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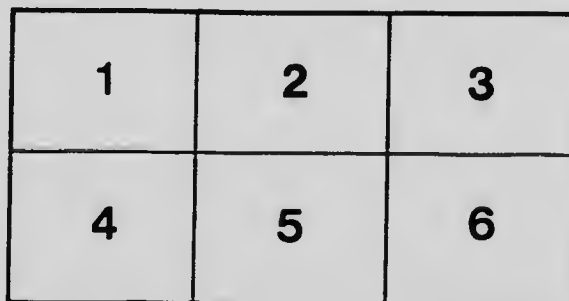
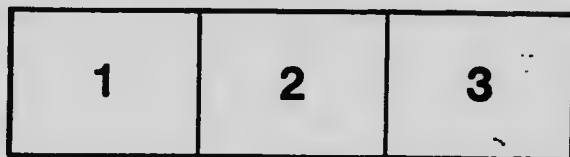
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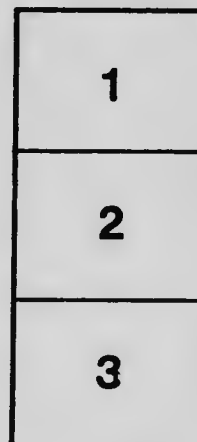
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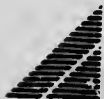
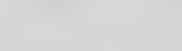
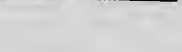
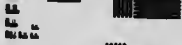
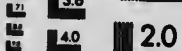
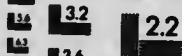
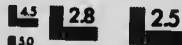
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ONTARIO AGRICULTURAL COLLEGE.

ALFALFA OR LUCERNE

BY C. A. ZAVITZ, PROFESSOR OF FIELD HUSBANDRY.

Alfalfa, also called Lucerne, is a hardy, perennial, leguminous plant which produces stems of an upright growth, flowers in purple clusters, and roots which penetrate deeply into the ground. It has been grown in the region of the Mediterranean Sea for more than two thousand years, and thrives on soils of various kinds and elevations, and in climates of different degrees of temperature and of different amounts of rainfall. Under favorable conditions, Alfalfa produces an abundant growth of tops which furnishes material of high nutritive value for farm stock. As a feed for farm animals, the crop is used in the form of pasture, green fodder, silage, and hay. When in the best condition for feed it is relished by all kinds of farm stock, including horses, cattle, sheep, swine, and even poultry.

Alfalfa is a great economizer of soil fertility, as it has the power of making use of the free nitrogen of the atmosphere and of the valuable mineral constituents of the subsoil. The abundant growth of roots in an Alfalfa sod has a very beneficial effect in the improvement of both the chemical and the mechanical condition of the soil. It is certainly a valuable crop to raise in those countries in which it will grow satisfactorily.

Experience with the crop shows that Alfalfa can be grown successfully in many parts of Ontario. Not only has it been tested in the Experimental Department of the Ontario Agricultural College, and on small plots over the Province through the medium of the Experimental Union, but it has been successfully grown also as a field crop on many farms in different parts of Ontario for several years past. Apparently, the very best results have been obtained from growing Alfalfa on land which is composed of a fertile soil of good texture, which contains a fair amount of humus and the proper kind of nitrogen-fixing bacteria, and which overlies a subsoil rich in lime and sufficiently open to permit of a full development of the extensive root system of the Alfalfa plants to a considerable depth in the soil. Good results should not be expected from growing Alfalfa on land which has a cold, sour, wet subsoil. It is probably safe to say that the undersoil has a greater influence than the soil at the surface in making the conditions favorable or unfavorable for the successful cultivation of these deep-rooted plants.

EXPERIMENTS IN GROWING ALFALFA AT THE ONTARIO AGRICULTURAL COLLEGE.

A considerable amount of experimental work has been conducted in the growing of Alfalfa in the Department of Field Husbandry at the Ontario Agricultural College. The College farm is located inland about thirty miles from Lake Ontario, sixty miles from Lake Erie, and seventy miles from Lake Huron, and at an elevation of 740 feet above the level of Lake Ontario, and 1,100 feet above the level of the sea. The average rainfall at Guelph is about sixteen inches for the six months from April to September inclusive, and the total precipitation about twenty-seven inches for the entire year. The mean annual temperature is 43.5° F.

The fifty-acre field, in which most of the experiments were conducted, is what might be termed an average clay loam, and has a gentle slope towards the southwest. Part of the land is underdrained with tile, and the remainder has a fairly dry subsoil. The character of the subsoil varies somewhat in different parts of the experimental field from a fairly stiff clay to a combination of clay and gravel. Alfalfa thrives well on all parts of the field, except on the low land, which will not permit of being underdrained to a greater depth than about eighteen inches. On this low land with a wet subsoil the Alfalfa does not usually live for more than two, or possibly for three, seasons.

THIRTY CUTTINGS OF ALFALFA IN TEN YEARS.

The following table gives the yields per acre of the different cuttings of both green fodder and of cured hay of the Alfalfa crop, as produced in the Experimental Department of the Ontario Agricultural College in each of ten years :

Years	Green crop (tons).					Hay (tons).				
	First cutting	Second cutting	Third cutting	Fourth cutting	Total	First cutting	Second cutting	Third cutting	Fourth cutting	Total
1896	9.96	6.47	4.06	2.06	22.55	3.08	1.91	1.29		
1897	12.04	5.61	4.43	.....	22.08	3.59	1.56	1.23	..	
1898	9.71	5.85	2.64	.....	18.20	2.30	1.75	.63	...	
1900	11.93	6.00	1.60	.....	19.53	2.33	1.47	.80	....	2.60
1901	9.70	2.20	7.49	.....	19.39	2.03	1.00	1.50	.....	4.53
1902	13.35	8.69	2.06	.....	25.00	2.50	2.02	.54	.....	5.06
1903	13.10	8.53	2.75	.....	24.38	2.50	2.09	.67	.....	5.25
1904	12.45	9.35	4.00	.....	25.80	3.40	2.50	1.08	.....	6.98
1906	9.78	6.60	4.85	.....	21.23	2.55	1.13	.58	.....	4.26
1907	14.55	3.95	.....	.....	18.50	2.95	1.05	.....	.....	4.00
Aver. 10 yrs.	11.66	6.32	3.48	.21	21.67	2.72	1.65	.83	.07	5.27

The foregoing results were obtained from different seedings which took place in various parts of the experimental grounds, mostly in com-

parative tests with different varieties of clovers. In every case the crop was sown in the spring of the year, at the rate of eighteen or twenty pounds of Alfalfa seed per acre, and usually with a grain crop, such as barley, sown at the rate of one bushel per acre.

In each of eight years, the Alfalfa gave exactly three cuttings, but in 1907 it produced only two, while in 1896 it gave four cuttings in the one season. It will be remembered that the spring of 1896 opened up very early, and that of 1907 exceptionally late. In 1896 the first cutting took place on June 1st and the second cutting on July 2nd, but in 1907 the first crop was not ready to cut until the 2nd of July.

Efforts were made to cut each crop quite soon after it had started to blossom, and always before it was one-third in bloom. The average dates of cutting were as follows: first cutting, June 21st; second cutting, August 2nd; and third cutting, September 21st.

It will be seen that the annual yield of Alfalfa per acre per annum in the average of the ten years' experiments was 21.67 tons of green crop, and 5.27 tons of hay. Hence, green Alfalfa furnishes about 24 per cent., or practically one-quarter, of its own weight in the form of hay. The first gives about double the yield of the second cutting, and the second nearly double the yield of the third cutting. It is generally more difficult to make good hay from the third than from either the first or the second cutting, owing to the unfavorable weather conditions. Within the ten years, here referred to, the Alfalfa produced more than six tons of hay per acre in each of three years, and less than four and one-half tons of hay per acre in each of two years. Since 1888, well-established Alfalfa at the College has been badly winter-killed on only one occasion and partly winter-killed on two occasions. It has usually survived the winter and the early spring in excellent condition. Unfortunately, the results for 1899 and for 1905 were not recorded sufficiently in detail to permit of their being used in the foregoing table.

VARIETIES OF ALFALFA.

There appear to be a few varieties of the wild forms of Alfalfa which are characterized by differences in the color and in the size of the flowers, in the coverings and in the structures of the pods, etc. Botanical authorities, however, have not made it clear that there are marked differences in the botanical structure of the Alfalfa which is used in cultivation. It is, nevertheless, true that the continuous growing of Alfalfa for long periods of time in different countries and under varying conditions of soil and climate, has furnished numerous strains or varieties which vary in important characteristics, when considered from a practical standpoint. Different forms or strains of Alfalfa are known principally by the country in which they have been grown for a number of years. Even this is very indefinite, as for instance, there appear to be different strains of Alfalfa produced in Turkestan, the value of which varies considerably. Much has been claimed in the United States and in Canada for the Turkestan Alfalfa. The results of experiments which have been conducted at Guelph,

however, within the past ten years, show that the so-called Turkestan Alfalfa obtained through the seed trade of the United States and of Canada, has displayed no perceptible advantages over the common variety grown in this Province. Wishing to obtain fuller information regarding the best sources of purchasing Alfalfa seed of the highest quality for use in Ontario, we secured for experimental purposes samples of seed grown in different parts of the world. Some of these were obtained through the kindness and the cooperation of the Department of Agriculture at Washington, and some were obtained direct by the College. In the spring of 1905, twenty-eight plots were sown in duplicate with Alfalfa seed obtained from different sources. From each of the plots three cuttings for hay were made in 1906, and one cutting for hay and one for seed in 1907. The following table gives the average dates of the first appearance of the bloom in the two years, and the total yield per acre of green crop and of hay from the three cuttings in 1906 and the one cutting in 1907:

Source of Seed.	Dates of first bloom. Average 2 years	Total yield per acre. Three cuttings in 1906 and one cutting in 1907.	
		Green crop	Hay
	June	(Tons)	(Tons)
Texas, Panhandle.....	21	28.8	7.3
Turkestan, Khiva.....	22	29.0	7.0
Turkestan, Samarkand.....	22	27.9	6.7
Nebraska.....	18	26.1	6.6
Montana, Northern.....	21	25.1	6.6
Chinese Empire, Sairam.....	21	26.0	6.5
New York.....	17	25.3	6.0
Montana, Southern.....	22	25.0	6.0
Germany.....	19	25.0	3.0
Utah, irrigated.....	22	23.9	5.9
Montana, Northern.....	21	24.5	5.8
Texas, Sherman.....		24.4	5.8
Russia, Simbirsk.....	18	26.4	5.7
Kansas.....	25	22.0	5.7
France, Poitou.....	19	25.7	5.6
Colorado.....	21	24.2	5.6
Nebraska.....	24	22.9	5.3
Utah, non-irrigated.....	19	22.0	5.3
United States, First Quality Commercial Seed...	18	22.2	5.0
Ontario, O. A. C. Seed, 1904.....	19	22.4	4.7
Italy.....	19	22.0	4.6
Ontario, O. A. C. Seed, 1903.....	21	20.1	4.3
Russia, Kharkoff.....	18	20.0	4.2
Turkestan, through Wm. Rennie, Seedsman, Toronto.....	23	19.6	4.2
France, Provence.....	21	16.8	3.5
Turkestan, through Currie Bros., Seedsmen, Milwaukee.....	19	17.8	3.2
Arabia.....	23	.6	.2
Peru.....		.0	.0

It will be observed that the results obtained from the seed of the Turkestan Alfalfa which was obtained in America were decidedly lower than those obtained from the seed of the Turkestan Alfalfa obtained from Turkestan through the Department of Agriculture at Washington.

The plots which were sown in the spring of 1905 from seed produced at the College in 1904 and in 1903 gave quite similar results to the first quality of the commercial seed grown in the United States. It should be stated, however, that both the seasons of 1903 and 1904 were unfavorable in Ontario for the production of Alfalfa seed of average quality. It should also be taken into consideration that the seed produced in 1903 was over a year old when it was sown in the spring of 1905.

It is interesting to observe that the greatest yield of cured hay per acre was produced by seed obtained from the northwestern part of Texas. The yield of the green crop, however, was greater from the seed obtained from Khiva, Turkestan, than from that obtained from any other source.

Although the germination of the seed obtained from Arabia and from Peru was excellent, and the crop in each instance was very promising in the autumn of 1905, the plants of the Peruvian Alfalfa were completely killed, and those of the Arabian Alfalfa were mostly killed before the following summer. Both these strains of Alfalfa are giving particularly good results in the southwestern part of the United States, but owing to their acquired habits of growth prove to be exceptionally tender in Ontario.

In 1907, the second crop of Alfalfa, on each of the plots here referred to, was allowed to go to seed. It was the desire to obtain seed of these different strains in order to continue the experiment, and to ascertain whether or not the seed obtained from the most productive kinds would continue to produce the best results. We hope that in time we shall be able to produce in Ontario a good supply of seed of the very best strains of Alfalfa.

INOCULATION.

It is a well established fact that leguminous crops, such as Alfalfa, Sainfoin, Clover, Peas, Beans, and Vetches, thrive best when they are grown in the presence of a certain species of bacteria. These micro-organisms, when present in the soil, enter the roots of the plants, forming enlargements or nodules on the roots. These very minute forms of life make use of the free nitrogen of the atmosphere, which is thus transferred to the plants, making them decidedly more valuable both in food constituents and in fertilizing materials. Each of the crops here referred to requires bacteria peculiar to itself. It is possible for Alfalfa to grow fairly well without the presence of these minute forms of life, by making use of the nitrogen already in the soil. Their presence, however, seems to have the double value of increasing both the quantity and the quality of the crop. Whether or not the proper bacterial forms are in the soil, can be ascertained by growing a small amount of Alfalfa and examining the roots for the presence or absence of the nodules. If no nodules are

present, it is quite evident that the soil is lacking the proper organisms. These, however, can be brought to the soil either by the application of inoculated soil from other fields, or by the artificial inoculation of the seed. For fuller information regarding this interesting and important phase of Alfalfa-growing, the reader is referred to the report of Prof. S. F. Edwards, as presented in the Ontario Agricultural College Bulletin No. 164.

The first experiments in the inoculation of seeds of leguminous crops were conducted at our College in 1897, when materials containing the nitrogen-fixing bacteria were imported from Germany. At a later date other experiments were conducted with the bacterial preparations obtained from Washington, and still later with those manufactured at our own College. Although we took great care in the experiments, no perceptible advantage in the yield of crop was obtained from the use of the different cultures. This was evidently due to the fact that the soil in the experimental grounds was already well inoculated, which was made quite apparent by the presence of an abundance of tubercles on the plants each year.

SOIL, SEED, AND SEEDING.

For the best results with Alfalfa, not only is it important to select land that is in a good state of fertility to enable the young plants to get a proper start during the first year, and that has a deep, sweet, subsoil with moisture surrounding its particles and with air between them to enable the Alfalfa roots to spread in various directions in search of moisture and of plant food, but it is also important to select land which is comparatively free from seeds and roots of weeds and of other troublesome plants, in order to give the Alfalfa full possession of the soil. We find that the Canadian Blue Grass, in particular, is apt to cause some trouble in growing amongst the Alfalfa plants at the College and in other parts of Ontario, unless the soil is thoroughly prepared before the seed is sown. In all cases, the soil should be well cultivated and a fine seed-bed formed, in order to permit of a quick and a uniform germination of the seed after it has been sown.

The quality of the seed is of vital importance. It should be large, uniform, and bright, of good vitality and free from impurities, especially from seeds of weeds and of other plants which are troublesome in a field of Alfalfa. It is wise to secure a sample before the bulk of the seed is purchased. This can then be examined and if the seeds are large and uniform, are free from seeds of sweet clover, yellow trefoil, etc., and will germinate well when placed between sheets of moist blotting paper or in a box of sawdust which is kept warm and moist, the larger bulk can then be ordered according to sample. The bulk lot when received should also be examined in order to be sure that it is the same as the sample previously examined. A little care in this way may avoid a total or a partial failure of a crop, and also the introduction on the farm of weeds which are difficult to eradicate.

Experiments have been conducted at the College in sowing Alfalfa in the autumn and in the spring, both with and without a nurse crop. The nurse crop used in the autumn was winter wheat, and that used in the spring was oats. As the result of two distinct experiments, each extending over a period of two years, it was found that the spring sowing gave the best results. The Alfalfa, which was sown in the spring alone, gave an average in the second year of the test of 17.2 tons, and that sown with oats, an average of 16 tons of green crop per acre. The Alfalfa sown in the autumn with winter wheat was partially, and that sown without any nurse crop was very badly winter killed.

In another experiment, spring wheat, barley, and oats were used as nurse crops. Five plots were sown with each kind of grain, thus making fifteen plots sown with grain and Alfalfa seed in the spring of 1899. The average total yields of green Alfalfa per acre obtained from the plots on which the nurse crops had been sown were as follows in each of the years 1900 and 1901 :

Nurse Crops.	1900	1901
Spring Wheat	16.3 tons.	24.7 tons.
Barley	13.7 "	22.2 "
Oats	9.5 "	16.3 "

In this experiment the spring wheat proved to be the best, and the oats the poorest crop with which to sow Alfalfa. The oat crop, especially if the seed is sown thickly, has a tendency to smother out the young and tender plants of Alfalfa. All nurse crops used with Alfalfa should be sown quite thinly.

In still another experiment, Alfalfa was sown alone and with one bushel of barley per acre. The test was made in duplicate. The average yield of green Alfalfa per acre during the three following years for each of the plots in both of the sets was as follows :

Sets.	Alfalfa seed sown with	Green Crop.	Hay.
No. 1.....	Nurse Crop of Barley.....	tons. 20.9	tons. 5.4
	Nothing.....	20.5	5.3
No. 2.....	Nurse Crop of Barley.....	23.6	6.1
	Nothing.....	21.3	5.5

This experiment was started in 1895 and finished in 1898. We now sow the Alfalfa seed in the spring of the year and usually with about one bushel of barley per acre. From this system excellent satisfaction has been obtained.

Under ordinary circumstances, we nearly always sow eighteen or twenty pounds of Alfalfa seed per acre, providing it is not sown in combination with different varieties of grasses and clovers. If the crop is to be grown principally for seed production, the amount of seed might be reduced to fifteen or sixteen pounds, and if for pasture or for a cover crop it might be increased to twenty-five or even thirty pounds per acre to advantage.

In preparing the land to receive the Alfalfa seed, it is an excellent plan to cultivate the soil thoroughly, and then to follow with a weeder, or with both a harrow and a weeder, immediately before the seed is sown. If a nurse crop of grain is to be used, the seeder attachment should be placed in front of the tubes of the grain drill. The land should then be levelled either with a light harrow or with a weeder. In this way the Alfalfa seed has the advantage of being located between the rows of grain, and at a suitable depth in well prepared soil which has been worked in such a way as to give the seed the advantage of both the fertility and the moisture in the soil.

INFLUENCE OF MANURES AND FERTILIZERS ON THE ALFALFA CROP.

The influence of manures and of fertilizers depends so much on the mechanical condition and on the fertility of the soil, as well as on so many other conditions, that it makes it a very difficult matter to conduct experiments at any one place and thus obtain results which can be applied to all kinds of land. Some soils are deficient in certain fertilizing elements, and other soils are particularly rich in those very elements; some soils are almost barren of humus, while others contain humus in abundance; some soils are in an acid condition, and Alfalfa would probably receive a decided benefit from an application of lime, while that on other soils would receive no advantage whatever if lime were used. All these things and many others should be taken into consideration when studying the results of fertilizer experiments conducted with Alfalfa at the College and elsewhere, with the object of getting information to use as a guide in other places.

In a representative part of the experimental grounds, four plots, each one-twentieth of an acre in size, were set aside in the spring of 1895 to test the influence of farmyard manure on Alfalfa. On two of the plots farmyard manure was applied at the rate of twenty tons (about twelve loads) per acre, and this was thoroughly mixed throughout the soil. The other plots were left unmanured, and the Alfalfa seed was sown on all four plots. The crops were harvested and the results carefully recorded in each of the three years 1896, 1897 and 1898. The following table gives the average annual yields of green crop and of hay per acre of the duplicate tests conducted during the three-year period:

Condition of soil.	Green Crop. (tons)	Hay. (tons)
Manured land.....	22.4	5.8
Unmanured land.....	20.7	5.3

These results show an annual difference of about one and three-quarters tons of green crop, or of one-half ton of Alfalfa hay per acre in favour of the land which had received the farmyard manure, at the rate of about twelve loads per acre before the Alfalfa seed was sown.

In another experiment, farmyard manure at the rate of twenty tons and hen manure at the rate of five tons per acre were applied as top dressings on Alfalfa plots which had already produced seven cuttings of Alfalfa. The manures were applied after the first cutting of Alfalfa had been taken from the land in 1902. After the application of the manures was made, two crops in 1902 and three crops in each of the years 1903 and 1904 were harvested, and the results recorded. The yields of green Alfalfa in tons per acre as follows :

	1902	1903	1904
1. Farmyard Manure.....	12.8	22.0	26.2
2. Hen Manure.....	13.2	19.8	23.8
3. No Manure.....	11.7	19.3	23.7

The first crop in 1902, before the manures were applied, produced green Alfalfa on the plots of the duplicate test at the following rates per acre: No. 1, 12.1 tons; No. 2, 12 tons, and No. 3, 12.7 tons. The influence of the hen manure was quite marked at first, but that of the farmyard manure was more lasting.

Two experiments with commercial fertilizers on Alfalfa have been conducted at the College. One of these, consisting of twenty plots, was started in 1899, when the fertilizers were used in the same spring in which the Alfalfa seed was sown, and the other, consisting of twelve plots, was started in 1902, when the fertilizers were used on Alfalfa sod which was well established. The first experiment consisted of four tests with five plots in each, and the second experiment of two tests with six plots in each test. The fertilizers used in each test consisted of muriate of potash and nitrate of soda, each sown at the rate of 160 pounds; of superphosphate, at the rate of 320 pounds; and of complete fertilizer, at the rate of 213 pounds per acre. In each test in the second experiment Thomas' phosphate powder was also used at the rate of 320 pounds per acre. One plot was left unfertilized in each of the tests of both experiments. After the fertilizers were applied, the first experiment was con-

ducted for two and the second for three years. The results of these experiments show that the phosphatic fertilizers gave the greatest yield of Alfalfa per acre. Of the different fertilizers used, the superphosphate gave the highest yield per acre in the first experiment, and the Thomas' phosphate powder the highest and the superphosphate the second highest in the other experiment. The greatest average annual yield of green Alfalfa per acre was produced on the land which had received the superphosphate at the time the seed was sown, but this increase, over the crop produced on the unfertilized land, was only one-half of a ton per acre.

USES OF ALFALFA.

Alfalfa can be used in Ontario for the production of hay, green fodder, pasture, seed, green manure, silage, a cover crop in orchards, etc. It is quite probable that its use in this Province will be in about the order in which the list is here given.

For the production of hay it is a most valuable crop. Under favorable conditions it produces large yields of hay of excellent quality. Very great care, however, should be taken to cut the Alfalfa just as it is starting to come into blossom, and always before it is more than one-third in bloom, as the crop very rapidly depreciates in digestibility after it has reached the stage of maturity referred to above. Great care should also be taken to not allow the Alfalfa to lie very long in the hot, dry sunshine, as the leaves soon become crisp and are easily broken from the plants. As the leaves are the richest part of the Alfalfa, special care should be exerted to have as few as possible lost. After the crop becomes sufficiently wilted it should be raked into winrows, and the curing process should be finished in the winrows or in the cocks.

The green fodder produced by Alfalfa is both nourishing and appetizing. It is often an advantage to start to cut Alfalfa for green fodder some time before it has started to bloom. The portion of the crop which cannot be used for this purpose before one-third of the blossoms have made their appearance should be cut and cured into hay. The fact that Alfalfa is a perennial plant, as well as the fact that it produces two, three or four cuttings in the one season, makes it a very desirable crop to use for the production of green fodder for feeding to farm stock.

In the average results of experiments conducted at the College in four different years, Alfalfa, when grown alone, gave a greater yield of pasture per acre than any one of the following crops: Common Red Clover, Mammoth Clover, Alsike Clover, White Clover, Yellow Trefoil, Sainfoin, or Burnet. When grown and pastured alone, however, there seems to be even a little greater risk of cattle and sheep becoming bloated when pasturing on Alfalfa than when pasturing on clover. There is also a danger of either cattle or sheep eating the Alfalfa so closely to the ground that they are apt to injure the crowns of the roots, and in some cases entirely kill the plants. Some very excellent results have been obtained from pasturing hogs and poultry on Alfalfa.

The writer has never heard of injurious results from bloating with any kind of farm stock pasturing on Alfalfa, providing it is used in combination with grasses and clovers in the form of a permanent pasture.

In each of five or six years, seed has been produced at the College from either the first or the second cuttings of Alfalfa. The results have been about the same from each cutting. The production of seed has been only fairly satisfactory at the College, but in some parts of Ontario Alfalfa seed growing is becoming an important industry.

No extensive experimental work has been conducted at the College in the production of Alfalfa silage, but a few reports have been received, stating that the crop can be used in that way with fair satisfaction.

Alfalfa certainly produces a large amount of exceedingly valuable material to use as a green manure. In the majority of cases, however, it is probably better to use the crop for feeding purposes, and then to save the manure and return it to the land in that form rather than to plow under the whole crop.

It is quite probable that there are many crops more suitable for using as a cover crop in orchards than Alfalfa. The growth of the plants is upright and rather open, and the roots penetrate so deeply into the soil that they tend to rob the subsoil of its fertility and of its moisture, both of which are so essential to the best welfare of the trees.

QUALITY OF ALFALFA AS A FEED.

In the years 1897 and 1898 Alfalfa was grown in our Experimental Department, and in comparison with red clover and with timothy both the chemical composition and the digestibility of the crops were determined in the Chemical Department of the College. The results of these investigations were given in detail in the Ontario Agricultural College Bulletin 111, which was issued in the year 1900. The following table gives the comparative amounts of digestible constituents in one ton of hay of each of the three crops:

Constituents.	Alfalfa. (lbs.)	Red Clover. (lbs.)	Timothy. (lbs.)
Prot. in.....	192.2	141.0	48.7
Fat.....	30.0	29.4	16.2
Nitrogen Free Extract....	496.6	587.4	528.4
Fibre.....	205.5	209.4	306.9

The figures here presented are quite suggestive and are worthy of careful study.

In "Farmers' Bulletin Number 215," issued by the Department of Agriculture of the United States in 1905, we find in the investigations there quoted the digestible protein to be 10.44 per cent. for Alfalfa hay and 6.8 per cent. for red clover hay. These figures would be equal to

208.8 pounds per ton of the former and 126 pounds per ton for the latter. These investigations show Alfalfa hay to contain about fifty per cent. more digestible protein than hay made from common red clover. It is certainly true that well cured Alfalfa hay is exceedingly nutritious.

INFLUENCE OF ALFALFA ROOTS ON THE SOIL.

In the years 1900, 1902 and 1903 experiments were conducted to ascertain the comparative value of the sods of Alfalfa and of Timothy. After the crops were removed from the plots the sods containing the roots of these crops was plowed. On the sods of 1900 winter wheat was sown in the autumn of the same year; on those of 1901, barley was sown in the spring of 1902, and on those of 1902 corn was planted in the spring of 1903. The average yields of the crops produced per acre are shown in the following table:

Sod.	1900 Winter Wheat.	1902 Barley	1903 Corn
	Bushels.	Bushels.	Tons.
Alfalfa Sod.....	61.5	30.2	24.0
Timothy Sod.....	42.1	19.7	17.9

In 1902, the test with Alfalfa and with timothy sods was repeated four times. Barley was sown on each of the eight plots in the spring of the year. The detailed results of yields per acre are very interesting, and are as follows:

Tests.	Alfalfa Sod.	Timothy Sod.
	(bus.)	(bus.)
Number 1.....	27.9	18.4
" 2.....	31.7	20.1
" 3.....	31.0	19.6
" 4.....	30.3	25.7

In comparing the mechanical condition of the soil on which Alfalfa and different varieties of clovers and of grasses had been grown, it was found that there was a marked difference resulting from the action of the roots of the different crops on the soil. This influence was shown in two ways in particular: first, by the difficulty or the ease in plowing the land, and second, by the stiffness or the mellowness of the upturned sods. In the spring of 1902, twenty-eight plots of sod were plowed. These were made up of four separate tests, each consisting of seven plots. Each test contained the sods of one variety of Alfalfa, and three varieties each of clover and of grass. When the plots of each of the four tests were

plowed, careful examinations were made and detailed notes were taken regarding the physical condition of the soil in each instance. It was found that the Alfalfa sod was more difficult to plow than that of any of the clovers or the grasses, but that the inverted sod of the Alfalfa plots was exceedingly mellow and friable, surpassing all others in this particular. The comparative differences of the various sods can be understood fairly well from the following figures :

Sods.	Difficulty or ease in plowing, 10 being most difficult.	Loose, friable condition of inverted sod, 10 being most friable.
Alfalfa.....	10	10
Common Red Clover.....	5	7
Mammoth Clover.....	6	6
Alsike Clover.....	4	8
Timothy.....	8	3
Meadow Fescue.....	7	4
Orchard Grass.....	7	4

An Alfalfa sod is usually a little more difficult to plow than that of some of the clovers and the grasses, owing to the very large roots of the Alfalfa plants, which are frequently pulled out of the subsoil instead of being broken or cut in two. When the roots, to the length of two, three, four or five feet or even more, are pulled out of the subsoil and left in the surface soil, a large amount of root material is thus deposited in the land at the very surface. The land is thus left in excellent physical condition, and as the roots decay they supply a large amount of humus, rich in fertilizing elements. In 1898, the Experimental Department spent some time in removing the Alfalfa roots from the land to a depth of two feet. This was divided into four layers, and the roots were carefully separated from each layer. The roots from each of these depths were then taken to the Chemical Department, where they were analyzed. The percentages of the fertilizing constituents in the dried roots of seventeen months' old Alfalfa were as follows for each of four depths in the soil of six inches each :

Roots taken from different depths of soil.	Nitrogen N.	Potash K ₂ O.	Phosphoric Acid P ₂ O ₅ .	Lime Ca O.
First six inches.....	1.64	.66	.55	.59
Second six inches.....	1.58	.41	.55	.38
Third six inches.....	1.59	.43	.51	.48
Fourth six inches.....	1.58	.42	.48	.75

The roots of young Alfalfa plants were found to contain larger percentages of fertilizing materials than those of the plants which were

seventeen months old. For the details of the results of the composition of Alfalfa roots from which these figures have been quoted, the reader is referred to pages 20 and 21 of the Annual Report of our College for 1908.

ALFALFA GROWN IN COMBINATION WITH GRASSES AND CLOVERS.

Five distinct tests have been made at the College in comparing twenty-one different mixtures of grasses and clovers for hay production. One test was started in 1897, one in 1898, two in 1900, and one in 1906. Each of these tests have been completed with the exception of the last one mentioned, which will be finished in 1908. Crops of green fodder and of hay were obtained from the four tests in each of two years. Alfalfa was included in seven of the mixtures. Of the twenty-one different combinations the six highest yielders of hay contained Alfalfa—the greatest yield being produced by the mixture of Alfalfa and tall oat grass. The details of the entire experiment will not be presented until after the results of 1908 have been secured. The following table, however, gives the average annual yield in tons of green fodder and of hay per acre of four of the mixtures in the four tests already completed:—

Mixtures.	Green Fodder.	Hay.
Alfalfa and Tall Oat Grass.....	15.17	4.41
Alfalfa and Timothy.....	13.80	4.00
Common Red Clover and Tall Oat Grass.....	10.71	3.39
Common Red Clover and Timothy.....	10.99	3.20

Although Alfalfa and tall oat grass gave an average annual yield of 1.2 tons of hay per acre more than common red clover and timothy, it is doubtful if even this mixture will equal Alfalfa alone for hay production.

Permanent pastures have never occupied as prominent a place in the agriculture of Ontario as they have in the agriculture of Great Britain. The scarcity of labor and the great development of our live stock industry are factors which are causing some of our most thoughtful farmers to consider the advisability of securing a first-class permanent pasture instead of relying so much on timothy for pasture purposes. Fields which are located long distances from the farm buildings or which are difficult to work on account of the presence of steep hill-sides, crooked rivulets, low spots, etc., might be converted into permanent pastures and thus prove of great economic value. This arrangement would not interfere materially with the regular crop rotation of the farm. From more than twenty years' work in testing different varieties of grasses and clovers, both singly and in combination, I would suggest the following mixture for permanent pasture on an average soil in Ontario: Alfalfa, 5 lbs.;

alsike clover, 2 lbs. ; white clover, 2 lbs. ; meadow " 4 lbs. ; orchard grass, 4 lbs. ; tall oat grass, 3 lbs. ; meadow foxtail, 2 lbs. ; and timothy, 2 lbs. ; thus making a total of 24 pounds of seed per acre. These varieties are all very hardy. Some of those used in Great Britain are not permanent in this country. None of the smaller growing varieties, such as the blue grasses and the bent grasses are mentioned, as there is scarcely a farm in Ontario in which the Canadian blue grass, the Kentucky blue grass or the red top will not grow naturally. The varieties here recommended are strong vigorous growers. Some of them produce pasture very early in the spring and others later in the season. Most of the varieties are superior to timothy in producing a growth during the hot, dry weather which occasionally occurs in the months of July and August. The seed can be sown in the early spring either alone or with a light seeding of spring wheat or of barley. Such a mixture as this when well established on suitable land should furnish a pasture, abundant in growth, excellent in quality, and permanent in character.

CONCLUSION.

Alfalfa should be very carefully tested on many farms throughout Ontario. Its large yields of nutritious feed for farm stock, its perennial character of growth, and its beneficial influence on the soil, are all features which commend it very highly for those farms on which it can be grown successfully.

There are different ways of laying down a plot or a field to Alfalfa, and we would suggest the following method as one which is likely to give very excellent results. Select land having a clean, mellow, fertile surface soil overlying a deeply drained subsoil having no acidity. Use large, plump seed, free from impurities and strong in germinating power. Inoculate the seed with the proper kind of bacteria, providing Alfalfa has not been grown successfully on the land in recent years. As early in the spring as the land is dry enough and warm enough to be worked to good advantage, make a suitable seed-bed and immediately sow about twenty pounds of Alfalfa seed per acre from the grass seed box placed in front of the grain drill, and about one bushel of spring wheat or of barley per acre from the tubes of the drill. Smooth the land with a light harrow or with a weeder, and if it is very loose and rather dry, also roll it and again go over it with the harrow or the weeder. As soon as ripe, cut the grain and avoid leaving it on the land longer than necessary. Give the Alfalfa plants every opportunity to get a good start in the autumn in preparation for the winter. If for hay, cut each crop of Alfalfa in the following year as soon as it starts to bloom. In curing, try to retain as many of the leaves on the stems as possible, and to protect the crop from rain. Never cut or pasture Alfalfa sufficiently close to the ground to remove the crowns of the roots, and thus injure or possibly kill the plants. If these directions are followed, the Alfalfa may be expected to produce large and valuable crops for a number of years without re-seeding.

