalfa, but

even in this section it is generally recommended that the alfalfa be seeded alone in midsummer. In sandy soils a very light seeding of small grain as a nurse crop is sometimes used to prevent the sand from blowing and injuring the young plants. In all cases the nurse crop, if ever used, should be cut as soon as it shows signs of injuring the alfalfa plants.

Sometimes a successful stand may be secured in Ohio and neighboring States by seeding in corn at the last working. This method is apt to prove a failure in case of a dry season.

INOCULATION FOR ALFALFA.

Throughout the western half of the United States the soil appears to be naturally supplied with the proper bacteria for the formation of the root tubercles. In the eastern part of the country, however, where the soil conditions are less favorable to the growth of these bacteria, it is nearly always necessary to supply them at the time of seeding. This inoculation may be supplied either by scattering soil from a successful alfalfa field or in the form of artificial cultures.

Inoculation by Soil Transfer.

Although possessed of some disadvantages, inoculation by means of soil from a successful alfalfa field will nearly always produce the desired results. It is essential that care be taken to avoid the introduction of seeds of noxious weeds or harmful plant diseases. The bulkiness of the 300 to 800 pounds of soil necessary for an acre makes it advisable to secure the soil from a field as near by as possible.

It has been found that soil from around the roots of the sweet clover (Melilotus alba) is quite as effective as alfalfa soil. In most sections of the country this plant may be found growing wild in scattered clumps. In the South, where bur clover occurs, soil from around its roots may be used with good results. The soil may be mixed with the seed and sown with it. It may also be drilled or broadcasted separately. If broadcasted, the soil should be scattered on -a cloudy day or toward evening and immediately harrowed in, as sunshine is harmful to the germs.

If the soil has to be freighted considerable distances, it is usually advisable to use but 200 or 300 pounds of soil per acre, but this should be mixed with several times its weight of ordinary soil to facilitate even scattering. If the soil is difficult to secure, it may be best to seed a very small area the first season, taking special precautions to have it thoroughly inoculated. This will then furnish an abundance of soil for inoculating a larger area the following season.

It can not be urged too strongly that inoculation is absolutely essential to the successful production of alfalfa. There are very few

soils outside the alfalfa districts that do not require inoculation, and it may be taken as a general rule that all other soils must have the inoculation supplied in order to grow alfalfa successfully. A few soils, however, especially those upon which sweet clover grows naturally, seem able to produce successful stands without artificial inoculation. These, however, are the exception rather than the rule.

Inoculation by Pure Cultures.

The artificial cultures supplied by the United States Department of Agriculture are fully explained in the Farmers' Bulletin on the subject. [a] These cultures are sent out in hermetically sealed tubes. The contents are mixed with clean water, and certain chemicals included with the outfit are added to the solution to form the food supply of the germs while they are multiplying. When the germs have increased sufficiently in number the solution becomes of a faint milky color. It is then applied to the seed. The seed should be dried in a shaded place and sown as soon as possible. The advantages of the artificial cultures lie in the greater ease of transportation and application as well as in the absence of the danger of introducing plant diseases or harmful weeds.

Inoculation produced by the cultures, in case it is successful, seems to be in every way as efficient as when the soil method is used. Fewer failures are reported in the case of the soil-transfer method, but the reason for this has not been definitely determined. It has been found that successes are more apt to follow inoculation with pure cultures if the seed is sown immediately after the seed has been dried after having been inoculated. There is some evidence accumulating to indicate that the germs in the pure cultures when they do survive are superior to those normally found in the alfalfa soil. It is suggested, therefore, that both the soil-transfer method and the artificial cultures be used.

TREATMENT THE FIRST SEASON.

If seeded in the late summer or early autumn, alfalfa will require no treatment that autumn unless a growth of more than 12 inches is made before cold weather. If this occurs, the plants should be clipped back so that they will go into the winter with 8 or 10 inches of growth. In this condition they will be best able to withstand the winter and will be in excellent shape to renew their growth the following spring. The first cutting of hay should be secured in the late spring.

If, on the other hand, the seed has been sown in the late fall or in the spring, but little more than a clipping can be secured in the late

[a] See Farmers' Bulletin 315, " Progress in Legume Inoculation."

spring or summer. This clipping should be made preferably when the basal shoots start and should be made 3 or 4 inches high, as the plants will be slow in recovering if cut too low. It may be necessary to cut at some other time than the ideal time indicated, as, for instance, when the weeds threaten to choke out the young plants, when the blossoms appear, or when the plants begin to turn yellow. Except in the latter case the clippings are usually left on the ground as a mulch. If the plants have turned yellow owing to some

disease, the clippings should be raked up and removed. A top-dressing of nitrate of soda will sometimes invigorate the diseased plants. The same statements govern subsequent cuttings the first summer, except that the growth is usually too heavy to be left on the field.

TREATMENT THE SECOND SEASON.

Ordinarily no treatment is required during the second season, except to cut the hay when the plants are about one-tenth in bloom, or, better, when the new crown or basal shoots are starting. It is important to get the hay off the field as soon as possible, in order to allow the new growth to commence uniformly over the field. If the windrows or cocks are allowed to remain too long on the ground, the alfalfa plants will be smothered out and then bare spaces will form the centers from which weeds will spread.

No pasturing should be allowed during the first or second seasons, as the crowns have not become sufficiently well developed to withstand the effect of trampling. About three-fourths to a full crop may be expected the next season after late summer seeding in the humid regions. Nearly a full crop is usual the second season after spring seeding if the weeds of the first summer have not seriously injured the stand.

TREATMENT DURING SUBSEQUENT SEASONS.

As long as an alfalfa field shows a perfect stand, with no tendency to run to weeds, it is not customary to give the field any special treatment. If the weeds begin to prove troublesome, it is advisable to disk the alfalfa after cutting. This process loosens up the soil and aerates it, which is decidedly advantageous to the alfalfa. The taproots of the alfalfa plants are not usually injured by this practice if the disks are set nearly straight, while the weeds are to a great extent destroyed. A spike-toothed harrow may follow the disk to level the ground.

In the East an implement known as an alfalfa renovator is meeting with success. It is a modification of a disk harrow with spike teeth on the disks. It is adapted to loosening up the ground and destroying the weeds without serious injury to the alfalfa. Many growers who have a large acreage of alfalfa disk their fields each

season. Disking, however, is apt to be destructive to the alfalfa in sections where the alfalfa does not thrive.

If there is a considerable growth of fall weeds or grasses these may be burned off the following spring before the alfalfa starts. The field should be burned before a strong wind to avoid injury to the alfalfa crowns. In sections where soils require liming, it is sometimes advantageous to make an application of lime either in the spring or after the first cutting. Slaked lime may be used, but ground unburned limestone is preferable, as this will not injure the alfalfa plants. A top-dressing of well-rotted or weed-free barnyard manure may be made during the early winter with advantage on most of the soils in the eastern half of the United States.

DRAWBACKS OF ALFALFA.

Valuable as alfalfa is, it is not without its drawbacks and weak points. It is difficult to establish, especially in the Eastern States, where red clover is generally successful. The

methods customary for the raising of red clover, however, do not apply to alfalfa and much has to be learned by experience as to the special requirements of the alfalfa plants.

The first cutting in late spring comes at a time when heavy-rains are apt to interfere with its proper curing. It does not cure at all readily and this point makes a good quality of hay extremely hard to get, especially from the first cutting. The bright green hay so common in the irrigated sections is almost never seen in the humid sections, owing to injury from rain. Alfalfa does not reseed itself, and, although the individual plants may live for years, when once a plant dies its place is taken not by other alfalfa plants but by weeds.

On farms where the production of alfalfa is a side issue, the three or four cuttings of hay procured during the season are apt to come at a time when the normal work of the farm is directed along other lines. In such cases attention can not be given to the alfalfa work at the proper time without handicapping the major lines of farm work.

Furthermore, when pastured by cattle and sheep, bloating is likely to occur, with the possibility of the loss of valuable animals. The seed is expensive and the cost of getting the ground in satisfactory condition is quite considerable, thus working a hardship if the stand is not a success, as is too often the case.

NEED OF EXPERIMENTING AT FIRST.

Perhaps no other crop requires such a variety of different treatments, depending upon the special locality in which it is grown, as alfalfa. For this reason early attempts are likely to be failures, and

consequently should be made upon a very small scale. Many have succeeded in producing profitable crops of alfalfa only after sowing it for several years in succession.

It is suggested that the area seeded at first be small, and that it be divided into a number of subdivisions, each receiving a different treatment; for instance, in the humid sections in regard to the application of fertilizers and lime. The accompanying diagram (fig. 6) indicates an experiment adapted to the Eastern half of the United States. A more simple form of this experiment is shown in figure 7. This calls for the application of lime to the northern half of the area and no lime to the southern half. The eastern half should then receive manure and the western half no manure. This will make 4 plots to the experiment, instead of 9 as in figure 6. The strips receiving lime and manure may well be wider than the strips not receiving such treatment. This will reduce the size of the check plot which receives neither application and thus less apt to succeed.

The method, however, is the important feature, and can be modified to suit the prevailing conditions. The idea is to try on the same field at the same time all the different treatments that are likely to prove successful. The treatment giving the best results can be applied to an increased acreage the succeeding season. In this way the experience which would otherwise require a number of seasons to procure can be obtained at the end of the first year.

1	2	3
4	5	6
7	8	9
On plots 1 and 4 apply nothing except lime on plots 1 and 4	On plots 2, 5, & 8 apply commercial fertilizer	On plots 3, 6 & 9 apply barnyard manure.

Fig. 6. A suggested outline for experiments wth alfalfa

Lime at rate of 2.5 bushels per acre.	Lime at rate of 2.5 bushels per acre.Manure liberal application.
No lime No manure	No lime. Manure (liberal application)

Fig. 7. A suggested outline for simple experiments with alfalfa

In the semiarid regions, where the preparation of the soil and the time of seeding are the important factors, the experiments can be formulated along these lines rather than to include the lime and fertilizers which are necessary in the eastern sections. In all cases it is important that a check plot be left that receives no special treatment that is, only the

ordinary treatment-in order to make possible a definite comparison of the effect of the different treatments.

UTILIZATION OF ALFALFA.

ALFALFA HAY.

Probably four-fifths of the alfalfa of the country is utilized in the form of hay. The number of cuttings depends upon the length of the growing season and the varieties and varies from eight and sometimes nine in the extreme Southwest to two in the northern and the semiarid sections. Under favorable conditions three cuttings may be obtained in the northern portion of the country, but in very dry sections one cutting may be all that can be secured in dry seasons. From thirty to forty days of good growing weather are usually required to produce sufficient growth for a hay crop.

Time of Cutting.

The general rule is to cut alfalfa just as it is coming into bloom. Feeding experiments show that the feeding value is highest when the alfalfa is cut in early bloom. Results obtained at the Kansas Agricultural Experiment Station show that with bay cut when one tenth in bloom the protein content is 18.5 per cent; when one-half in bloom, 17.2 per cent; and when in full bloom, 14.4 per cent.

Cutting just as the field commences to show the blooms -usually gives satisfactory results. It is safer and better, however, to watch for the starting of the basal shoots which are to form the growth for the succeeding crop. In this way the new growth is ready to take immediate possession of the ground and no delay results. On the other hand, if the cutting takes place before these shoots are formed the new growth is delayed until they can be formed. If the cutting be delayed until these shoots have attained any considerable height they will be cut off by the mower to the injury of the succeeding crop. In case, however, dry weather retards the development of the basal shoots until after the plants commence blooming, the crop should be cut at once so as to get the best quality of hay.

Methods of Harvesting.

The methods of harvesting alfalfa hay vary considerably in the different sections of the country. The ideal everywhere, however, is

to enable the hay to reach the feed lot or barn with the least possible amount of handling and exposure to the weather. In the West, where the absence of rainfall during the haying season is the general rule, the conditions for curing the hay are nearly ideal. It is the usual practice to start the mowers in the morning and rake the hay into windrows the following day. (See fig. 8.) The hay is then cocked or is stacked or baled direct from the windrows as soon as the hay is sufficiently cured. This is usually within two days after raking if the hay is to be stacked, or three days if it is to be baled. The raking commences as soon as the leaves are wilted, but when the stems are still green. It is cocked when the stems are " half dry." It may be stacked when moisture can no longer be twisted out of a wisp of the hay. It is not in suitable condition for baling, however, until the stems will break under heavy twisting in the hand.

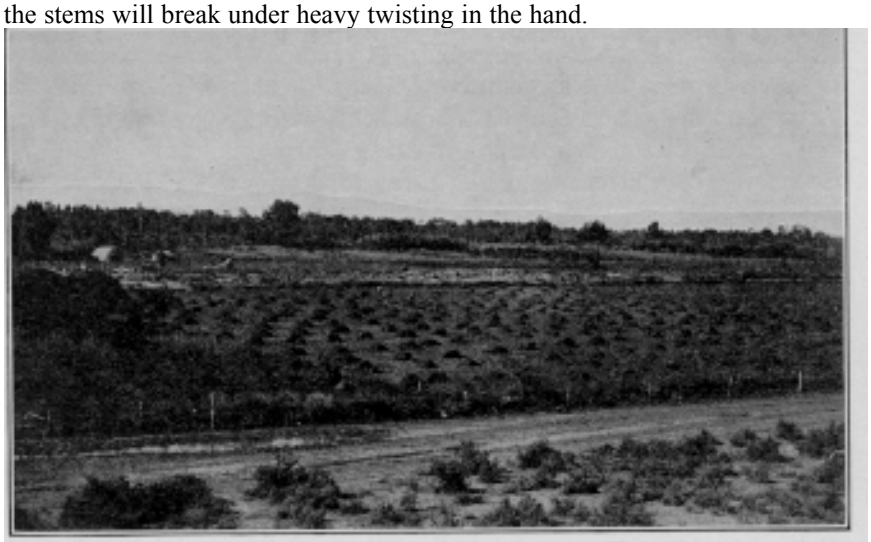


FIG. 8.—An irrigated alfalfa field in the West.

In the humid sections of the country the process of curing the hay is much more difficult, and the cuttings must frequently be delayed for several days on account of bad weather. The operations in this connection are, however, practically the same as in the dry sections, except that more time is required. Stack covers may in some cases prove necessary. A European device which has been locally adopted in this country consists of a three-legged stool upon which the cock is built, thus permitting rapid drying in the event of rain.

Machinery for Making Hay.

In the East it is the practice to use the ordinary haying machinery in the making of alfalfa hay. In the West, however, special ma-

chinery which results in decreasing hand labor to a great extent is used. Mowing machines cutting a swath six or eight feet in width are sometimes used on the large alfalfa fields. The rakes are the ordinary dump rakes or, maybe, side-delivery rakes which leave the hay in a continuous windrow parallel with the swath. This is then in proper shape for loading on to the hayrack with a hay loader or for handling with sweep rakes, buck rakes, or " go-devils." At the barn or stack, hay forks or stackers do away with the necessity of hand pitching. With them it is possible to lift from 100 to 500 pounds of hay from the load and place it at any desired place on the stack or in the MOW.

Importance of the Leaves for Hay.

One of the dangers to be guarded against in alfalfa hay making is the shattering of the leaves. Only two-fifths of the total weight of the alfalfa plant is in the leaves, yet three-fifths of all the protein is contained in them. In other words, 44 pounds of the leaves contain as much protein as 100 pounds of stems. Analyses show that the leaves are somewhat richer than bran for feeding purposes . Much of the loss of leaves ordinarily occurring during harvesting may be saved by proper attention to the curing operations.

. **Injury to Hay by Exposure to Rains.**

Experiments at the Colorado Agricultural Experiment Station have shown that a considerable proportion of the crude protein in hay is soluble and that as much as 40 per cent may be lost by two weeks' exposure to rains aggregating a total of about one and three-quarters inches. In this particular experiment the protein content of the hay was reduced from 18.71 per cent to 11.01 per cent. This indicates clearly one of the handicaps to the successful production of alfalfa hay in sections of heavy rainfall during the haying season. Even a slight rain destroys the green color of the hay which is so characteristic of the western-grown hay cured without having been wet.

Stacking Hay.

The use of hay forks and stackers throughout the alfalfa districts makes it possible to build very large stacks. (Fig. 9.) The large size of the stacks is a decided advantage, as a smaller percentage of the bay is exposed to the elements. Alfalfa hay does not shed water readily, and if barn protection or a shed roof is not provided it is commonly the practice to cover the stacks with canvas or with grass hay or millet to shed the water. A load of green alfalfa placed upon the top of the stack will on drying form a good protection to the stack.

Baling Hay.

If alfalfa hay is to be transported any considerable distance, it is usually baled. (See fig.10.) Otherwise it is fed from the stack or barn.

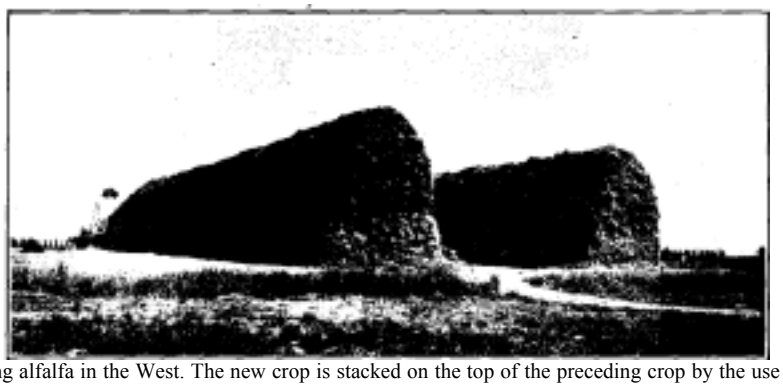


Fig. 9 – stacking alfalfa in the West. The new crop is stacked on the top of the preceding crop by the use of large hay forks.

The baling is done either from the windrow or from the stack. If from the windrow care must be taken to have the hay at the proper

Fig 10. – Baling alfalfa hay. The sweep rake, or "go-devil," is used to bring in the hay from the windrow.

stage of curing so that it will not be so damp as to heat and spoil or so dry as to lose its leaves. The ordinary bale weighs about 90 pounds.

Spontaneous Combustion of Hay.

When alfalfa hay is stacked or put away in the barn too green it is apt to heat and may in extreme cases become so hot as to take fire and burn. In such cases care should be taken to admit no air into the heated mass, which will then be unable to burn for lack of oxygen. If this heating process is not carried too far it results in what is known as brown hay. In this form it is still well relished by stock and apparently loses none of its feeding value.

ALFALFA MEAL.

Within the past few years the manufacture of alfalfa meal from alfalfa hay has assumed considerable importance. The meal is either put on the market just as it is ground or is mixed with other concentrates, such as molasses, bran, and corn chop. The, advantages of alfalfa meal lie in the fact that it is usually fed with less waste than the hay; the hay used for the meal is generally of better quality arid has a higher percentage of protein than the ordinary hay. There is also considerable advantage to be derived from the reduction of freight charges.

A pound of alfalfa hay does not contain any more nutriment when -ground up into meal than it did before, and for feeding in the alfalfa districts it is doubtful if the advantages pay for the greater cost of the meal. It is, however, a verv convenient form for special purposes, such as city trade and where ihe product has to be shipped to a distance. Alfalfa meal is an excellent feed for poultry.

ALFALFA FOR ENSILAGE.

The readiness with which alfalfa hay may usually be cured and utilized renders the making of ensilage from the alfalfa unnecessary except under special conditions. In the humid sections the first crop is sometimes ensilaged when the frequent rains in the late spring prevent its being properly cured as hay. The third cutting is usually ready for cutting about the time corn is ready for the silo and may be mixed with the corn silage.

Pure alfalfa ensilage is apt to be slimy, and considerable losses due to spoiling around the edges of the silo appear to be inevitable. It is necessary to use a deep silo for alfalfa to make possible sufficient pressure to prevent spoiling. The Colorado Agricultural Experiment Station found that ensilage made from the whole alfalfa showed a loss of 10.7 per cent, while (he chopped alfalfa was damaged to the extent of 7.3 per cent.

A form of ensilage is made by putting the green alfalfa in large stacks and preventing the access of air while the heating process is in progress. This method is open to the danger of overheating.

ALFALFA AS A SOILING CROP.

The readiness with which alfalfa renews its growth after each cutting, as well as its value as a feed, makes it an ideal soiling plant

for all classes of stock. There is practically no danger from bloat, as is the case when the alfalfa is pastured. The field from which the daily cuttings of green feed are taken should be large enough to be cut over in four or five weeks, as under such conditions the part of the field first cut will be ready for the second cutting by the time the first crop is entirely utilized.

ALFALFA PASTURE.

Alfalfa should never be pastured during the first or second season of its growth. Even an old field of alfalfa should be grazed rather sparingly if a uniform stand is to be maintained. The last crop of alfalfa is frequently pastured off, as other grazing is often short in the autumn. Care should be taken not to pasture too closely in the late autumn, as the plants should be allowed to go into the winter with some growth upon the crowns. This will enable them to withstand the winter better and also to store up reserve food material for a vigorous early growth the following spring. The evil effects of the trampling of the stock while grazing can be overcome by disking to loosen up the compacted ground.

All kinds of live stock may be pastured upon alfalfa. Horses and sheep are more destructive to the stand of alfalfa than are cattle, as they graze more closely. Hogs are apt to injure the stand by rooting unless their noses are ringed. The utilization of alf- alfa for hog pasture is in the aggregate probably the most extensive, as nearly every farmer throughout the alfalfa regions makes a practice of this chiefly because it proves to be a very profitable method of utilizing the crop. An average field of alfalfa will support continuously during the growing season about ten large hogs to the acre and enable them to make good gains, especially if a small quantity of grain is fed in addition. The usual custom is to allow 1 pound of grain a day for every hundred pounds live weight of the hogs.

The principal drawback to the pasturing of cattle and sheep on alfalfa is their tendency to bloat. This danger can, however, be reduced to a minimum by proper precautions in not allowing the cattle to go on to the pasture with empty stomachs, especially when the, alfalfa is wet.

When the animals become bloated several remedies are usually at hand for the malady. A large bit an inch in diameter may be tied in the mouth, a piece of rubber tubing may be passed through the mouth to the first stomach, or as a last resort the animal may be tapped to allow the escape of the gas. For this purpose a trochar is best, but in the absence of this instrument a small-bladed knife may be used to make the incision about 6 inches in front of and slightly below the left hip bone. A straw or quill may be used to permit the escape of the gas. [a]

a See Special Report of the Bureau of Animal Industry. " Diseases of Cattle."

Alfalfa is one of the most highly nutritious and palatable of feeds for all classes of farm animals either in the form of green alfalfa or as hay. The following tables indicate the results of experiments to determine the relative value of several different kinds of feeds:

Average percentage composition of alfalfa and other forage crops.[a]

Kind of forage	Number of analyses	Water	Ash	Protein	Crude Fibre	Nitrogen free extract	Ether extract (fat)
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Fresh alfalfa	23	71.8	2.7	4.8	7.4	12.3	1.0
Fresh clover	43	70.8	2.1	4.4	8.1	13.5	1.1
Alfalfa hay	21	8.4	7.4	14.3	25.0	42.7	2.2
Clover hay	38	15.3	6.2	12.3	24.8	38.1	3.3
Timothy hay	68	13.2	4.4	5.9	29.0	45.0	2.5
Cowpea hay	8	10.7	7.5	16.6	20.1	42.2	2.2

[a] In part from Henry's "Feeds and Feeding." Appendix

Average percentage digestibility of alfalfa and other forage crops.

Kind of forage	Number of experiments	Protein	Crude Fibre	Nitrogen free extract	Ether extract (fat)
		Per cent	Per cent	Per cent	Per cent
Fresh alfalfa	2	81	45	76	52
Fresh clover	2	67	53	78	65
Alfalfa hay	28	73	43	66	54
Clover hay	46	55	49	69	53
Timothy hay	26	48	52	63	57
Cowpea hay	2	65	43	71	50

Digestible nutrients in alfalfa and other forage crops.

Kind of forage	Digestible nutrients in 100 pounds			
	Dry matter in 100 pounds	Protein	Carbohydrates	Ether extract
	Pounds	Pounds	Pounds	Pounds
Fresh alfalfa	28.2	3.9	12.7	0.5
Fresh clover	29.2	2.9	14.8	0.7
Alfalfa hay	91.6	11.0	39.6	1.2
Clover hay	84.7	6.8	35.8	1.7
Timothy hay	86.8	2.8	43.4	1.4
Cowpea hay	89.3	10.8	38.6	1.1
Wheat bran	88.1	12.2	30.2	2.7
Shelled corn	89.1	7.9	66.7	4.3

The following table indicates the actual feeding value of eight different kinds of feed, based on the amount of digestible nutrients contained in them. These values are calculated from the figures given in the table just preceding. The values per pound assigned as the basis of calculation are protein, $0.0674; carbohydrates (starches, etc.), $0.0064; ether extract (fats, $0.0112. These figures are merely relative, as the prices of the food elements vary in the different sections and from year to year. It will be noted that the value of alfalfa hay is slightly more than double that of timothy.

ALFALFA FOR DAIRY COWS.

Dairy cows require high protein feeds in order to produce profitable flows of milk. These can be supplied by feeding nonleguminous roughage and such concentrates as bran and corn meal. Such concentrates are expensive, however, and can be replaced by a feed like alfalfa. Experiments made by the Tennessee Agricultural Experiment Station in regard to the replacing of grain with alfalfa in rations for dairy cows indicated that 1-1/2 pounds of alfalfa will replace I pound of wheat bran. The tests showed that with alfalfa hay at $10 a ton and wheat bran at $20 the saving effected by substituting alfalfa for wheat bran is $2.80 for every 100 pounds of butter and nearly 20 cents for every 100 pounds of milk.

ALFALFA FOR BEEF CATTLE.

Alfalfa forms probably the best roughage for fattening cattle, as its lack of bulkiness enables the animals to consume sufficient quantities for rapid gains. It is also very valuable for young growing stock before the fattening period commences.

The Utah Agricultural Experiment Station conducted an experiment, extending over a period of five years to determine the quantity of beef produced to the acre from alfalfa hay cut in the different stages of maturity. It was found that hay cut when in full bloom produced 562 pounds of beef annually to the acre, while that cut in early bloom produced 706 pounds. The hay that was not cut until half the blooms had fallen produced only 490 pounds of beef to the acre. At the Nebraska Agricultural Experiment Station 2.41 pounds of beef were produced daily on a full ration of corn and alfalfa, while only 1.48 pounds were produced by a ration of corn and prairie hay.

ALFALFA FOR SHEEP.

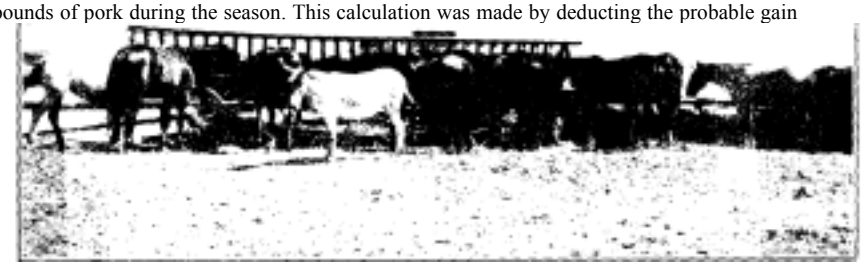
Alfalfa is an ideal hay for sheep, but is apt to cause bloat if used as pasturage. It is the custom throughout the mountainous regions of the West to pasture the sheep on the wild grasses in the mountains during the summer and then-drive them to the valleys during the winter to be fed on alfalfa hay. As an instance of its value for sheep in the East, the experience of the Wing Brothers, in Ohio, may be cited. Spring lambs cost them $6 per hundred pounds when alfalfa was not used in the ration, as compared with $2.50 per hun-

dred when alfalfa formed the principal part of their feed. It is the practice in the West to cut alfalfa hay for sheep just as it commences to bloom instead of when one-tenth in bloom, as is customary for dairy cattle., or when one-half to two-thirds in bloom if for horses.

ALFALFA FOR HOGS.

Alfalfa is fed to hogs for the most part in the green state, either as a soiling crop or as pasture. The bay, however, constitutes a maintenance ration for hogs during the winter, and when fed on it sows enter the spring farrowing season in excellent condition. Wherever possible brood sows should secure alfalfa at least during the hatter portion of the period of gestation.

At the Kansas Agricultural Experiment Station it has been shown that an acre of alfalfa produced 776 pounds of pork during the season. This calculation was made by deducting the probable gain



due to the small ration of grain fed in connection with the pasturage. In another experiment it was shown that for every bushel of Kafir corn meal and 7.83 pounds of alfalfa hay the hogs made a gain of 10.88 pounds. When the alfalfa was withheld from the ration the gain was only 7.48 pounds for each bushel of grain fed

ALFALFA FOR HORSES.

Alfalfa may be fed to horses both in the green state and as hay. (Fig.11.) Instances are on record where horses have performed heavy work during the summer season on nothing but green alfalfa. There is a prejudice on the part of liverymen against alfalfa and in favor of grass hay, owing to the laxative effect of the alfalfa. Many persons hold that the kidneys are unduly stimulated by alfalfa, but this does not appear to be well substantiated by experimental data. On the contrary, there are numerous instances on record where alfalfa hay and green alfalfa have formed a major portion of the ration for the work

ing animals of the farm for years without injurious effect. Alfalfa is a most excellent feed for young growing stock, especially horses, but care must be taken to avoid feeding too much hay to colts, as coarseness is apt to be developed.

ALFALFA FOR POULTRY.

Alfalfa makes an excellent feed for all kinds of poultry. They can be allowed the range of an alfalfa field during the summer or it can be cut green and fed to them. In the winter alfalfa meal fed in a mash may be used as a part of the ration with good effect in maintaining the egg production. It is quite as valuable for this purpose as red clover.

ALFALFA FOR BEES.

The development of the honey-producing industry in the 'West has been practically coincident, with the extension of alfalfa culture. Statistics indicate that the heaviest yields of honey per stand of bees are secured in the sections showing the greatest acreage of alfalfa. That the honey is of a good quality is evidenced by its standing in exhibitions of this class of products. The number of times that the alfalfa fields come into blossom during the season makes possible the gathering of successive crops of honey.

ALFALFA IN MIXTURES FOR PASTURE.

Although alfalfa is generally grown alone, there are exceptions to the general practice which indicate that its use in inix0res might profitably be extended in many sections. Alfalfa alone is apt to be a richer feed than is necessary for a steady diet and may well be used in connection with some of the tame grasses.

The tendency of a pure stand of alfalfa to produce bloat appears to be overcome if the stock be allowed access to the ordinary tame grasses. An adjoining field of a tame grass answers the purpose, but it is usually best to seed the alfalfa in a mixture with one or more of the staple tame grasses which succeed in the locality in question. A half of a full seeding of alfalfa is recommended.

In the East orchard grass and meadow fescue are recommended, as these do not spread by underground rootstocks and endanger the stand of alfalfa. Kentucky bluegrass is apt to run out the alfalfa if this grass is used in the mixture in the bluegrass sections. In the Great Plains region west of Missouri and Iowa smooth brome-grass gives good results when used in a mixture with alfalfa, although this grass spreads by underground rootstocks and has a tendency to crowd out the alfalfa, especially when pastured without being cut for hay.

WINTER GRAIN IN ALFALFA FIELDS.

In the Southwest the mild winters and the occurrence of much of the rainfall during the colder months make it possible to seed wheat or barley in -a stand of alfalfa after the last cutting and harvest it 339

at the proper stage for hay the next spring with the first cutting of alfalfa. The presence of a crop of small grain during the winter. months prevents the growth of troublesome weeds, which sometimes almost ruin the first cutting of alfalfa. This practice has the further advantage of giving a mixed crop of alfalfa and grain hay, which is regarded as superior to pure alfalfa, owing to the scarcity in that section of feeds rich in carbohydrates or starchy matter. This method is also commendable when for any reason the stand has become thin, as through the action of field mice. The amount of grain to be seeded and disked in depends on the thickness of the stand of alfalfa. This practice has been followed for many years in certain parts of the Southwest, although its value does not appear to be recognized to the extent that it apparently deserves.

EFFECT OF ALFALFA ON THE LAND.

Alfalfa acts in a manner similar to red clover and other leguminous crops in increasing the yields of the succeeding crops. The roots add nitrogen directly to the soil and are efficient by reason of their deep-feeding habit, bringing up other mineral constituents from the lower layers of the soil and thus rendering them accessible to the shallow-feeding crops.

Results at the Wyoming Agricultural Experiment Station show that on irrigated land the effect of alfalfa was to increase the value per acre of subsequent crops as follows: Potatoes, $16; oats, $16; wheat, $8 to $12. These increased gains were made without cost in fertilizing the land, as the alfalfa had been regularly cut for hay for five years. In Colorado and Nebraska the yields of grain are sometimes nearly doubled when immediately preceded by alfalfa.

As an instance of the effect of alfalfa on soils in the South, it may be mentioned that on the plantation of Mr. Ben De Gray, near Shreveport, La., 23 bales of cotton, weighing 575 pounds each, were produced on 18 acres the season after an 11-year-old field of alfalfa had been plowed up. This soil had been in cotton for several years previous to the seeding of the alfalfa and had not given more than onehalf bale of cotton to the acre in any one season.

ADAPTABILITY OF ALFALFA TO ROTATIONS.

The value of a successful alfalfa field is so great that there is always the temptation to let it stand as long as it will produce paying crops. The difficulty of getting rid of a stand of alfalfa as well as the uncertainty of establishing the new stand and the high price of the seed all work against the utilization of alfalfa in the ordinary rotations of the farm. There are many fields in the West more than 25 years old which are still giving satisfactory crops of hay. With the gradual exhaustion of soil fertility, alfalfa is securing a place in the farm rotations in spite of the drawbacks to its use in this manner.

ALFALFA IN LONG ROTATIONS.

In the West an alfalfa field does not usually reach full maturity until the third year, and except in special regions it is seldom customary to plow down the alfalfa until it has been in at least five years. In the humid sections the rotation period is shorter, owing to the tendency of the alfalfa to run out in from three to five years.

Mr. Joseph E. Wing, of Mechanicsburg, Ohio, recommends the following rotation as being adapted to that section: Alfalfa, 4 years; corn, 1 year; beardless barley sown with alfalfa, 1 year. The cultivated corn crop affords opportunity to destroy any weeds which may have obtained a foothold in the alfalfa field.

ALFALFA IN SHORT ROTATIONS.

The expense incident to the establishment of an alfalfa field makes it usually of doubtful economy to turn under the alfalfa at the end of the first or second year, unless with the object of increasing the fertility of the land for some more profitable crop. In eastern Colorado the soils are lacking in the nitrates and phosphates, and it is now impracticable to -row more than two successive crops of sugar beets, cantaloupes, or potatoes. At the end of the second year the land is put into wheat to be followed by oats and alfalfa. The alfalfa makes a moderate growth the first season and at the end of the second season is turned under in preparation for another series of truck crops. The alfalfa is sometimes allowed to stand for more than two seasons.

In the Eastern States it is not usual for the alfalfa to stand more than a few years before it is overcome by weeds. The expense incident to establishing alfalfa is the principal drawback to its utilization in a short rotation such as is customary with red clover. Where the initial cost of establishing the alfalfa is not too great, the returns the first summer after early autumn seeding may be sufficient to justify turning the alfalfa under after securing the three cuttings which are possible during the first full growing season. The following tabulation indicates the approximate cost and returns per acre under this system:

Plowing	$ 2.00
Harrowing	1.00
Fertilizers	10.00
Lime	5.00
Rent	3.50
Seed, 25 pounds, @ $0.18	4.50
Seeding	.50
Harvesting, 3 tons, @ $2	6.00
Plowing under alfalfa	3.00
Total cost	35.50
Three tons of alfalfa @ $15	45.00
Cost, to be deducted	35.50
Profit	9.50

SHORT ROTATIONS ON SANDY SOILS OF THE NORFOLK SERIES.

The soils of the Norfolk series are especially adapted to truck crops. The residual effect of the fertilizers necessary for the truck crops, such as potatoes, can be utilized for the alfalfa. . In this connection, Dr. B. T. Galloway, Chief of the Bureau of Plant Industry, writes as follows:

The following statements regarding the methods to be adopted in order to secure satisfactory crops of alfalfa are applicable to a type of soil common along the Atlantic coast from New England to South Carolina and known as Norfolk sand. The suggestions are particularly adapted to conditions in Maryland and Delaware, where this type of soil exists. The Norfolk sand type of soil is thin and light, lacking in organic matter, but capable under proper management of producing good crops of several kinds.

Alfalfa on such soil is in its prime the first year after sowing and the second year usually begins to fall. Notwithstanding this fact we believe that it is a profitable crop to grow and one worth going to considerable trouble to secure. Our preference is to keep the crop on the land only one year, or at most two crop years, and to this end we find that the most satisfactory method is to run a rotation planned for either three or four years, the number of years depending upon the vigor of the alfalfa the second season. The rotation we follow, with certain minor modifications, is given below:

First year: Early potatoes, alfalfa sown after potatoes are dug-August 15 to 20.

Second year: Alfalfa.

Third year: Alfalfa.

Fourth year: Corn, crimson clover in corn at last cultivation, crimson clover turned down early the next spring and land brought back to potatoes again.

For the potatoes we use a fertilizer containing approximately from I to 112 per cent of nitrogen, 8 to 10 per cent of phosphoric acid, and from 10 to 12 per cent of potash. This is applied at the rate of from 1,200 to 1,500 pounds per acre, half broadcast and half in the drills at the time of planting. We usually also put on about ten loads of well-rotted stable manure prior to plowing. No additional fertilizer Is used for the alfalfa.

As soon as the potatoes are dug the ground is thoroughly put in order and ground quicklime is drilled in at the rate of 1,000 pounds per acre. We endeavor to get the lime in about ten days or two weeks before the time for planting the alfalfa. When all is ready for planting we apply from 250 to 300 pounds of soil per acre from a good alfalfa field. We then inoculate the seed and sow same broadcast at the rate of 25 pounds per acre. After sowing the seed the same is harrowed in with a spike-tooth harrow. We cut from 3 to 31 tons of alfalfa the following year. In the fall top-dress this with stable manure, eight to ten loads to the acre, or about 500 pounds of complete fertilizer with the constituents mentioned above. This fertilizer costs about $25 per ton. The second year's crop should yield about 121 tons if conditions are favorable. In about one-third of the cases, however, sorrel and other weeds will take the second season's crop. Coarse manure Is spread on the alfalfa field in the fall and winter and the next spring the ground is prepared and put in corn, crimson clover being sown at the last cultivation and then turned down the following spring and the land brought back to potatoes again.

The rotation may be carried out by keeping, the land in alfalfa only one year, and this is our preference. Following this practice we introduce wheat, the rotation running:

First year: Potatoes, alfalfa sown after potatoes.

Second year: Alfalfa.

Third year: Corn, wheat sown after corn. 339

Fourth year: Wheat, followed by crimson clover or cowpeas, the same being turned down for potatoes.

Our experience indicates that it does not pay to attempt to put down a permanent alfalfa field on this soil; hence, some short system of crop rotation must be adopted. The rotations, of course, will have to be planned to fit the needs of the individual in so far as labor, markets, and other things are concerned. We are running a number of other rotations, but the two foregoing will suffice as examples of standards which we believe are probably the most profitable, all things considered.

GETTING RID OF A STAND OF ALFALFA.

The methods adopted in eastern Colorado, where alfalfa is used to a great extent in short rotations, is to plow shallow in the fall and then plow deep the following spring. The plows are sometimes provided with a knife attachment to the land side to cut the roots near the outer edge of the next furrow. (See fig. 12.) A riding plow is preferable owing to its rigidity. The fall plowing exposes the crowns and a small portion of the root to the weather. The deep plowing the following spring so effectually buries the crowns that the limited amount of reserve food present in the severed portions does not enable them to reach the surface. The deep plowing also prevents the cultivator teeth from catching on the alfalfa roots when cultivating the succeeding' crop. In some irrigated sections it is the practice to

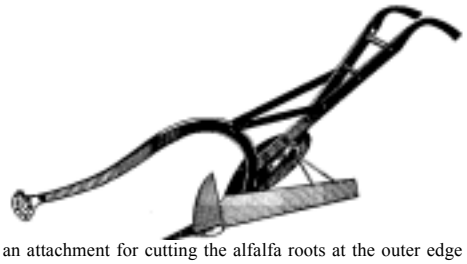


Fig 12. Plow with an attachment for cutting the alfalfa roots at the outer edge of the succeeding furrow.

flood the field to kill the plants before plowing. In still other sections the stand is very heavily pastured, preferably with hogs. This so reduces the vitality of the plants that it is comparatively easy to get rid of them.

SEED -PRODUCTION OF ALFALFA.

The alfalfa seed producing sections of the United States are much more limited in extent than are the sections where the hay can be successfully raised. Alfalfa sets seed in paying quantities only when there is a comparative shortage in the moisture supply. In the irrigated sections it is the practice to withhold one irrigation when seed is desired. In the sections where alfalfa is raised without irrigation, a seed crop is usually secured in the dry years only.

Alfalfa requires a dry, hot season for the best development of the seed crop, and for this reason it is customary to save that crop for seed which will mature during the hottest and driest part of the summer. This is ordinarily the second crop, but south of central Kansas it may be the third crop, and in the northern sections may

have to be the first crop, owing to the short growing season. In sections where the second crop would come only a little too late for the heat of midsummer, it is the practice to clip back the first crop when half grown. The alfalfa then comes on more evenly than had it not been cut back, and in addition blooms considerably earlier than had the full first crop been matured.

When allowed to make seed the alfalfa should be cut when from two-thirds to three-fourths of the pods have turned brown, as this will insure the greatest quantity of good seed. The methods of harvesting the seed vary widely in the different sections. A self-rake reaper, a mower with a dropping or bunching attachment, or a selfbinder with the tying attachment removed is sometimes used. These leave the alfalfa in convenient forkfuls which reduce the amount of shattering in handling.

Alfalfa is thrashed from the field if possible, but it is often necessary to stack the crop before thrashing. An alfalfa huller built along the lines of a clover huller is usually most satisfactory, but few sections produce enough alfalfa seed to justify the use of these special hullers. Very satisfactory results can be secured with the ordinary grain thrasher by screwing down the concaves and providing a set of alfalfa sieves.

A thin stand of alfalfa is best for seed-producing purposes. The yields usually run from 2 to 5 bushels to the acre, but occasionally much higher yields are secured. Most of the alfalfa seed is produced in Utah, Idaho, Colorado, California, Arizona, Montana, Kansas,-and Nebraska. The supply of seed raised in this country is far short of the demand, as is evidenced by the fact that over 6,000,000 pounds were imported during 1906.

ALFALFA IN CULTIVATED ROWS FOR SEED IN THE SEMIARID REGION.

Preliminary experiments indicate that the growing of alfalfa in cultivated rows for seed offers considerable promise of success in regions where the rainfall is sufficient for only one or two cuttings of alfalfa hay. Probably the most extensive area to which this method promises ~o be adapted is the Great Plains area immediately west of the one-hundredth meridian in Texas, Oklahoma, Kansas, Colorado, Nebraska, and South Dakota. This section is characterized each season by periods of relative drought, which are in accordance with the needs of alfalfa for seed production.

It has also been found that to give the best results the plants should be thin on the ground. Individual plants have been known to yield over an ounce of seed. The most promising method is to seed the alfalfa thinly in rows from 30 to 40 inches apart and cultivate the same as corn. It will usually be necessary to thin out the plants as they grow larger, since each plant requires isolation for the best results in the production of seed.

ALFALFA VARIETIES.

Under most conditions, especially in the alfalfa districts, ordinary alfalfa, whether from American or European grown seed, gives quite as satisfactory results as any of the special varieties. In certain sections of the country, however, special varieties of alfalfa have been found to be more valuable than the ordinary forms. Of these the Turkestan, Arabian, and Peruvian varieties have been introduced through the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture.

TURKESTAN ALFALFA.

Turkestan alfalfa was introduced into the United States in 1898, and has since been tried in all parts of the country. It has been found to be superior to the ordinary alfalfa in only limited sections. It is decidedly inferior in the humid sections east of the Mississippi River, but has given somewhat, better results than the ordinary alfalfa in the semiarid portions of the Great Plains and in the 6olunibia Basin. In addition to its drought resistance, it is also hardier than many of the commercial strains.

HARDY ALFALFA.

There have appeared during the past years several strains of alfalfa which are characterized by their hardiness and general ability to withstand conditions which are rather too severe for the best production of ordinary alfalfa. There is some variation in the characteristics of these alfalfas, which may be grouped under this general head, but they agree in showing a considerable diversity in the color of the flowers, which varies from yellow to blue, green, and various shades of violet and purple. These colors are often clouded with a smoky line. The predominating color is the violet of the ordinary alfalfa. The most conspicuous examples of hardy alfalfa are the commercial sand lucern and the Grimm alfalfa of Minnesota.

The sand lucern has been grown for a number of years in this country. It has recently been found to be adapted to the colder and drier sections of the country, where it is proving the equal of any of the alfalfas under test. It seems particularly adapted to withstand the cold winters of the Northern States, where ordinary alfalfa is very likely to winterkill. It is not always the heaviest yielder in sections where ordinary alfalfa succeeds, but its yields are always satisfactory, and it is especially recommended for conditions where ordinary alfalfa does not succeed by reason of high altitudes, light rainfall, or severe winters. Its chief drawback is its tendency to lodge.

The Grimm alfalfa, which has been grown for many years in Minnesota with excellent success, was brought from Wertheim, Province of Baden, Germany, in 1857, by a German farmer named Grimm. 331)

It is claimed by some that this variety has attained increased hardiness since its introduction into Minnesota.

DRY-LAND ALFALFA.

Dry-land alfalfa is the name usually given to ordinary alfalfa seed produced for one or more generations in the semiarid sections without irrigation. It is proving somewhat superior to ordinary alfalfa under semiarid conditions, and as a drought-resistant alfalfa is about equal to Turkestan alfalfa and sand lucern.

ARABIAN ALFALFA.

Arabian alfalfa is proving of special value in the southwestern portion of the United States, where the winters are very mild. It is characterized by its large leaflets and the hairiness of the steins and leaves, quick recovery after cutting and very rapid growth during the growing season, and also by its ability to grow at cooler temperatures than ordinary alfalfa. 6n the other hand, it is extremely tender to actually freezing temperatures and generally winterkills in all except the Southern and Southwestern States. Its quick recovery after cutting and its longer growing season enable several more cuttings per season to be obtained than are possible for the ordinary alfalfa. Unfortunately seed of this variety is not yet on the market.

PERUVIAN ALFALFA.

Peruvian alfalfa is similar to Arabian alfalfa, and is likewise characterized by its long growing season and lack of hardiness. It grows taller than Arabian alfalfa, but the stems are more woody. The seed is not yet on the market in this country, as it is not grown in Peru or elsewhere in large commercial quantities.

ENEMIES OF ALFALFA.

WEEDS.

Over a considerable portion of the country weeds constitute the worst enemy of alfalfa. This is especially true in the humid sections and in those parts of the West and Southwest where the bulk of the rainfall comes during the comparatively mild winters. Witchgrass or couch-grass in New York and the New England States, crabgrass in the Eastern States south of New York, bluegrass in the bluegrass sections, and the " foxtail " or wild millets *(Chaetochloa spp.)* and crab-grass in the Central States are the worst enemies in the respective Sections from the standpoint of the alfalfa plant.

In the irrigated sections of the West, especially in those sections characterized by rainfall during the comparatively mild winters, the growth of the wild barleys *(Hordeum spp.) is* a decided drawback to the successful production of alfalfa. They mature shortly before the first cutting of alfalfa, and the beards of the grass heads frequently

ruin the first crop of hay, which is sometimes burned to destroy the grass seed. These wild barleys are also known as foxtail grass, squirrel-tail grass, and wall barley.

Since alfalfa is not usually a clean-cultivated crop the problem **of** weed destruction is a serious one. Disking is usually the most effective remedy for weeds, as the alfalfa is generally benefited by the operation, while the weeds are greatly injured, owing to their different root systems. In sections where the wild barleys are troublesome it is sometimes thought necessary to burn the first crop of hay. Another method is to cut the first crop while the wild barley is still immature and feed the mixture of alfalfa and grass hay. The objection to this method is that it necessitates the cutting of the alfalfa when too young. A heavy growth of crabgrass is sometimes burned in the early spring.

Dodder is one of the worst weeds so far as alfalfa is concerned. The accompanying illustration (fig. 13) indicates the general appearance of the mature plant. The dodder seeds germinate in the ground and the young plants soon attach themselves to *the alfalfa seedlings. As soon as the threadlike stem is firmly attached to the alfalfa plant the stem connecting it with the ground withers away. Thenceforth the dodder lives entirely on the alfalfa (fig. 14). It is very difficult to eradicate when once established, and for this reason great care should be taken to avoid introducing it with the alfalfa seed at seeding time. [a] Grazing close with sheep has been recommended as being effective in holding dodder in check. If dodder appears in isolated spots through the field, it is advisable to cut the affected alfalfa plants very low and remove them. Destroying the

Fig. 13-Mature dodder plant on an alfalfa stem.

a See Farmers' Bulletin 306, entitled " Dodder in Relation to Farm Seeds."

dodder by burning with different inflammable materials has occasionally proved successful, but it is apt to be more expensive than the removal of the affected portions of the plants. If the stand of alfalfa is badly affected with dodder, the alfalfa should be plowed up before the dodder goes to seed and the land kept in cultivated crops for two or more years. The seed of dodder is illustrated in figure 4.

Fig. 14-Young alfalfa plants attacked by dodder. As soon as the. dodder thread fastens itself to the alfalfa the stalk attaching it to the ground withers and dies.

RODENTS.

The worst animal pests are gophers [a] ground squirrels, prairie dogs, and mice. These are especially troublesome in the western half of the country, where they injure the alfalfa by eating the roots as well as the foliage. The mounds of gophers are very annoying, as they interfere with mowing. These pests are less troublesome where irrigating water is available with which to drown them out. The burrows, however, cause the waste of much water when irrigating. Poisoning and destruction by traps and cats are the best means of holding the pests in check.

INSECTS.

Grasshoppers are at present the worst insect enemies with which alfalfa must contend. ' These are most troublesome in the arid sections of the West, where the alfalfa fields may be the only succulent growth for miles, and the grasshoppers from large areas congregate upon the relatively small fields of alfalfa. They are also especially destructive to the alfalfa in the semiarid sections where alfalfa must be produced without irrigation. A flock, of turkeys is often efficient

Fig. 14. Young alfalfa plants attacked by dodder. As soon as the dodder thread fastens itself to the alfalfa the stalk attaching it to the ground withers and dies.

[a] See Biological Survey Circular No. 52, entitled “Directions for Destroying Pocket Gophers”: also Biological Survey Circular No. 32, “Directions for the Destruction of Prairie Dogs.

in holding grasshoppers in check, as is also a sheet-iron device known as a "hopperdozer," which is run over a field and catches the grasshoppers in an open oil-filled pan[a]

Another very effective means of destroying grasshoppers is to disk the fields in late winter. This exposes the half -developed young to the early spring freezes and to the attacks of birds. This operation is also to some extent effective against the alfalfa webworm (Loxo*stege commixtalis)*.

Blister beetles also prove troublesome at times when they appear in considerable numbers. The general practice is to cut the alfalfa on the appearance of any such pests, when they will be forced to starve or migrate. The alfalfa and clover chalcis fly *(Brucophagus funebris),* found also in Europe and Siberia, is proving destructive to the alfalfa seed crop wherever it is grown.'

PLANT DISEASES.

There are two general classes of diseases which affect the alfalfa plant, namely, those which affect the roots and those which attack the stems and leaves. Of the former, root-rot (Ozonium *omnivorum)* is the most important. This disease is practically identical with cotton root-rot and prevents the successful production of alfalfa in considerable portions of eastern and southern Texas. It spreads in widening circles throughout the field, causing an almost complete destruction of the stand as the disease progresses. There is no practical remedy, and land so affected must be kept out of alfalfa or cotton for several years. Another disease which attacks the alfalfa roots is the " sclerotium " disease, which appears as black excrescences about the size of wheat grains. There is no practical remedy for this disease other than to throw the land out of alfalfa for a number of years.

Of the diseases which attack the leaves and stems, the leaf-spot disease *(Pseudopezia Medicaginis) is* the most common. This appears as minute black spots on the mature leaves. Leaf-rust *(Uromyces trifolii)* produces small reddish spots on the leaves. Powdery mildew *(Erysiphe trifolii)* and downy mildew *(Peronospora trifolii)* form whitish patches of considerable size on the leaves. Another form of leaf -spot disease *(Macrosporium sarcinaeforme) is* sometimes destructive. This appears in the form of well-defined circular spots which show numerous small black dots scattered over their surfaces. The most effective remedy is to cut the plants when any of these diseases begins to prove destructive. This process invigorates the plant, and most of the spores by which the disease is spread are destroyed. The

a See Bureau of Entomology Circular No. 84, entitled " The Grasshopper Problem and Alfalfa Culture."

b See Bureau of Entomology Circular No. 69, entitled " Some Insects Affecting the Production of Red Clover Seed."

anthracnose disease *(Colletotrichum trifolii)* attacks the stems and forms purple patches which gradually increase in size. This is destructive locally in the East. No effective remedy has been discovered for this disease.

SPECIAL INSTRUCTIONS FOR GROWING ALFALFA, ARRANGED BY SECTIONS OF THE UNITED STATES.

NEW YORK AND THE NEW ENGLAND STATES.

Alfalfa is grown with some difficulty on the soils in New York and the New England States, with the exception of the limestone areas. Outside of the limestone regions liming is always necessary. Even in the limestone areas it is often advisable to apply lime. At least a ton of lime to an acre is usually required, and more than this may be necessary on the heavier soils. Well-rotted barnyard manure is the most satisfactory fertilizer, but a complete commercial fertilizer may be used in the absence of the manure.

When the alfalfa is once started under favorable soil conditions, weeds, including bluegrass, are likely to prove the most dangerous enemy. For this reason it is best to precede the alfalfa for at least one or two seasons with some clean-culture crop. The best method is to manure heavily in late winter or in early spring; then plow and lime, and at seeding time harrow frequently to prevent weed growth and to produce the necessary fine tilth and firm seed bed.

Inoculation with nitrogen-fixing bacteria is essential unless the soil is known to be naturally supplied with these germs. The seed should be sown alone at the rate of 20 to 30 pounds per acre. It may be drilled or sown broadcast and covered lightly with a smoothing harrow. Sowing with a nurse crop in the early spring is practiced in some sections, but better results are usually obtained by waiting until early summer and seeding the alfalfa alone.

Good results may also be obtained by seeding the latter part of July on land which has been repeatedly harrowed for several weeks. This method is recommended in case weeds are thought to be troublesome. Alfalfa is more likely to winterkill under this last method, but this danger may be less than that of the weeds on a weedy soil if sown in the spring.

A half bushel of oat's to the acre may be seeded with the alfalfa in late summer. These will make considerable growth before being killed by the cold weather. The dead clumps of stems will catch the snow, and thus afford protection to the alfalfa plants.

In most parts of New York and the New England States alfalfa growing is still in the experimental stage. The experiments which may well be performed according to the directions given under the heading " Need of experimenting at first " are (1) application of

lime at different rates; (2) comparison of manure and commercial fertilizers; (3) seeding at different times.

Mr. F. E. Dawley, of Fayetteville, N. Y., in a recent letter gives the following brief suggestions based upon his experience and observations:

Weeds are usually a serious pest, and some previous crop to rid the soil of these in a measure is advisable. Hoed crops, such as corn, potatoes, and cabbage, are very satisfactory. Near canning factories it is often practicable to grow a crop of peas before the alfalfa is seeded. This calls for July seeding of the alfalfa. The ground is simply disked after the vines have been removed. In seeding alfalfa the three most serious difficulties are lack of proper inoculation of the soil, which is largely overcome by the use of soil from successful alfalfa fields; acidity of the soil, which is corrected by the use of lime and wood ashes; and improper drainage. From 25 to 30 pounds of seed to the acre are generally used to insure a full stand. A medium application of complete fertilizer is usually made at seeding time. Most successful alfalfa growers topdress their alfalfa fields about once in three years, spreading from 8 to 15 loads of well-rotted stable manure with a manure spreader.

MIDDLE ATLANTIC AND SOUTHERN STATES.

In the Middle Atlantic and Southern States the limestone soils are best adapted for the production of alfalfa. Even these soils often require liming for the best success. In the nonlimestone regions the soils require heavier liming to overcome the natural acidity of the soil. A deep, fertile, well-drained, well-limed soil is required.

Well-rotted barnyard manure is the most satisfactory fertilizer. Green-manure crops are also efficient in building up the humus content of the soil. If neither of these can be used, commercial fertilizers can be applied. A good formula is muriate of potash, 75 pounds; acid rock, 250 pounds; and nitrate of soda, 50 pounds, to the acre.

Inoculation with nitrogen-fixing bacteria is almost always essential to success. The seed should be sown without a nurse crop, and at the rate of from 20 to 30 pounds to the acre.

Spring seeding is generally unsatisfactory, as the plants are very likely to be choked out by the weeds of midsummer. Late fall seeding is open to the same objection and to the additional drawback of being likely to cause winterkilling. The ideal time of seeding is in the late summer after the greatest danger of weeds is past. Repeated harrowings for six weeks preceding the sowing time will destroy the successive crops of germinating weeds and put the land into an ideal, well-settled, finely pulverized condition for the alfalfa seed.

The date of the seeding will vary as one passes from north to south. In the latitude of Washington, D. C., August 15 is usually best; in North Carolina, September 15 is recommended; and in the extreme South the seeding may be delayed until the middle of October. In the South the danger of fall drought sometimes makes it necessary to postpone the seeding until February.

In most parts of this section alfalfa growing is still in an experimental stage, and it is usually necessary for each farmer to do some preliminary experimenting before seeding a large field. The points which need to be definitely determined in any given section are the best kinds and quantity of fertilizers to use and the amount of lime necessary to bring the soil into proper condition for alfalfa.

The following extracts are taken from a letter written by Mr. B. 11. Strong, of West Point, Miss., indicating his methods of producing alfalfa:

> We get the best results in growing alfalfa where we follow cotton, as the cultivation of cotton leaves the land in perfect condition. In preparing cotton land for alfalfa we simply break out the center of the cotton row, plowing lip the stalks with a " buster " plow, then run a disk harrow across the rows at a right angle, which leaves the land smooth. We then harrow with ail irontooth harrow, sow the seed, and harrow again. I have used from 2212 to 30 pounds of seed per acre, sowed with the wheelbarrow seeder, and tind I get the best results where I use 30 pounds.

OHIO, MICHIGAN, INDIANA, ILLINOIS, IOWA, MISSOURI, EASTERN - KANSAS, AND EASTERN NEBRASKA.

Throughout this section late summer seeding is giving the best results, although spring and fall seeding are usually successful in the western part of this section. Liming and inoculation are advisable, except in Kansas and Nebraska. The -seed should be sown alone at the rate of about 20 pounds per acre. If sown in the spring the soil can not usually be put into proper condition before the middle of May.

If the weeds prove troublesome it may be necessary to harrow the ground repeatedly until midsummer to destroy the successive crops of weeds as they germinate. The alfalfa seed can then be sown and the plants still attain a considerable size before winter. Alfalfa is more likely to winterkill under this last method of seeding, but this danger is usually less than that from the weeds when sown in the spring.

A nurse crop of beardless barley or oats is sometimes successfully used by experienced alfalfa growers, but the practice is not recommended, as it is apt to injure the stand of alfalfa. The plants should be at least 6 inches high if they go into the winter, in order that the snow may be caught for the protection of the plants.

The following extracts are from statements made by Mr. Joselih E. Wing, of Mechanicsburg, Ohio:

> Alfalfa is easily established in this section, provided certain rules and require ments are met. First, one must sow on dry, well-drained ground. The water table should be down at least 30 inches, and it is much better if it can be low- ered 60 inches below the surface. Away from the limestone it is a safe rule to thoroughly lime the land a year before seeding. The safest form of lime is the ground, unburned limestone. This may be applied in any amount up to 5 or 10 tons per acre without injury to the land and with relatively perinatient

effect. The soil itself must be made rich. Stable manure is best; about 300 pounds of 16 per cent acid phosphate to the acre is also very beneficial. Inoculation is often very helpful. Inoculation with soil from a good field of alfalfa .is usually the most practicable method. It is also a good plan to seed a small amount of alfalfa on the prospective alfalfa field the year previous, as this usually insures inoculation. The ground when plowed must be harrowed frequently and given every opportunity to become well settled. If spring sown, a nurse crop may usually be used. This had best be beardless spring barley, although oats may be substituted. About a bushel of either to the acre should be sown. It is generally necessary to cut these early for hay. The alfalfa should not be cut till buds have set on the stems near the base and are starting to make the new growth.

If late seeding is practiced the land should be plowed late in the spring and the weeds kept down by harrowing until seeding time. It is also possible to remove an early maturing crop in early July in time for early August seeding.

NORTH CENTRAL STATES (MbNTANA, NORTH DAKOTA, SOUTH DAKOTA, XINNESOTA, AND WISCONSIN).

In the North Central States it is necessary to seed alfalfa in the spring or early summer, owing to the inability of the fall-seeded plants to make sufficient growth to prevent their being winterkilled. A month or six weeks should usually be allowed for freshly plowed land to settle. If spring seeding is practiced, fall plowing is usually necessary. Corn-stubble land may, however, be disked in the spring and settled firmly enough by two or three harrowings. In the less arid eastern portion of this section early summer seeding often gives the most satisfactory results. In the semiarid portions of this section care must be taken to conserve the soil moisture by proper methods of culture previous to seeding.

Inoculation with nitrogen-fixing bacteria is usually necessary and should be used unless the soil is known to be well supplied with the germs. The seed should be sown at the rate of about 20 pounds to the acre, generally without a nurse crop, although in Wisconsin a nurse crop with spring-seeded alfalfa has frequently been successfully used. In all cases the alfalfa should be allowed to go into the winter with at least a month's growth, as this will hold the snow and tend to proteef the crops from injury during the winter.

IRRIGATED SECTIONS.

Alfalfa is especially adapted to the irrigated sections of the United States, The dry climate is apparently essential to the best growth of the plants and the water supply can usually be controlled so as to be applied when most needed. The seeding usually takes place in the spring, and quite often some small-grain crop is seeded with the alfalfa. The alfalfa is so thoroughly at home that it succeeds in spite of the nurse crop rather than by reason of it.

In the extreme South and Southwest it is often the practice to seed alfalfa in the f all with small grain. In most cases the land receives

a thorough irrigation shortly before seeding. The crust is broken when the seeding takes place and the moisture is usually sufficient to enable the plants to make a satisfactory start. It is sometimes the practice to irrigate the ground immediately after seeding and then irrigate a second time just as the seedlings are trying to break through the crust. The plants are then able to get through the crust before it has a chance to form a second time. This method, however, is not usually to be recommended.

It is generally the best practice to irrigate alfalfa a few days before cutting and then give a second irrigation when the crop is about half grown, which is commonly about fifteen days after cutting. The advantage of irrigating before rather than immediately after cutting, as is often the practice, is that there is not the delay in starting the new growth. This delay may be injurious, as several days are usually required to get the hay off the ground, and in the mean time there is almost no growth on the part of the alfalfa.

Experiments performed by the Utah Agricultural Experiment Station in cooperation with the United States Department of Agriculture indicate that a relatively small amount of water properly applied is sufficient for satisfactory crops of alfalfa. The following table indicates a partial summary of the results:

Inches of water applied	Number of Irrigations	Yield per acre, in tons
17.058	3	3.125
17.33	4	3.468
24.97	4	5.017
25.002	2	1.55
61.465	12	6.243

Methods of Irrigation.

The check system of irrigation as practiced principally in California calls for a heavy initial expense, but when once the squares or contour checks are constructed the irrigations can be made at a minimum of expense for labor and water. The flooding system from ditches is in common use throughout most of the alfalfa sections of the West, and while somewhat wasteful of water it does not demand the heavy initial outlay for careful leveling of the ground, as is the case with the system of checks just mentioned. The furrow system is much less used for alfalfa than the two former methods, but is especially adapted to soils subject to alkalia.

a See Farmers' Bulletins Nos. 158, entitled How to Build Small Irrigation Ditches," and 263, " Practical Information for Beginners in Irrigation;" also Office of Experiment Stations Bulletin No. 145, entitled " Preparing Land for Irrigation and Methods of Applying Water."

SEMIARID REGIONS.

The, principal factor in the successful production of alfalfa in the semiarid sections is the conservation of soil moisture before the alfalfa is seeded. The proper preparation of the ground for planting usually calls for special treatment of the soil for at least a year preceding the time of sowing in order that the rainfall of the entire year may be stored up in the ground and may be available for the young alfalfa plants.

Fall seeding is not usually advisable, owing to the danger of drought and the small growth which the plants are able to make before winter. For this reason spring seeding is usually practiced, even though the danger of weeds in summer is considerable.

The seed should be sown broadcast or drilled in at the rate of 8 to 12 pounds of good seed per acre. A more nearly even stand can be secured by dividing the seed and sowing one-half each way across the field. If sown broadcast, a harrow should be used to cover the seed 11 to 2 inches deep. If the soil is sandy and likely to blow before 2 the plants can make sufficient growth to cover the ground, a half bushel of oats per acre may be seeded with the alfalfa.

Unless weeds prove very troublesome the first clipping should not take place until the plants are well toward full bloom or until the basal shoots are well started for the second crop. Recent experiments show that larger plants are produced when they are left uncut during the first season. If an experimental tract of several plots is established, as suggested under the heading " Need of experimenting at first," the points which need determining are different methods of previous preparation of the ground; time, rate, and manner of seeding; and whether the alfalfa should be clipped the first season.

EASTERN OREGON AND EASTERN WASHINGTON.

Alfalfa is thoroughly established in the irrigated portions of this section and its culture is gradually being extended in the semiarid nonirrigated sections, although much lighter yields are obtained than where the crop is grown under irrigation. In the absence of more drought-resistant plants, however, alfalfa takes front rank as a leguminous forage plant. On dry soils it is slow in becoming established, and not until the third year are the best results to be looked for.

The ground should, if possible, be summer fallowed . the previous season to destroy the weeds and conserve the moisture for the germination of the seed. Intertilled crops, such as corn and potatoes, instead of the summer fallow, may precede alfalfa. Spring seeding is generally practiced, as the f all rains usually come too late to permit f all seeding.

If impossible to precede alfalfa with summer fallow or intertilled crops, a small-grain crop may be used, in which case the stubble should be plowed under as early in the autumn as possible and left unhar-

rowed until early spring, when it should be thoroughly worked and packed before seeding. The seed should be sown broadcast or drilled at the rate of 10 to 12 pounds per acre and covered about 1/2 inches deep. The alfalfa should be clipped high when the basal or crown buds begin to grow into stalks even though the weeds are not troublesome. There is some evidence to show that under very dry conditions the plants should not be clipped the first season.

Under favorable conditions one cutting of hay may sometimes be procured toward the end of the first season. Alfalfa should not, be pastured until the third season, and even then but sparingly if the stand is to be maintained. Disking early the second season is usually advisable to break the crust and stimulate the plants. Alfalfa will stand a great deal of harrowing without injury, and in this way the weeds are held in check and the moisture is conserved. In most of this section the raising of alfalfa without irrigation is still in the experimental stage. The experimental plot described under the heading " Need of experimenting at first " should include variations in the preparation of the soil; time, manner, and rate of seeding, and the treatment of the plants the first, two years.

Mr. Max Hinrichs, of Pullman, AVasli.. an extensive grower of alfalfa without irrigation, writes in part as follows:

As a result of past experience T now seed only on land that has raised a cultivated crop, as corn or potatoes, the previous year. I sow not to exceed 5 pounds of choice seed per acre. I find that it is essential to-have a thin, even stand under the dry-land conditions here. I first disk the land thoroughly in the spring, about the first week in April; drill 35 pounds of oats or barley; then barrow, seed the alfalfa broadcast, and harrow again. I prefer to cut the grain a little green, but usually get a good crop of grain. The next spring I give the alfalfa a good harrowing, or if the land is very hard a light disking is best,
repeat this cultivating every spring, disking deeper each succeeding year.

SOME ALFALFA DON'TS.

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Don't fail to provide for ample inoculation; soil from an old alfalfa field is best.
Don't sow poor or weedy seed.
Don't sow on a weedy soil.
Don't sow on any but a sweet, well-limed soil.
Don't sow on poorly drained soil.
Don't sow on any but a finely prepared, well-settled seed bed.
Don't pasture the first or second year.
Don't lose the leaves; they constitute the best part of the hay.
Don't seed a large acreage to begin with. Experiment on a small area first.
Don't give up. **Many prominent alfalfa growers** finally succeeded only after many failures.