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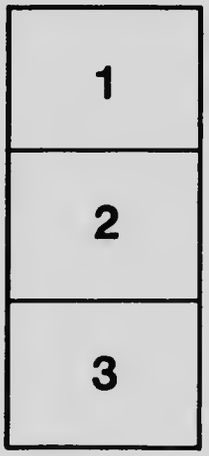

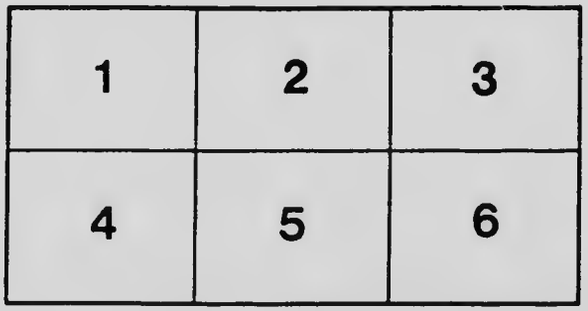

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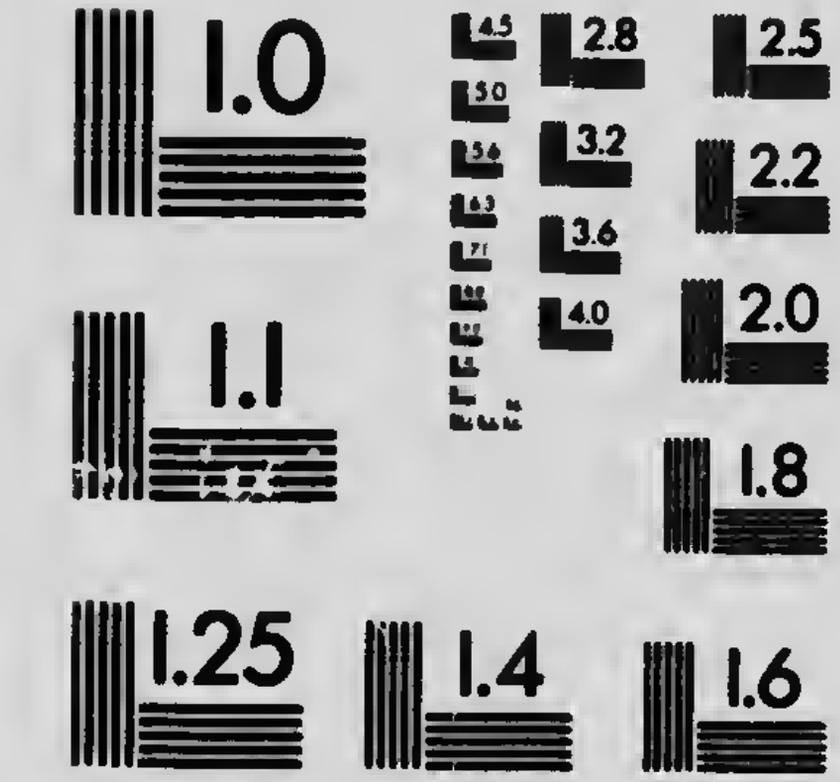

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DEPARTMENT OF AGRICULTURE

CENTRAL EXPERIMENTAL FARM
OTTAWA, CANADA

ALFALFA OR LUCERN

(Medicago sativa, L.)

ITS CULTURE, USE AND VALUE

Part I.—By J. H. GRISDALE, B. Agr.
Agriculturist of the Central Experimental Farm

Part II.—By F. T. SHUTT, M.A.
Chemist, Dominion Experimental Farms

Part III.—By J. FLETCHER, LL.D.
Entomologist and Botanist, Dominion Experimental Farms

BULLETIN No. 46

JUNE, 1904

Published by direction of the Hon. SYDNEY A. FISHER, Minister of Agriculture, Ottawa, Ont.
491—1

To the Honourable
The Minister of Agriculture.

SIR,—I take pleasure in submitting for your approval Bulletin No. 46 of the Experimental Farm series on Alfalfa or Lucern. This bulletin consists of three parts.

Part 1 has been prepared by J. H. Grisdale, Agriculturist of the Central Experimental Farm; part 2 by Frank T. Shutt, Chemist of the Experimental Farms, and part 3 by James Fletcher, Entomologist and Botanist of the Experimental Farms.

The economy of growing alfalfa for the feeding of stock and for ploughing under to enrich the soil has not yet been fully realized by the farmers of Canada. The adaptability of this plant to many of the climatic conditions found in this country, its deep-rooting habit which gives it the power of drawing moisture and plant food from depths not reached by other plants, and the large quantities of palatable and nutritious fodder it produces, all combine to make it a most desirable crop. Further, the ploughing under and decay of the roots, stems, and leaves of this plant adds largely to the available plant food contained in the soil, and thus furnishes nutriment for succeeding crops.

It is hoped that the facts submitted in this bulletin will induce many Canadian farmers to sow some portion of their land with this useful fodder crop, and that thus the benefits arising from its cultivation may become more generally known.

I have the honour to be

Your obedient servant,

WM. SAUNDERS,
Director of Experimental Farms.

Ottawa, June 28, 1904.

PART I.

ALFALFA OR LUCERN: ITS CULTIVATION AND USE.

By

J. H. Grisdale, B. Agr., Agriculturist, Central Experimental Farm.

Alfalfa or Lucern is grown in Canada more or less extensively from the Atlantic to the Pacific ocean. It is the staple forage plant for winter feeding in the drier parts of British Columbia, and it has been grown in Southern Alberta for many years. It is not much known in Manitoba, but is possible of easy propagation in almost all parts of Ontario. It is, and has been grown long and successfully in Quebec, and is not unknown in Nova Scotia and New Brunswick. In Prince Edward Island, whether due to lack of interest or some peculiar climatic or soil condition, it has never, so far as the writer knows, been grown with success.

It has been grown with varying success for many years on the different farms included in the system of Dominion Experimental Farms. The first trials in most cases proved more or less discouraging, but experience gradually acquired rendered later experiments more successful. At Ottawa in recent years a failure with this crop has been practically unknown, and stands eight and nine years old can be shown. At Brandon in Manitoba a plot sown in 1896 has been giving crops varying from 1 ton, 1,500 lbs., to 3 tons, 1,500 lbs., annually ever since. It is therefore apparently quite hardy in that part of the province. It might be stated, however, that 60 lbs. of seed of unknown vitality was sown to the acre in the case mentioned, a larger quantity than we have ever found necessary. In Assiniboia, at Indian Head, Mr. Mackay sowed a plot of Turkestan Alfalfa in 1900 which came through the winter in good shape, but was turned under without any crop being harvested. Common alfalfa seed was sown on a half-acre plot at the rate of about 30 lbs. per acre in 1902. It came safely through the winter of 1902-3 and gave a crop of 1 ton. 1,012 lbs., per acre in the summer of 1903. At latest reports it is still standing and doing well. At Nappan, Mr. Robertson has grown it with rather poor success for three years. At Agassiz conditions do not favour this crop, but as stated elsewhere, it is very extensively grown in some parts of British Columbia, as for instance, in the Kamloops and other of the dry interior districts. The writer has seen it growing at Calgary, Alberta, and has been credibly informed that it has been growing for over twenty years at Maple Creek, Assa.

As stated, it has been grown in almost every province to a greater or less extent. That it has not been grown more largely seems due to two things, first, that very little is known about its good qualities as a forage plant and, second, that very few know the proper methods of cultivation and its peculiar soil and moisture requirements.

Without careful observance of its peculiar requirements success may not be hoped for, but a careful study of, and compliance with these is amply repaid by almost certain success and large returns.

THE PLANT.

Lucern is another name for Alfalfa. It is a leguminous plant just as are peas, beans and clovers. Plants of this family are all rich in protein (see part II).

Alfalfa is a perennial, that is a plant capable of living many years under favourable conditions. It is upright and branching in its habit of growth, the mature plants varying in height from 1 to 3½ feet. Its leaves are three parted, the leaflets being narrowly oblong in outline. Its flowers are purple, and are arranged like those of the vetch rather than as those of the clovers. It sometimes produces seeds in Canada in small quantities.

The stem is rather woody, which characteristic develops very rapidly as maturity approaches. The leaves are attached by slender stems which become very brittle when the somewhat matured plant is dried.

The roots penetrate deeply into the soil. It has a tap root (see illustration page 12) which has been known to go to great depths where the subsoil was permeable.

The rootlets bear nodules which enable it to secure its nitrogen supply from the air. 'The young plant consists of a number of low branches springing from a simple basal stalk at the crown of the root. These branches ascend directly above ground and form a compact tuft. On the old plant, however, certain of the more robust stems elongate underground and become new branch-producing stocks.

In this way the simple stock or rhizome becomes two or many-headed.' (For fuller description of plant and illustration see part III.)

SOILS.

As just stated, alfalfa is a deep-rooted plant, hence in considering soil suitable for this crop the character of the subsoil must always be of primary consideration. Two qualities are absolutely necessary in the subsoil for an alfalfa crop to succeed. It must be well drained to a depth of at least 2 feet, and it must be possible of penetration by the roots of the alfalfa plant to a similar or greater depth.

Any field likely to be under water, or the soil saturated with water at any time, for more than thirty-six hours at a time, is quite unsuitable for alfalfa. Any field with a hard-pan subsoil within two feet of the surface will prove unsatisfactory for alfalfa.

The most suitable soil conditions for securing a good stand of plants and securing good and continuous crops afterwards, are a light sandy loam in good heart over a deep loose alluvial subsoil.

A subsoil rich in plant food is of course very valuable, but, while fertility in the subsoil is important, permeability is still more to be sought after. A sandy subsoil while not in itself so rich in plant food is likely to give much better results than a clayey subsoil under a similar surface soil. Upon the fertility and physical condition of the surface soil more than upon any other factors depends the success of the first year. The success or failure of later years depends in a great measure upon the subsoil.

SOIL PREPARATION.

To insure a good stand three conditions are necessary in the land selected:

1. Freedom from weeds.
2. Excellent physical condition or tilth.
3. Abundance of plant food.

Freedom from weeds may be secured by sowing immediately after a hoed crop as potatoes, corn or roots, or by sowing after a complete or a partial summer fallow. Clover sod, stubble, or even old meadow ploughed shallow in August, rolled and cultivated at frequent intervals during September, and receiving proper treatment in October, may be expected to give good results. In October it should be ploughed again with a subsoiler attached to the plough, or ploughed with two ploughs, one without a mould board following in the track of the other, and stirring the subsoil as much as possible, or cultivated lengthwise, crosswise and angling with a strong stiff-toothed cultivator, to be followed by a double mould board plough, leaving the whole field in ridges about 7 inches high and 22 inches apart.

Such treatment insures a seed bed permeable to early roots, fairly rich in plant food, and in excellent physical condition. The latter condition is insured by the retention of the humus or decayed vegetable matter (roots, fallen leaves, &c., of previous crop) in the surface soil, and by the facilities for drainage afforded by the ridging of the surface soil and consequent exposure of the upper subsoil to the effects of the frost.

In the spring as early as possible the proposed alfalfa field should be prepared for seeding. The preparation should consist of frequent cultivations, harrowings and rollings until the seed bed is perfectly smooth and mellow.

SOWING THE SEED.

Alfalfa may be started successfully with a nurse crop. Where preferred it may be sown alone. In either case, a liberal seeding of good germinable seed is necessary. Before purchase a sample of the seed should be secured and tested for germination. It should show over 90 strong germinable seed to the 100. Such seed should be sown at the rate of 25 lbs. to the acre. Seed showing a less percentage of germination must be sown more thickly.

Particularly strong heavy soil may be expected to give somewhat better results when a nurse crop is used. Oats, wheat or barley may be used for this purpose. It is probably better to sow somewhat less than the regular amount of grain to the acre, of the sort chosen when sowing as a nurse crop. Some growers advise about half a bushel of seed of the nurse crop to the acre no matter what kind is used, but, with climatic conditions such as maintain in Ottawa, it would not be advisable to sow such small quantities. The drier the climate the smaller the amount of seed of the nurse crop it is advisable to sow. It would seem wise to sow the usual amount of seed per acre of the nurse crop selected (oats 2½ bus., wheat 1½ bus., and barley 1¾ bus. per acre) for the Maritime Provinces, Quebec and Eastern Ontario; about half the regular seeding in central and western Ontario; no nurse crop in Manitoba nor in the North-west Territories; and in British Columbia more or less than half a seeding according to the particular district.

With light soils it is usually better to use no nurse crop, but the state of fertility of the particular field should always be considered. A light soil rich in plant food and humus would indicate strongly the use of a nurse crop.

The seed should be sown only after the field is in a state of almost perfect tilth. No cultivation, or at most very little, should be given after the seeding is done. The seed may be sown either broadcast or in drills. Sowing the seed from the grass seed spouts of the average seeder is probably the best method. The spouts should be pointing backwards rather than forward. The ground should be rolled shortly after seeding, and the surface lightly scratched with a brush harrow, a breed weeder or a tilting harrow fairly well tilted back. This latter operation is to prevent evaporation and is necessary only in dry times or in localities having small rainfall.

Any person sufficiently interested to try a small plot should prepare the seed bed thoroughly as indicated above, then sow in rows from 7 to 9 inches or further apart. Another method which we have found very successful is to sow shallow in rows about 15 inches apart and cultivate between the rows. The treatment prescribed for the first season 'without nurse crop' should otherwise be the same as for larger areas.

TREATMENT DURING FIRST SEASON.

The first summer is a critical time in the life of the alfalfa plant.

Without Nurse Crop.—Young alfalfa plants are very tender and must be given no rough treatment before they are well established, but the field must be mown and mown often during the first year to insure success. Blooms should never be allowed to appear. The crop should be cut as often as it reaches 8 to 10 inches in height. Frequent cuttings keep down weeds, aid root development and encourage growth. The clippings should, in almost every case, be left on the field as a mulch. As wide cutting a mower as possible should be used and the sickle bar should be tilted to avoid cutting too close.

With Nurse Crop.—During the growing period of the nurse crop no attention is necessary. As harvest time draws on, however, careful watch must be kept to see that the young alfalfa plants are not being smothered by lodging grain. If success with alfalfa is the chief aim, no crop should be allowed to lie lodged upon it for more than a day or two. When harvesting the nurse crop the binder should be set to cut 5 or 6 inches from the ground. Shocks should not be allowed to stand for more than two days on the same spot, they would smother out the young alfalfa.

It is not advisable to allow live stock of any kind to graze upon an alfalfa field the first season, but it is not advisable to leave a very high growth to be crushed down

by the winter snow. The best plan is to cut at a height of about 5 inches from the ground in September and then leave untouched for the rest of the season.

FEEDING VALUE.

As a feed for stock alfalfa may be used in several ways. For the exact composition and comparative feeding value see Part II.

Pasture.—It is frequently used as pasture and judging by our experiments here has no equal among forage plants for palatability, grazing capacity per acre and food value. All classes of live stock soon learn to like it and thrive upon it. As a pasture for dairy cows it cannot be surpassed. Sheep thrive upon it exceedingly. Swine are very fond of it and do well upon it as a sole feed. Horses eat it with avidity and improve in condition upon such pasture. In a trial here with dairy cows it seemed to be worth much more than any of the grasses or clovers tested at the same time (red clover, alsike clover, timothy, brome grass and orchard grass).

It should not, however, be pastured too closely at any time. Such treatment would be particularly dangerous the second season. Sheep allowed to crop it closely do very great injury. Another disadvantage is that the trampling of the stock hardens the soil and slowly but surely kills out the catch.

Precautions must be taken too, where it is grazed, to prevent injury to the animals grazing. Cattle and sheep sometimes bloat when allowed to eat it wet with rain or dew. Such stock should be turned in only when the alfalfa is dry or when they have just had a feed of some other forage. Bloating occurs very seldom, but it occurs occasionally, and it is well to avoid any possibility of loss in this way. Hogs and horses are not subject to bloat.

As Ensilage.—Mixed with corn or red clover it is exceedingly valuable for making into ensilage. We have never tried it as an ensilage plant by itself. It has been so used, however, elsewhere and has given good results. In districts where wet weather usually prevails in June the conversion of the first cutting into ensilage would be the most practical way of saving the crop in palatable and nutritious form.

As Soiling Crop.—It is as a soiling crop for dairy cattle that alfalfa is particularly valuable. It makes a very rapid early spring growth and is usually ready to cut before any other green feed. It may be cut for this purpose before any blossoms appear, and will thus admit of being cut about four times in the season in this district. No other soiling crop approaches it in value as a feed for milk production.

It may also be used as a soiling crop for pigs. Where so used it may be expected to reduce the cost of producing pork by from 25 to 50 per cent in comparison with pigs fed on grain alone.

To give the best results when used for this purpose it should be cut before any blossoms appear, even earlier than when cut to feed to cows. Feed all the pigs will eat up clean. It should be fed both morning and evening.

To summarize, alfalfa used as a soiling crop may be expected to produce from 15 to 24 tons per acre of the finest kind of green forage, most palatable, very nutritious and suitable for horses cattle, sheep and swine.

As Hay.—It is as a hay crop that alfalfa has won fame and place in British Columbia and the United States, and it is undoubtedly possible of extensive use for that purpose wherever it can be successfully grown in Canada. Under favourable soil and weather conditions it may be expected to produce from five to six tons of hay to the acre per annum.

Alfalfa hay, well made, has no equal as a dry feed for live stock, but no other kind of hay requires as much care, skill and experience or information in the making as does alfalfa.

As the plant begins to blossom its stems begin to turn woody. Plants far advanced in the blossoming stage have very woody stems, easily lose their leaves and then make unpalatable, indigestible and generally inferior hay.

It is evident, therefore, that to secure good results the crop should be cut at an early stage. Experience has shown the beginning of the blossoming stage to be the best time. The very best time is when about 10 per cent of the blossoms are in

bloom. It is then in its best feeding condition and will come along most rapidly for the next cutting. If the cutting be delayed not only will the hay cured be of an inferior quality, but recovery will be slow and incomplete, entailing a smaller total yield for the year than would otherwise have been produced.

THE MAKING OF THE HAY.

No more than can be conveniently handled in one day should be cut at one time. It is best to cut in the morning as soon as free from dew. Leave in the swath, preferably shake up with the tedder at intervals till late afternoon or until the hay is well wilted, but not dry enough to lose its leaves, then rake into windrows. If rain threatens put into cock for the night and open out in the morning to finish curing. It should be cured until it will keep without heating, but not made so dry as to cause the leaves to drop off. In the curing and housing it should be handled as little as possible, as each handling means the loss of a considerable number of leaves, and the leaves are, by very much, the more valuable part of the crop.

Alfalfa hay should, if at all possible, be made without getting wet with rain. After being exposed to rain in the curing it is not worth nearly so much for feed, losing probably half its value. The rain not only causes many more leaves to fall off, but seems to remove much of the palatability, digestibility and food elements of the remaining leaves and stems.

It should be well protected when cured, as it absorbs rather than sheds rain. If stored in stacks, a thatch, a canvas, or a lapping board roof should be put on.

ITS FERTILIZING NEEDS.

Just as when sown to clovers and other legumes, both the physical condition and the average plant food content of a soil are improved and increased rather than injured or depleted by being under alfalfa for a time. Certain amounts of the chief elements of plant food are, however, removed by each crop and the application of farm yard manure in the fall at the rate of say 10 tons per acre every two years will prove profitable. If it is desired to supplement an insufficient supply of barnyard manure, the following dressing of commercial fertilizer per acre will most likely be found valuable: 30 lbs. nitrate of soda, 300 lbs. bone meal, and 80 lbs. muriate of potash.

ITS FERTILIZER VALUE.

It is as a soil renovator or improver that alfalfa growing is frequently advocated. As mentioned above, however, soil in fairly good heart is necessary to get the crop started. But once started there is no doubt that it has great value as a factor in the improvement of the physical condition and in increasing the fertility of the field where grown. For a full discussion of its value in this connection see Part II, but an examination of the cut on page 12 will show the depth of root that the plant throws out. These roots are valuable not only on account of the plant food they supply when decomposing in the soil, but are valuable because they open up the subsoil and render it more permeable to surface water, so improving the soil very materially. Undoubtedly the long roots bring up from depths not reached by the roots of other plants much of the food required by the plant, hence the importance of such roots and the great value to agriculture of the plant that is able to produce them.

SUMMARY.

1. Sow sufficient seed.
2. Sow good seed, that is germinable seed.
3. Sow on well-prepared land in good state of fertility.
4. Sowing without nurse crop overcomes in some measure poverty of soil.
5. Proper preparation of the right kind of seed bed and careful observance of directions for first year treatment are necessary to insure a long series of remunerative crops.
6. Before sowing be sure that a sufficiency of plant food exists in the surface soil to grow a good crop (40 bushels to the acre) of oats.
7. Do not sow on poorly drained land; 'well drained' should mean drained to a depth of at least two feet.

PART II.

ALFALFA: A FODDER AND A FERTILIZER.

ALFALFA AS A FODDER.

BY

FRANK T. SHUTT, M.A., CHEMIST, DOMINION EXPERIMENTAL FARMS.

Alfalfa merits attention, both as a fodder and as a fertilizer. As the former, it furnishes a large amount of forage especially rich in flesh-forming constituents and as the latter it may be employed with advantage to maintain and increase soil fertility by the addition of considerable stores of nitrogen and humus.

Alfalfa is a legume—a class of plants including the clovers, peas, beans, vetches, &c., and characterized by possessing a large proportion of nitrogenous matter (crude protein) in their tissues. The legumes are further remarkable for their peculiar and valuable property of being able to draw upon that inexhaustible store—the air—for the greater part of the nitrogen they possess. It is this latter fact that distinguishes the legumes from all other plants and which has given them the name of 'nitrogen collectors.' All other plants are 'nitrogen consumers': that is, they draw their supply from the soil and consequently by their growth leave the soil poorer in this element. For many centuries it was considered that the growth of legumes enriched rather than impoverished the soil, increasing the yield of subsequent crops of grain, roots, &c., but the definite knowledge of the fact and how it was brought about dates back but a few years and must be regarded as the most important discovery in agricultural science of the nineteenth century.*

Without discussing in any detail the constituents of fodders and their function in the animal economy, it may suffice for present purposes to point out that the value of a forage crop depends chiefly on the amount of 'dry matter' it furnishes and the relative richness of this dry matter in flesh-formers or protein. In the following table the composition of a number of our more common coarse fodders is given, allowing a comparative study to be made of their relative feeding values.

COMPOSITION of Coarse Fodders.

Name.	Water.	Dry Matter.	Crude Protein.	Ether Extract or Fat.	Nitrogen-free Extract or Carbo-hydrates.	Fibre.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Alfalfa, green	71·8	28·2	4·8	1·0	12·3	7·4	2·7
" hay	8·4	91·6	14·3	2·2	42·7	25·0	7·4
Red Clover, green	70·8	29·2	4 4	1·1	13·5	8·1	2·1
" hay	15·3	84·7	12·3	3·3	38·1	24·8	6·2
Timothy, green	71·0	29·0	2·3	0·9	15·4	8·8	1·6
" hay	13·2	86·8	5·9	2·5	45·0	29·0	4·4
June grass, green	73·1	26·9	3·1	1·1	13·4	7·0	2·1
" hay	15·3	84·7	7·4	2·5	42·1	27·2	5·5
Corn forage, green	79·3	20·7	1·8	0·5	12·2	5·0	1·2
" silage	79·1	20·9	1·7	0·8	11·0	6·0	1·4
Mangels	90 9	9·1	1·4	0·2	5·5	0·9	1·1

It is evident from the foregoing that alfalfa, in common with clover and other legumes, furnishes a more nutritious fodder, weight for weight, than the grasses,

* The means by which the legumes are able to appropriate the free nitrogen of the air may be briefly stated as follows: There are certain micro-organisms or bacteria present in the soil which are able, when attached to the roots of the growing legume, to utilize the nitrogen of the air existing between the particles of the soil, and to pass it on in some organized form to their host plant, enriching its tissues of root, stem, and leaves. The attachment and growth of these bacteria cause the formation of nodules or tubercles on the roots of the legume, and these nodules, swarming with their countless inhabitants, are to be found in sizes varying from that of a pin's head to that of a pea or larger, and frequently scattered in large numbers over the roots of the plant.

Indian corn or roots, and it, therefore, only remains to present certain particulars respecting its composition at various stages of growth and to detail the amounts of real cattle food obtained per acre by a greater or less frequency of cutting during the season.

THE YIELD OF ALFALFA FROM TWO AND FOUR CUTTINGS, RESPECTIVELY.

In the irrigated districts of the Western States, alfalfa is the most important and most valuable of all fodder crops, being cut from six to eight times in a season and yielding in all from eight to fourteen tons per acre of fodder of a high protein content. Experience in Canada, though limited as yet, shows it to be a forage plant of wide adaptability and capable of producing profitable crops when once established. Though somewhat difficult to cure, owing to the readiness with which the leaves drop off in drying, it possesses characteristics which make it of special value for pasturage and soiling, viz., its very early growth in spring and its property of quickly sending up an aftermath when cut.

To obtain data regarding the relative yields—both as to amount and feeding value—when cutting the crop two and four times, respectively, during the season, certain experiments were made in the year 1901 on the Central Experimental Farm at Ottawa and the results of this investigation may now be presented.

The plot of our experiment was sown in May of the previous year, so that the results indicate returns from the second season's growth. Half the plot was cut twice and half four times, and the several yields weighed and analysed. The following are the data:—

TABLE I.—Yield and Amount of Dry Matter from Two and Four cuttings, respectively.

Date of Cutting.	Average Height of Plants.	Two Cuttings—Per Acre.					Four Cuttings—Per Acre.				
		Weight of Crop.		Dry Matter.		Crude Protein.	Weight of Crop.		Dry Matter.		Crude Protein.
	Inches	Tons.	Lbs.	Tons.	Lbs.	Lbs.	Tons.	Lbs.	Tons.	Lbs.	Lbs.
June 4	*30						6	920	1	610	522
" 21	†39	12	1,600	3	297	1,027					
July 15	‡28						4	960	1	438	368
Aug. 1	§20	4	320	1	445	384					
" 19	**20						5	1,120	1	329	473
Sept. 18	††20						2	1,760		1,168	295
Totals		16	1,920	4	742	1,411	19	760	4	545	1,658

The composition of the foregoing yields, as regards water and dry matter, is given in the following table:—

TABLE II.—Dry Matter in Crop cut at various times throughout the Season.

Date of Cutting.	Plot cut twice.		Plot cut four times.	
	Water.	Dry Matter.	Water.	Dry Matter.
	Per cent.	Per cent.	Per cent.	Per cent.
June 4			79·8	20·2
" 21	75·4	24·6		
July 15			72·8	27·2
Aug. 1	70·6	29·4		
" 19			79·1	20·9
Sept. 18			79·7	20·3

* About one week before blooming. † Just bursting into bloom. ‡ About half the plants in bloom § About one-tenth of plants in bloom. ** No bloom showing. †† No bloom showing.

From the foregoing tables it will be seen that the yield of fresh material is greater from the area cut four times than from that cut twice. However, owing to the fact that the average moisture content of the former was higher by about five per cent, the total yield from the plot cut twice contains more dry matter. The dry matter of the former (four cuttings), however, furnished the more nutritive fodder from the presence of an additional 250 pounds of crude protein. In a word, the plot cut twice gave the more dry matter, and the plot cut four times the more crude protein.

A comparison of the amounts of dry matter and albuminoids* per ton of fresh material in the various cuttings—possibly the most interesting feature in the investigation—is given in the following table:—

TABLE III.—Dry Matter and Albuminoids Per Ton, in Fresh Material.

	Dry matter. Lbs.	Albuminoids. Lbs.
Plot cut twice—		
First cutting (June 21)	492	49
Second cutting (August 1)	588	63
Plot cut four times—		
First cutting (June 4)	404	46
Second cutting (July 15)	544	66
Third cutting (August 19)	419	60
Fourth cutting (September 18)	405	70

The percentage of albuminoids in the dry matter was also determined

TABLE IV.—Albuminoids in Dry Matter.

	Percentage.
Plot cut twice—	
First cutting (June 21)	10·0
Second cutting (August 1)	10·7
Plot cut four times—	
First cutting (June 4)	11·3
Second cutting (July 15)	12·2
Third cutting (August 19)	14·2
Fourth cutting (September 18)	17·1

From the data of tables III. and IV. it will be seen that the stage of growth influences both the amount of dry matter and the proportion of albuminoids in the dry matter. The later cuttings, weight for weight, will, as a rule, contain more dry matter and invariably furnish a fodder richer in albuminoids than the earlier cuttings. Thus, in the plot cut four times one ton of the fourth cutting (September 18) is equal, as regards albuminoids, to one and a half tons, approximately, of the first cutting (June 4). Similarly, in the case of the plot cut twice, we find the greater feeding value per ton from the second cutting. (See table III.)

In conclusion, we may place side by side the pounds *per acre* of albuminoids from the two and four cuttings of alfalfa, respectively.

ALBUMINOIDS—POUNDS PER ACRE.

	Plot cut twice. Lbs.	Plot cut four times. Lbs.
June 4	...	295
June 21	629	...
July 15	...	297
August 1	262	...
August 19	...	331
September 18	...	200
	891	1,123

* The 'crude protein' includes the 'albuminoids' and certain other nitrogenous substances of a less nutritive character—the amides and allied bodies. Upon the proportion of the more important albuminoids (the true flesh-formers) present, the value of the fodder very largely depends.

It is evident, therefore, that although the amount of dry matter was somewhat larger from the plot cut twice, the plot cut four times yielded considerably the larger weight of albuminoids.

ALFALFA AS A FERTILIZER.

The practice of using one or other of the legumes as a 'green manure' is becoming more and more popular, both in the preparation and enrichment of the soil for the ordinary farm crops as well as for the successful and economical cultivation of orchards (see bulletin No. 40, Experimental Farm Series, Clover as a Fertilizer). A few years ago the relative merits of alfalfa and certain clovers in this connection were ascertained at the Central Experimental Farm, Ottawa, and we now append in tabular form the data obtained.

YIELD and Amount of certain Fertilizing Constituents per acre from three months growth of Clover Crops, Experimental Farm, Ottawa.

Seed sown July 13, 1896, cut October 20, 1896.	Weight of Crop per acre (green).		Organic matter.	Ash.	Nitrogen.
	Tons.	Lbs.	Lbs.	Lbs.	Lbs.
Alfalfa—					
Stems and leaves	5	1,192	2,664	510	75
Roots.	5	558	3,120	613	61
Total	10	1,750	5,784	1,123	136
Mammoth Red—					
Stems and leaves	6	1,310	2,269	508	82
Roots	3	1,260	1,409	219	48
Total	10	570	3,678	727	130
Crimson—					
Stems and leaves	11	234	2,093	602	85
Roots	3	201	801	199	19
Total	14	435	2,894	801	104
*Common Red—					
Stems and leaves	4	1,779	1,842	481	70
Roots	2	1,445	1,394	172	47
Total	7	1,224	3,236	653	117

In the following brief remarks we have brought together the more salient features of this system of green manuring with legumes.

Primarily, it is useful in furnishing nitrogen and humus—the former an essential element of plant food, the latter a most important constituent of soils, both chemically and physically.

When employing rye, buckwheat or other plants not legumes, the nitrogen stored within the tissues of the crop has been obtained from the soil, but with the legumes

* In the experiments here recorded the common red clover has given a much less weight of stems, leaves and roots than the mammoth red clover. In other experiments, however, recorded in bulletin No. 40, pp. 19 and 20, the common red has almost equalled the mammoth red in this particular, and in one instance the weight from the common red was greater. Hence, where there is any difficulty in procuring the seed of the mammoth red the common red may be substituted with good results.

(alfalfa, clover, pease, &c.) the case is different. They, under favourable conditions, have the power of appropriating the larger part of their nitrogen from the atmosphere; on account of this property they have, as already stated, been termed 'nitrogen collectors.' Since nitrogen is the most expensive of all the elements when fertilizers have to be purchased, the value of green manuring with the legumes, which are exceedingly rich in this constituent, becomes apparent.

The humus thus supplied increases the retentive power of light soils for moisture, ameliorates the condition of heavy clays, and regulates the soil temperature. By the carbonic acid liberated in its decay, the inert plant food of the soil is rendered more available.

The elements that compose the humus of the legumes, are for the most part derived from the atmosphere, so that in the benefits conferred by the presence of humus and its decomposition there is a distinct gain.

Further, we may well suppose that the mineral matter or ash constituents of the green crop are, by the decay of the latter in the soil, set free in a condition more or less immediately available to plants. Hence, although such a method of manuring has not added to the total store of mineral food in the soil, it has materially enhanced its value by conversion into more assimilable forms.

A consideration of the data in the foregoing table shows that in total yield of crop, alfalfa stood second. It was from this legume we obtained the largest amount of humus-forming material in the stems and leaves, as well as in the roots. It also afforded the most nitrogen per acre, nearly half of which was in the roots—a feature in which it stands alone among the clovers experimented with and one of great importance when the crop is intended for soiling or curing. The extensive or rather deep-root system is of much value in the mechanical improvement of the soil; it also serves to bring to the surface layers much plant-food ordinarily out of the reach of farm crops.

The mineral matter exceeded by 300 pounds per acre the amount in the Crimson Clover crop—the next best in this respect. More than half of the 1,100 pounds of ash constituents recorded as stored in the yield per acre, was contained in the roots.

Taking into consideration all the important requirements, from a chemical standpoint, of a crop for green manuring, the alfalfa gave the best results in the present investigation.

PART III.

LUCERN OR ALFALFA.

(Medicago sativa, L.)

By James Fletcher, LL.D., F.R.S.C., F.L.S.

The frequent demands for information concerning Lucern or Alfalfa from all parts of Canada make it advisable to publish a note, giving briefly some of the more important facts bearing on the cultivation of this legume, as well as a reference to such success as has attended the efforts of enterprising farmers who have experimented with it. Its great value in the semi-arid districts of western North America, and in many parts of South America, can hardly be overstated. This has doubtless led to the numerous trials which have been made from time to time in almost all parts of the Dominion.

Notwithstanding that these attempts to establish lucern among the regular fodder crops of Canada it must be acknowledged to have not been so far very successful,

Fig. 1.—Lucern: *a*, *b*, seed pod; *c*, seed —1, *b*, *c*, enlarged.

(Jared G. Smith, Farmers' Bulletin No. 31, United States Department of Agriculture.)

yet, from careful observations and inquiries made during a period of many years, the writer feels justified in recommending farmers in all parts of the Dominion to give this clover a much more extensive trial than up to the present time it has received. These experiments should naturally be made on a small scale at first, until the suitability of the locality has been proved. Lucern has been styled 'a fickle crop,' owing to the irregular results which have been obtained in growing it in the same district, or even in two fields close to each other in the same locality.

The most important requisite for success is a permeable, well-drained subsoil, in which the water level does not rise higher than eight or ten feet below the surface. Provided that the actual soil in which the plant grows is tolerably fertile, and that it

has been well prepared, lucern will succeed on soils of a very diverse nature, ranging from the lightest of sandy loams to heavy clay.

Lucern or Alfalfa (*Medicago sativa*, L.) is an upright branching, deep-rooted smooth perennial plant, belonging to the natural order Leguminosæ, to which also belong the various clovers, pease, beans, vetches and similar plants. For all practical purposes of the farmer, it may be regarded as a clover, and may be put to the same uses. It is precisely the same plant as is frequently spoken of under its other name, Alfalfa, and is not as some of our correspondents have thought, a true grass, such as timothy, June grass or millet. The name Lucern, by which this plant is known in Europe and most parts of eastern North America, is not derived from the Swiss Canton of Lucerne, but is said to be a corruption of the old Cataline name 'Userdas,' whence came 'Laouzerdo' used in the south of France, and this word, by easy corruption, has changed to lucern. The other name, Alfalfa, is of Arabic origin, and was taken with the plant into Spain by the Moors. The Spaniards naturally called the new plant by the name used for it by its introducers, and then brought it with them under that name to North America, where it is now widely used, particularly in the West, where lucern is most grown, and where Spaniards were formerly numerous. The cultivation of lucern probably dates further back than that of any other fodder plant known. An interesting account of its history is given in the United States Farmers' Bulletin, No. 31. Lucern is a native of valleys of Western Asia, and has been found wild in Beloochistan, Afghanistan and Cashmere. It has been cultivated as a fodder plant for more than two thousand years and was introduced into Greece at the time of the Persian war, B.C. 470. It was brought to Mexico and this continent at the time of the Spanish invasion, since which time it has slowly and gradually spread over the whole continent, until it is now cultivated more or less over vast areas north and south of the equator.

Lucern grows to a height of from one and a half to over three feet at the time of flowering. The proper time to cut the crop is when about one-tenth of the flowers have turned purple. The leaves consist of three oblong leaflets, which are notched at the end and borne each one on a slender stalk. The purple pea-shaped flowers are in long, loose clusters and occur all over the upper part of the plant. The pods are spirally twisted and contain several yellow kidney-shaped seeds, which are about one-half longer than red clover. The root system consists of a single tap-root, which under favourable soil conditions will run down to a great depth, an average of ten or twelve feet being common, and there are authentic records of the roots having penetrated to a depth of over fifty feet. This deep-rooting habit gives the plant great agricultural value as a soil improver by carrying the materials for humus and nitrification of the soil a long way below the surface, and also because the plants not only derive much of their nourishment from depths not reached by ordinary crops, but the vitality of the plant is protected from drought, and when the roots decay, channels useful in the drainage of the subsoil are opened up.

The young plantlet, which for some time after starting from the seed is slender and delicate, is well shown at figure 2. When the stems are cut or grazed off, the stalk dies down to the very base and new buds are produced on the upper part or crown of the root. The plants do not reach full growth until the third year, when they present the appearance shown at figure 3. The crown of each plant by that time produces a great many stems and forms a strong tuft of excellent fodder. Owing to the smallness of the plants the first year, farmers are sometimes disappointed at the appearance of the crop; but if, when the seed has been sown broadcast, one plant can be saved to every five or six inches, the stand will be thick enough. It is best to sow lucern in drills seven or eight inches apart.

This plant has no running root-stocks, and there is not the slightest probability of its ever becoming a troublesome weed. It spreads only by seed. When it is desired to clear it from land, it can be easily done, although it will require a good plough and a strong team of horses. The roots, once cut below the surface, do not produce new shoots, but die. Under irrigation the plants are easily killed by flooding the fields for three or four days in hot summer weather.

Fig. 2.—Lucern seedling, 6 weeks old.

Fig. 3.—Lucern, 3 years old.

(Jared G. Smith, Farmers' Bulletin No. 31, United States Department of Agriculture.)

Lucern is a long-lived perennial, and it is not often advisable to lay down land to this crop unless it can be left undisturbed for several years. The heaviest crops are borne after the third year. On the experimental grass plots at the Central Experimental Farm, we have cut three crops a year, aggregating an average of five tons of cured hay to the acre for nine years, and this too was upon a piece of gravelly and by no means rich land. Ex-Governor Hoard, of Wisconsin, tells me that there are plots of lucern now growing near some of the old Spanish monasteries in California which were sown fifty years ago.

As stated above, when a piece of well-drained suitable land is to be sown to lucern, it should be tolerably rich, or in the condition known to farmers as 'in good heart,' that is, fit to give profitable returns from any ordinary farm crop. If it is not, it will be better to put on a good heavy dressing of barn-yard manure, plough deeply and grow a crop of corn or potatoes for the first year. Lucern may be sown either in spring or summer, but does far better when sown in spring. The seed bed must be deep, well firmed but mellow, and with a smooth surface. The disc harrow, roller, and smoothing harrow, should be well used before seeding, until the land is in the very best condition possible. When the young plants are well up, 8 or 10 inches, the field should be mowed and all weeds must be kept down carefully for the first year with scythe and hoe. Any weak spots should be picked up, if necessary, by sowing some more seed before August.

If not put out of sight by the roller, corn roots should be raked off the land before seeding. When sown alone, fifteen to twenty-five pounds of lucern seed should be used to the acre, and it is generally conceded, particularly in the West, where there is sometimes a lack of moisture, that it thrives best when sown without a nurse crop. However, excellent results have been sometimes secured when the seeding has been done with a light crop of barley or wheat.

With a good stand, a light crop of hay may be taken the first autumn; but it is better to cut and leave this on the field as a winter mulch. Every spring the field should be harrowed before the shoots appear, with a heavy harrow to loosen up the surface and kill weeds. This treatment, with an autumn dressing every three or four years of short barn-yard manure thoroughly composted so as to destroy weed seeds, will keep a well-established field of lucern in good paying condition for a great many years. Some fields in California, Kansas, Virginia and Colorado have been giving crops continuously for over twenty-five years. Weeds and irregularities in the surface of the land are the two chief causes of failure in keeping lucern fields up to a paying standard. This shows the importance of very great care in preparing the land before seeding, and, as the field remains under the same crop for many years, more than ordinary outlay is justifiable at the outset.

Where lucern is to be grown under irrigation in the West, Mr. Jared G. Smith advises (Farmers' Bull. 31, p. 12) that the seed be 'drilled or sown broadcast in spring, as soon as the ground is warm and when danger of hard frost is past. It is best to sow without a nurse crop. Where the land is under ditch, the fields should be irrigated before seeding and not again until the seedlings are at least six weeks old. The first six weeks or two months in the life of the plant is the critical period of its growth. It is at this time very susceptible to any sudden change of temperature or to an excess of water in the soil. If the land be irrigated directly after it has been ploughed and harrowed, the soil becomes a reservoir of water necessary for the growth of the young plants, and no further irrigation will be required until the alfalfa is well established. The seed should be covered very lightly, to a depth not exceeding an inch. A light harrow or brush will be sufficient.'

'Land on which alfalfa is to succeed must be well drained, as in the East. It is a mistaken idea that alfalfa fields must be kept continuously water-soaked. The plant cannot make its best development with wet feet. The soil must be deep, rich and mellow, and the ground water not less than six or eight feet below the surface. The soil in which it most delights is dry and well drained, and if, in addition to these qualities, the lay of the field is such that water can be turned on once or twice during a hot, dry summer, the very best conditions for the growth of alfalfa will be attained.'

It is sometimes desired to grow lucern mixed with grasses, and this may be done in many parts of the country if varieties are chosen which will not smother out the young seedlings. Mr. D. O'Hara, of Bonaparte, in the Ashcroft district of British Columbia, has grown a mixed crop of lucern and Awnless brome with the greatest satisfaction, and reports that others have done the same, and further adds the interesting information that in such a mixture the lucern is protected to such a degree that in winters, when grown alone, it has winter-killed, while, mixed with some grasses, the plants have come through without injury. In the West, undoubtedly the best kinds of grass for mixing with lucern would be the awnless brome or the western rye-grass, which might be mixed in the proportion of ten pounds of lucern to six pounds of the grass seed. Awnless brome does not as a rule make a very heavy growth the first season, and therefore it would not crowd out the somewhat delicate lucern seedlings, nor deprive them of too much soil moisture. The lucern, being a very deep-rooted plant, would be well suited for cultivation with either of these grasses, the root systems of which are much nearer the surface.

In the East, meadow fescue, tall oat grass and orchard grass might be used for the same purpose. Timothy flowers too late to make a good mixture, although it has been used to a considerable extent.

In localities where the snowfall is light or cannot be relied on to remain throughout the winter, a light top-dressing of manure in autumn or during the winter is very useful in protecting the young plants.

It is probable that lucern is one of the most valuable fodder plants known, and that it has a very wide range of usefulness, by far greater than up to the present time has been discovered. It yields heavy crops of from twelve to twenty-four tons to the acre of early, succulent green feed, or from three to six tons of cured hay of the highest quality. In all conditions it is palatable and attractive to every kind of stock and has, besides a special value on account of the large amount of nitrogen it contains. This valuable plant food increases considerably the utility of manure from animals fed upon lucern and other leguminous plants. Like all other members of the clover family, this has on its roots nodules or galls inhabited by myriads of minute organisms known as nitrogen-gathering and nitrifying bacteria, which perform the useful offices of collecting nitrogen from the air and changing its condition, so that plants can make use of it as food. The abundance of these nodules varies with the soil in which the plants grow, and the vigour of the plants is directly affected by their abundance. When the seed is sown on new land, there are not nearly so many of these important bodies on the roots as where a crop of lucern has previously flourished, nor are the plants so vigorous. It has been found that the soil may be easily inoculated so as to be able to grow better crops, by scattering some soil from an old lucern field or from a spot where the white sweet clover, also known as Bokhara clover (*Melilotus alba*, L.) has grown.

Prof. Cyril G. Hopkins says (Bulletin 94, Illinois Agric. Exp. Station, 1904): 'We have conclusive evidence that infected sweet clover soil can be used for the inoculation of alfalfa fields. The infected soil may be obtained from any place where sweet clover is found with abundance of tubercles on its roots. The soil may be collected to a depth of three or four inches and scattered over the alfalfa field at the rate of 100 pounds or more to the acre. It is well to scatter the infected soil at about the time the alfalfa is seeded, and harrow it in with the alfalfa seed, although it may be applied some days or even some weeks before seeding time, and probably it would be all right to apply the infected soil the autumn before; for it is known that the bacteria will live in soil for several months, even though the soil be placed in sacks and allowed to become quite dry. Investigations have shown that 100 pounds of thoroughly infected soil to the acre is sufficient to produce a very satisfactory inoculation within one year from the time it is applied.'

It may also possibly be the case, although it has not as yet been proved, that other kinds of these useful nodule-inhabiting bacteria which occur on one kind of leguminous plant, may be able to establish themselves on the roots of other nearly related plants growing near them. A few of the bacteria are probably carried with the seeds to a new locality; but it takes some time before they increase sufficiently to help the crop, and, if some soil can be procured from an old field and scattered over the surface, the plants respond rapidly and much time is saved. That lucern improves the soil where it is grown, is shown by the remarkable increase in the crops which follow it.

The seed of lucern can be grown in Canada, but it is more economical at present to import seed and cut the crop for feed or hay.

As stated, lucern has been tried in every part of the Dominion, and remarkably good results have been obtained in many parts of Ontario, Quebec and British Columbia. One of the finest fields of lucern which I have ever seen, was at Cowansville, Que. Mr. F. W. Hodson, the Dominion Live Stock Commissioner, has grown lucern mixed with grasses with the greatest satisfaction, near Myrtle, Ontario, getting from three to four tons to the acre each year for several years, and this on a clay hillside which for many years had been almost bare of vegetation, owing to the heavy nature of the soil and to the steep slope of the hillside, which allowed of much erosion during heavy rains. Several small patches have been grown in Manitoba and Mr. Bedford, the Superintendent of the Manitoba Experimental Farm, writes:—'On this

farm, when sown without a nurse crop, alfalfa, common red, mammoth red, alsike and white Dutch clovers form robust plants by fall, and do not fail to pass the winter successfully. I sow in spring without a grain crop, because, when sown with grain, alfalfa and other clovers, but particularly alfalfa, have been winter-killed, the roots produced during the first year being small and short. I have grown alfalfa since 1887.'

When travelling through the Northwest provinces, I have frequently come across farmers who have small patches of alfalfa, some of these of three or four years' standing, and Mr. T. N. Willing, of Regina, who, as Provincial Weed Inspector, has exceptional opportunities of seeing what crops are grown on farms in all parts of the Northwest provinces, and who, as a practical farmer, is well able to judge the value of crops, writes:—'I am sorry to say I am not aware of any one who is conspicuously successful with alfalfa on a large scale, although many have tried small patches, which have apparently given most promising results. Mr. W. Stevens, of Cloverbar, near Edmonton, has a patch in its second season, which wintered perfectly; when mowed at the end of July it was between three and four feet high and gave a crop estimated at from three to three and a half tons. Near Battleford, the late Mr. Laurie sowed alfalfa about 1884; the season was dry, but the plants struggled on in spite of drought and gophers; the farm was subsequently abandoned, but in 1900, the alfalfa area was still clearly defined and proved attractive to the cattle. Mr. Laurie was satisfied that this would have done well, had he been able to care for it better. A man near Boscurvis has grown alfalfa for three years, and it has constantly improved. Near Prince Albert it was grown for five years by Mr. Acorn, but was then killed out by a late spring frost.'

Mr. John Dixon, of Maple Creek, Sask., has had an acre and a half of lucern under cultivation for over twelve years and reports it to be improving every year. The first year it was sown it came up nicely, but so much was killed the next winter that grass was sown on the plot the following spring. However, lucern appeared later and has continued to improve year by year since that time. The first crop of hay was ready to cut on June 1. Mr. Dixon's plan is to cut once for hay and then let the plants go to seed. He never pastures it and gives it a top-dressing every third or fourth year. The patch is much admired by visitors, and Mr. Dixon's experiment has induced many others in the neighbourhood to try this clover. Less than 100 miles south of Maple Creek, in the State of Montana, lucern is grown in large quantities, and I can see no reason why it should not do equally well in many parts of our Northwest provinces, if the land is carefully prepared. Mr. Dixon, writing of his experiment, says: 'We have tried lucern in several other places and under different conditions, but without any decided success. It will not succeed in low, wet lands or on land which floods, the stems being very much affected by water. I fancy it thrives best on a sandy loam and under irrigation. The little plantlets are very tender and hard to start. Although they usually die for want of water, yet they are easy to kill if they get too much. We are convinced that a second sowing on the same piece of ground gives better results than the first seeding; that is, should the first sowing not be successful, the same ground should be cultivated and seeded the second time, when a better stand will be secured.'

The Honourable C. F. Cornwall, of Ashcroft, B.C., reporting on his district to the Deputy Minister of Agriculture for British Columbia, 1901, says: 'For stock-feeding alfalfa and sainfoin are chiefly grown and are produced in great quantities.'

Besides the ordinary form there are some other species or varieties of lucern which are cultivated to a certain extent. The Intermediate Lucern, the Yellow or Sand Lucern, and a variety of the common form from Turkestan, and known by the name of Turkestan Alfalfa, are the varieties most grown. Both of the first-named have succeeded well on the Experimental Farm grass plots and have given in this single experiment heavier crops than the ordinary form. All are very much alike, and it is probable that they are merely varieties or forms of one species. The Turkestan alfalfa appears to be merely a vigorous form which has been grown in Western Asia for a long time and has thus become accustomed to more severe conditions than the common lucern. The two plants, after some years of cultivation, are

almost indistinguishable, although the Turkestan variety is rather more vigorous in growth.

The facts given above will, I trust, induce some who have not already done so, to try a small plot of this valuable fodder plant. During the last hundred years, outside certain regions in the West and South, reports of successes and failures have been about equally divided, and there must be some reason for the differences in results. I am inclined to think that these are chiefly due to a lack of care in choosing suitable land and in preparing the seed-bed for the reception of the seed. Lucern has succeeded so far north and under such severe winter conditions that I cannot think that low temperatures have been the chief cause of failure. A covering of snow is a great protection to the roots, but our beds at Ottawa have several times been exposed to temperatures many degrees below zero when entirely bare.

The seed of this clover is cheap, is easily obtained in all markets, and the value of the nitrogen collected by the plants, even if they live for only one year, will by far exceed the cost of the seed and all labour expended.

[Photo by Frank T. Shutt.]

Sheep Feeding in Alfalfa Pasture, Second Year of Growth. Central Experimental Farm, Ottawa. May 31, 1904.

[Photo. by Frank T. Shutt.]

Crop of Alfalfa (Two Years' Growth) being Ploughed Under, showing extensive Root System. Central Experimental Farm. May 31, 1904.