A Legume for Acid Soils
LOTUS ULIGINOSUS
(L. major)

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Foreword

The need for a legume that will thrive and live a long time under certain adverse conditions has long been recognized. Such a legume should (1) be able to grow on a reasonably acid soil, (2) be able to stand the moderate amounts of flooding during winter months common in many high rainfall areas, (3) be able to grow and improve soils low in soil fertility and organic matter, and (4) be palatable to livestock and withstand heavy grazing.

Such a legume has been found in Lotus major, sometimes known as Big Trefoil, and the use of this crop is being rapidly accepted along the coast in Oregon and Washington. This crop, introduced from Europe by the U. S. Department of Agriculture and under trial at the John Jacob Astor Branch Experiment Station at Astoria, Oregon, for the past 25 years, promises a radical change in agricultural production in the areas where adapted.

This bulletin reports on these trials and gives instructions for growing and harvesting this crop.

Wm. A. Schoenfeld
Dean and Director

Picture on cover—

Figure 1. Dairy cows on Lotus major pasture on tideland pasture at John Jacob Astor Experiment Station, Astoria, Oregon.
A Legume for Acid Soils*

LOTUS ULIGINOSUS

(L. major)

by

H. B. Howell†

Introduction

LOTUS ULIGINOSUS, Schkuhr is quite commonly referred to as Lotus major in the Pacific Northwest. It is a legume that has been grown in a limited way in some of the European countries for more than a century. It is of recognized forage value in the British Isles, Denmark, Germany, France, Italy, and some of the other southern European countries according to McKee and Schoth (1). They state that in the northern European countries it is used primarily for pasture purposes while in southern Europe it is used for pasture, forage, and seed. It has been introduced into Australia and New Zealand in the past 25 years and is being grown commercially there under certain conditions. Levy (2) (3) reports that “the introduction of Lotus major and bent grasses to wet hill country has in many instances turned failure to success.”

Lotus major, sometimes known as Big Trefoil, should not be confused with Lotus corniculatus, known also as Birdsfoot Trefoil.

Description and varietal differences

Lotus major is a very long-lived herbaceous perennial with very vigorous underground spreading stems or rhizomes. In common with other legumes it is able, through the nitrifying bacteria which are present in the nodules on the roots, to make possible the fixation of large quantities of atmospheric nitrogen. Lotus major more nearly resembles fine stemmed alfalfa than any other plant. Instead of the plants thinning as they get older and the stems getting coarser, the underground spreading root stocks keep sending up new stems, and as a result the stems generally stay fine. The plants under ordi-

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The author acknowledges the assistance of H. A. Schoth, Senior Agronomist, U. S. Department of Agriculture, Corvallis, Oregon, who furnished the original seed, has cooperated in the entire program, and who assisted by reviewing the manuscript; also the assistance given by Dr. D. D. Hill, Head, Farm Crops Department, Oregon State College, in reviewing the manuscript. The late George R. Hyslop, Head, Division of Plant Industries, Oregon State College, aided very materially by many suggestions.
The photographs for Figures 1, 5, 6, 10, 11, 12, and 17 were supplied by John Burtner, Director of News Bureau, Oregon State College. Figure 14 was furnished by Ben Buisman, Editor, Oregon Grange Bulletin. Other photographs are by the author.
†Superintendent, John Jacob Astor Branch Experiment Station, Astoria.
nary conditions grow 24 to 36 inches tall, but with the fine stems it does not stand up too well unless supported by vigorous growing grasses. (See Figure 2.) Each leaf has three leaflets, borne at the end of a short petiole, and two leaflets on the main stem at the base of the petiole. The flowers are a brilliant yellow. Seeds are very small, a trifle smaller than white clover, and average one million seeds per pound.

Figure 2. Lotus major planted with grasses on left and planted alone on right. Grasses with stiff stems help in holding Lotus major erect for better mowing.

_Lotus corniculatus_ should not be confused with _Lotus major_. It appears to thrive under quite different conditions. It is a tap rooted plant, which thrives under drier conditions, and stands colder winters. There are many indications that it also will not stand as high soil acidity as will _Lotus major_.

McKee and Schoth (1) give the following description of varieties and forms: "The characteristics that distinguish _Lotus corniculatus_ and _Lotus uliginosis_ (major) from all other _Lotus_ species are as follows: Styles not dentate; flowers yellow; calyx campanulate;
teeth equal and equaling the tube: leaves not dotted or revolute: banner equaling the wings and keel: bracts three: stem or keel shorter than keel.

"The only characteristics definitely distinguishing the two species are the rhizomes and flowers. The definite features of these are as follows:

"Flowers usually 8 to 12 (rarely 6 to 7) Rhizomes spreading L. uliginosis
"Flowers 5, sometimes 6 and 7 Rhizomes not spreading L. corniculatus

"Lotus uliginosis is only moderately variable and but two varieties have been described. The following key gives the characteristics separating these:

"Plants smooth or nearly so—var. glabriusculus Bab.
"Plants hairy—var. villosus (Thuill.) LaMotte.

"Lotus corniculatus is extremely variable and a large number of varieties have been described."

It is the opinion of the author that other varieties of Lotus major will be recognized and described from time to time. Principal seed stocks available in the past have been largely of the variety villosus, although stocks of the variety glabriusculus are increasing.

History

Lotus major was first introduced at the John Jacob Astor Branch Experiment Station, at Astoria, Oregon, in 1923 when a small amount of seed of one of the varieties (Lotus uliginosis var. glabriusculus) was sent for trial by H. A. Schooth, Agronomist, U. S. Department of Agriculture, stationed at Corvallis, Oregon. All of the trials reported in this bulletin have been carried on under this same cooperation. This new legume was originally planted on the low and rather wet tidelands of the John Jacob Astor Station and persisted in the small plot under pasture and other uses until 1943, when it was plowed up in line with development work.

In 1935, the Lotus still dominated the plant population, indicating its successful resistance to the encroachment of native and introduced grasses. Seed of this planting was saved for the first time in 1935 and subsequently many root cuttings were taken from this plot. Present seed stocks of all locally produced seed of this variety have come from this source. Figure 3 shows a portion of this original planting 20 years of age.

During the years 1935 to 1939 the original planting and others made from it attracted so much attention that efforts were made to find additional seed supplies. As a result, importations were made in 1939 through commercial channels from seed firms in France and
Figure 3. Stand of *Lotus major* twenty years after planting, growing on land subject to winter overflow and used for hay, silage, and pasture during this period.

The British Isles. These importations proved to be entirely of *Lotus uliginosis* var. *villosus*. Up to that time no attention was being given to varietal differences. In more recent years a few small importations of seed have been made from Australia although importations from there are difficult because of certain noxious weeds generally present.

Other introductions of *Lotus major* have been made into several sections of the Pacific Northwest. Efforts to trace these to any definite plantings have failed. They were probably introduced as foreign seeds in imported clover seeds.
One of the plantings near Rosburg, Washington, on the north shore of the Columbia River, was first identified about 1914 and has since spread over an area of some 200 to 300 acres without any seeding being done. It is relished by cattle and very well regarded by farmers in that area.

Another such introduction, of years standing, is in the Loon Lake area of western Douglas County, Oregon, not far from the Pacific Ocean. Both of these plantings are of the variety *glabriusculus*.

Climatic conditions in these coastal areas are moderate. Rainfall varies from 60 to 80 inches annually, most of it occurring from October to May with rainfall too low during the summer season for

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**Figure 4.** Lotus major growing in wet spot on cut-over land. Water stands in these spots for about 4 months during the winter. As water recedes the crop will start growing.
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maximum crop production. Winter temperatures seldom fall below 20 degrees F. Trial plantings of Lotus major have withstood winter temperatures of zero. In the past few years Lotus major has been successfully grown in Oregon in the Willamette Valley, mostly in Clackamas County, where rainfall averages about 45 inches annually.

Adaptions and Uses of the Two Varieties

Both varieties of Lotus major are readily eaten by all classes of livestock, as pasture, silage, and hay. In the pasture stage in particular there seems to be a preference by livestock for the smooth type (var. glabriusculus). Along the Oregon coast Lotus major has been grown under varying conditions. On low lands it has the ability to withstand long periods of surface flooding after the plants are well established. Instances of it being covered by surface water for three months or more without damage to the stands have been observed, although practically no growth is made during the time it is submerged. This has been during the winter or dormant season. Figure 4 shows plants of Lotus major emerging in the spring after being covered with water for more than three months. Figure 5 shows the characteristic tussock growth of wet lands being invaded by Lotus major; at the right is the same plant after digging, showing the white Lotus roots spreading into the tussock roots.

On these low lands it has been observed that Lotus major will stand more flooding than Astoria bent grass and as much as Seaside bent grass. It has also been grown successfully in combination with Reed Canary grass. Figure 6 shows Lotus major on low land

Figure 5. Lotus major will grow with tussock clumps. On left, it is growing into a clump. At right, the same plant has been pulled to show the white underground creeping roots of Lotus major. Tussocks are one of the worst weed problems on wet lands. They are seldom grazed except by horses when feed is very short.
A LEGUME FOR ACID SOILS

Figure 6. Lotus major and Reed Canary grass growing on low lands at the Astor Experiment Station.

successfully competing with Reed Canary grass. Flooding with brackish water for short periods apparently did no injury to the Lotus plants.

On upland soils in this area that remain relatively moist throughout the summer months, Lotus major is a very promising legume.

On these lands of low natural fertility, it has a very stimulating effect on the yields of grasses grown with it. Identical mixtures of grasses with and without Lotus major have shown that the legume and its effect on grasses increased the total yield from two to three times. See Figure 7.

Just how extensively this crop may prove adapted to various parts of the United States is not as yet definitely known. MeKee (1) reports that it shows promise in the southeastern part of the country and in his bulletin makes a report on old trials as far north as Massachusetts. There have been a number of successful plantings in western Washington and in northern California along the coast.

Lovvorn in North Carolina and Ritchie in Florida report that preliminary trials look very well under certain conditions.
H. A. McDonald (6) in his very comprehensive work on Birdsoot Trefoil (*Lotus corniculatus* L.) makes many references to Lotus major (*Lotus uliginosis*) but concludes that it is not as well adapted to New York as is Birdsoot Trefoil.

**Obtaining a Stand**

**Soil and fertilizer requirements**

Lotus major is commonly grown on hundreds of acres of naturally acid soil as a result of research at the J. J. Astor Station. Trials of limestone on it have failed to give any improvement either

Figure 7. Lotus major with grass on left of log produced three times as much feed as same grasses on right of log. Lotus planted 2 years after the grasses were seeded. The stand is now 10 years old.
in securing stands or in yields. (This has not been indicated as the effect on *Lotus corniculatus*). It was found that it could be grown on soils of pH 4.5 to 5.5 without limestone and there is some indication that this range of acidity is preferred by the plant to soils more nearly neutral or alkaline. Experimental work now in progress indicates that more attention should be given to the acidity of the soil planted to various legumes. Acidity ranges may be one of the determining factors relating to the use of Lotus major in various plantings. On soils of pH 5.2 and lower, stands of Lotus major have been obtained easily.

Experiments show that the use of phosphorus carrying fertilizers has a slight stimulating effect on Lotus major. This is commonly expected on all legumes in the coastal section of Oregon, although successful stands have been obtained and maintained without it. On the poorer hill soils nitrogen at the rate of 20 to 40 pounds of actual nitrogen per acre and phosphorus at the rate of 50 to 60 pounds phosphoric acid per acre were beneficial in obtaining stands of both Lotus major and companion grasses. There is considerable experimental evidence that Lotus major will grow at lower fertility levels and at higher acidity than any other common legume, although it will naturally do better on soils of relatively high fertility levels.

This crop has not been particular as to soil type. It grows successfully on a range of soils including the older sand dune lands near the coast, the silt loam soils of the Melbourne series common to the coast foothills, and on heavier clay tideland soils which always have a high water table and often have surface water during the winter months. Figure 8 shows the flood condition during the winter months of land at the J. J. Astor Station on which Lotus major is being grown. This condition occurs several times during the winter and generally lasts three to ten days at a time.

**Seedbed preparation**

The preparation of the seedbed has proved to be one of the most important points in obtaining stands of Lotus major. The seeds, as indicated previously, are very small and if covered more than $\frac{1}{4}$ inch deep the sprout often will not reach the surface of the soil. Surface planting under most conditions has given best results and is recommended.

This means very thorough seedbed preparation, combined with a cultural program to compact the soil until it is very firm. This can be accomplished by a drag, float, or roller. It is practically impossible to get the seedbed too firm or too fine. The use of a cor-
Figure 8. Typical diked tideland common to Oregon coast. This land floods during heavy rains in winter, water remaining 3 to 10 days. This land is now growing Lotus major.

rugated roller prior to seeding is a good practice, but use of a roller after seeding puts seed in too deep. A common rule is that in walking over the prepared seed bed a man should not make footprints deeper than a thin shoe sole. Many instances of failures to obtain stands of Lotus major can be attributed to loose seedbeds. In examining poor stands it has often been observed that when a truck or tractor has been run over the ground prior to planting good stands result in these tracks even though the rest of the planting fails. Good stands have been obtained on cut-over timber lands by early spring seedings without any seedbed preparation. Care must be taken, however, to control native growth by grazing to prevent the shading out of the small seedling Lotus plants.

Dates of seeding

Lotus major like many other long-lived plants does not establish itself rapidly. The seeds being small have little stored food; the seedlings start slowly and do not generally begin to develop underground stems or rhizomes until about a year after planting. Because of this slowness in getting established, early spring planting is desirable, and along the Oregon coast the best time is from March 1 to April 1. Fall planting has not proved successful as even light frosts tend to heave the young seedlings out of the ground. In a few
instances the hard seed in fall plantings has held over and germinated in the spring, resulting in partial stands.

When sown in mixtures with grasses, as is generally recommended, the young Lotus major plants should be at least partly protected to prevent them from being crowded or shaded out by the grass. Pasturing or clipping back may be needed to keep the grasses in check the first year. Pasturing 30 to 60 days after seeding has not proved detrimental to the Lotus.

The use of any grain crop as a nurse crop is not recommended as it generally results in failure to obtain stands of Lotus major.

**Rate of seeding**

There are about one million seeds per pound of Lotus major and for each pound seeded per acre there will be about 23 seeds per square foot. Rate-of-planting trials at this Station varying from 1½ pounds to 10 pounds per acre have given identical stands and yields. Experience indicates that 2 pounds per acre with adapted grasses gives satisfactory stands. If seeding alone is practiced the use of 3 to 4 pounds per acre is desirable.

**Transplanting**

Another method of obtaining stands is by transplanting plants or root cuttings. While this requires more labor, stands are generally obtained much faster than by use of seed. As the crop when established lasts from 10 to 25 years, transplanting is not too laborious or expensive a method. Root cuttings should be set (using either the hand method or a mechanical transplanter) about 2 feet by 2 feet during spring months. Another method of obtaining plants is to wait until the top growth is about 8 to 10 inches high and grasp handfuls of the tops near the ground and give a quick jerk. In this way most of the stems will come up with small roots attached. The tops are then cut partly back to prevent excessive wilting before setting out. Cultivation of the transplanted plants during the first summer is desirable and then planting to grass seed in the fall will help control weed growth. Figure 9 shows a transplant similar to one set out on the left and the resulting plant on the right two years later. At the right is a closer view of the same plant with some of the underground spreading stems indicated.

The transplanting method used at the J. J. Astor Station has made it possible to increase rapidly Lotus major plants of superior characteristics.

**Inoculation**

Lotus major requires inoculation for successful growth. Lack of inoculation has resulted in many failures. This legume requires
its own special inoculant and is not inoculated by any of the other common legume inoculants. Because the soil has grown clovers or alfalfa well previously is not an indication that Lotus major planted on this soil will be inoculated. In a few isolated cases where native Lotus plants grow stands have become inoculated. Inoculation of the seed is inexpensive, however, and is good insurance in securing a stand.

*Lotus corniculatus* does not cross-inoculate with Lotus major and vice versa.

With lack of inoculation the plants turn yellow and look unthrifty when 2 or 3 inches high, and no nodules can be found on examination of the roots. These conditions may sometimes be corrected, if treated promptly. If inoculated soil is broadcast over the area and if there is rain following, some inoculation of existing plants may result. This requires more soil, is more expensive than treating the seeds originally, and is less satisfactory.

There are two principal methods of inoculating the seed: one with pure culture, and the other with soil. Soil inoculation has given
much better results in experimental work at the J. J. Astor Station and by farmers than the use of pure culture. The soil inoculating method is simple and easy. Obtain soil from the surface few inches of a field growing Lotus major satisfactorily and use at the rate of 1 pound of soil to 10 pounds of seed. Mix soil and seed thoroughly, adding just enough water or skim milk so that by rubbing the seed becomes covered with a coating of the soil. Treatment a few hours or the night before seeding will allow the seed to dry sufficiently so that it does not stick together. Putting the inoculated seed through a fly screen before mixing with grass seed or planting will help break up small lumps.

Another method of soil inoculation is to mix enough water with the soil so that there is a small amount of free water and then sprinkle this over the seed and mix. Use just enough of this muddy water to moisten the seed and not leave any free water, then spread seed out to dry.

In any inoculation treatment keep seed out of direct sunlight and if possible plant on a cloudy day.

**Grass Mixtures**

The kinds of grasses to use in mixtures with Lotus major depend on a number of conditions, such as the ultimate use of the crop, soil moisture, fertility, and crop competition. In many areas where Lotus major is adapted native grasses and weeds furnish very heavy competition. While these may not crowd out the legume if kept under control during the seedling stage, they are less desirable than are many other plants.

For seed production purposes, the use of a single grass with the Lotus major will result in partial recovery of pure grass seed as well as that of the legume. On wet land meadow foxtail is an excellent grass. Wet lands previously in bent grasses or where bent grass may volunteer may be seeded to bent and Lotus major. Seed of either of these grasses is easily separated in the cleaning process. Where seed production is the objective the use of timothy is not recommended as it is difficult to separate in cleaning.

Seed production on drier uplands may well include Alta fescue. This grass with a stiffer growth will help hold up the Lotus major and make harvesting easier.

For pasture and forage purposes it is desirable to use a mixture of such grasses as common and perennial rye, Alta fescue, orchard, meadow foxtail, and others as adapted to the particular locations.

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1See Oregon State College Station Bulletin 433, *Meadow Foxtail.*
2See Oregon State College Station Bulletin 427, *Alta Fescue.*
Figure 10. Bracken fern infests over one million acres in western Oregon and is a constant fire hazard to adjoining homes and farm buildings. Lotus major in mixtures with proper grasses, particularly alta and creeping red fescues, will crowd out fern in 4 or 5 years. Subterranean clover is shaded out in such heavy growth unless pastured. The crop shown above was cut for seed of Lotus major.

For use on bracken fern lands, creeping red fescue is very desirable in making a heavy sod to help keep down the fern growth. Lotus major with this fescue and also with Alta fescue has made possible satisfactory forage production on thousands of acres of bracken fern lands in western Oregon and western Washington. Figure 10 shows Lotus major and grasses growing on fern land.

Suggested mixtures for some of the foregoing conditions are as follows:

**For Seed Production**

<table>
<thead>
<tr>
<th>Wet land</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Meadow foxtail</td>
<td>8-10</td>
</tr>
<tr>
<td>Lotus major</td>
<td>2</td>
</tr>
<tr>
<td>(2) Astoria, Seaside or Highland bent</td>
<td>6-8</td>
</tr>
<tr>
<td>Lotus major</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drier uplands</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alta fescue</td>
<td>10-12</td>
</tr>
<tr>
<td>Lotus major</td>
<td>2</td>
</tr>
</tbody>
</table>
## For Pasture, Hay, and Silage

<table>
<thead>
<tr>
<th>Wet lands</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Meadow foxtail</td>
<td>4</td>
</tr>
<tr>
<td>Alta fescue</td>
<td>4</td>
</tr>
<tr>
<td>Perennial rye</td>
<td>4</td>
</tr>
<tr>
<td>Lotus major</td>
<td>2</td>
</tr>
<tr>
<td>White clover</td>
<td>2</td>
</tr>
</tbody>
</table>

### Drier lands

| (2) Perennial rye                 | 4      |
| Alta fescue                       | 4      |
| Orchard                           | 4      |
| Lotus major                       | 2      |
| Sub clover                        | 4      |

### Bracken fern lands

| Alta fescue                       | 6      |
| Creeping red fescue               | 6      |
| Perennial rye                     | 4      |
| Lotus major                       | 2      |

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### Methods of Seeding

Mixing seed of Lotus major and grasses (after inoculation of Lotus) aids in the even distribution of the small amount of the Lotus seed. If care is taken, however, the small amounts of Lotus major seed may be distributed by the use of a carefully regulated wheelbarrow seeder (use care to plug or tape all small openings), or a Cahoon type broadcast seeder.

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### Utilizing the Crop

#### Pasture

One of the major problems in pastures on the acid soils of the coastal area is to maintain a stand of most legumes. Many of the soils require as much as 2 tons of limestone per acre every five years to get a satisfactory stand of legumes and even then the grass competition during winter months is very severe. Pasturing too closely for the good of the livestock is really the only way of maintaining stands of most legumes on these soils. Lotus major during the 25 years it has been on trial at this station has successfully resisted the crowding of many grasses and has maintained a good stand without liming. While it makes practically no top growth during the winter months it makes a good growth during the growing season. Like other legumes it is eagerly sought after by all classes of livestock. Chemical analysis of Lotus major of pasture length (3 to 5 inches tall) showed a crude protein content of 28.5 per cent on a dry matter basis.

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1. See Oregon State College Station Bulletin 432, Growing Subclover in Oregon.
2. Analysis by Dr. J. R. Haag, Oregon Agricultural Experiment Station.
Even the closest pasturing by sheep over extended periods has not affected the stands. There has been no evidence of hydrocyanic acid poisoning either in pasture or in the hay stage. (4)

Bloat of cattle and sheep pastured on mixed Lotus major and grasses has not been reported, but it is believed bloat might occur on pure stands under just the right conditions, and care should be used in pasturing pure stands.

Pasture on cut-over lands

Lotus major has shown more promise than any other legume for seeding on cut-over timber lands. These lands, which formerly

Figure 11. Lotus major and grasses growing on cut-over land at 1,200 feet elevation. This soil is strongly acid and there is no practicable method of distributing lime.
Figure 12. Visitors examining Lotus major planting on logged off land while plants are in bloom. Only practicable method of seeding was to scatter seeds on top of ground in early spring, then after 50 to 60 days graze to keep competitive plants from shading out small seedlings.

grew fir, hemlock, and Western red cedar trees up to seven feet in diameter, are almost universally quite acid and there is no practicable way to apply lime because of the contour and logs and stumps. The acidity of these lands generally varies between pH 4.7 and pH 5.7. Seedings of Lotus major on these lands made ten years ago have continued to improve and are competing successfully with the bent grasses and fescues which comprise the principal ground cover. Seedings on these lands have been made during March and all seed has been sown on the surface without any seedbed preparation.

Silage

It is a common practice in the coastal section of Oregon for farmers to make multiple use of seeded grass and legume areas. For example, a field may be pastured in the spring, then allowed to grow up for silage harvest, to be followed by a light hay crop or a seed crop, and finally pastured in the late fall. The use of grass and legume silage is definitely on the increase and the mixtures previously given have been used for this purpose. It is a common practice to cut Lotus major and grass stands during late May for silage and then to harvest a follow up crop of hay or seed. Yields of
silage at this time have averaged about 10 tons per acre. Silage of this type made from immature growth is very palatable and has in many cases been used as the exclusive roughage ration for both dairy and beef cattle. This silage has averaged 12 to 15 per cent crude protein on a dry matter basis.

**Hay**

When cut at an appropriate stage of maturity, hay made from Lotus major compares favorably with alfalfa hay. Analyses* of four samples of dried Lotus major are tabulated below:

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Description</th>
<th>Crude protein</th>
<th>Calcium</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>7444</td>
<td>Cut 5-29-44 (10-12 inches high)</td>
<td>21.02</td>
<td>0.904</td>
<td>0.391</td>
</tr>
<tr>
<td>7454</td>
<td>Cut 9-20-43</td>
<td>17.05</td>
<td>0.452</td>
<td>0.291</td>
</tr>
<tr>
<td>7452</td>
<td>Cut 9-20-43</td>
<td>16.30</td>
<td>0.450</td>
<td>0.244</td>
</tr>
<tr>
<td>7453</td>
<td>Cut 9-20-43</td>
<td>14.87</td>
<td>0.546</td>
<td>0.230</td>
</tr>
</tbody>
</table>

The calcium contents appear to be significantly lower than those of alfalfa hay. This may be explained by the ability of Lotus major to grow on more acid soils.

**Yields Compared to Other Legumes**

It is not the purpose to convey the idea that Lotus major will or should replace many of our standard legumes but instead that it be used where production of other legumes is not satisfactory or where the Lotus may prove to be better adapted. It is hard to compare with alfalfa because alfalfa will not grow on these acid soils. As stated elsewhere it compares favorably with alfalfa in feeding value. Yields of Lotus major and grasses are comparable with alfalfa in dry matter per acre.

Where Ladino clover thrives and lasts reasonably well it has quicker regrowth after cutting or pasturing than has Lotus major and probably will outyield it. The difficulty of such comparisons is that where one crop, like Lotus major, does well the others do not do so well. At the J. J. Astor Station, Ladino clover stands last only two years, even after heavy liming.

**Seed Production and Harvesting**

Seed production has been carried on at the J. J. Astor Station for the past 12 years. While climatic conditions for harvesting are not too favorable, satisfactory yields have been obtained except for one year (1941) when unfavorable weather conditions resulted in the loss of over half the crop.

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*Analyses furnished by J. R. Haag, Department of Agricultural Chemistry, Oregon Agricultural Experiment Station.*
Seed yields have varied from 75 to 225 pounds per acre, with an average of 127 pounds. The variety *villosus* is a much heavier seed yielder than the variety *glabriusculus*, generally yielding two to three times as much seed. This is largely due to the fact that the lighter yielding one seems to continue growth and does not set seed so well. Insect activity may have an influence on this point.

It is generally thought by research workers that *Lotus major* is self-sterile in seed setting. However, Silow (5) reports: “Plants of *Lotus major* are, on the whole, incapable of spontaneous self-pollination; but after artificial self-pollination practically all plants are self-fertile, some to a very high degree. Thus this perennial species is almost entirely dependent upon insect visitors for seed formation.”

Cross-pollination probably results in the wide range of types observed in *Lotus major*. Under conditions of plentiful moisture the *Lotus major* plant continues to grow and bloom after the first blossoms are set and the seed crop is ready to harvest. This makes harvesting conditions difficult as the seed shatters very easily after maturity. On drier soils this continued growth is not so great, but the seed shatters easily. It is generally cut just as the first seed pods begin to shatter. To observe this condition the grower must watch carefully as the shattered pods merely twist up and are practically

Figure 13. Foliage, ripening seed pods, and blossoms, all on same plant show wide range of maturity.
the same shape as before shattering. Figures 13 and 14 show mature seed pods and blossoms on the same plants.

Mowing for seed while the plants are somewhat moist with dew will reduce shattering. On drier lands it is best to windrow with a swather on the mower and thresh with a combine harvester. On wetter lands it is generally necessary to turn the crop by hand to facilitate drying. Use of the side delivery rake is not advised as it shatters the seed badly. Harvesting standing with combine harvesters is not advised. Instead it is cut, raked with a dump rake, shocked, and then brought to the thresher with buck rakes. The use of field harvesters to gather the material in the semigreen condition in the field followed by drying by artificial means has been tried and offers possibilities as long as the seed is high priced. This reduces loss from shattering and has been quite profitable.

Lotus major threshes easily but care must be taken to see that the wind is so adjusted that seed does not blow over with the straw. Ordinary seed cleaning machinery is used to clean the seed.
The seed is almost round. It is yellowish green in color with some color variations and has a tendency to get darker with age. The average germination test is from 40 per cent to 60 per cent in 10 days and runs 30 per cent to 50 per cent hard seeds with a total germination of 85 per cent to 95 per cent. In many cases it has been observed that these hard seeds and later germination have been a help rather than a handicap in getting stands.

Seed of Lotus major is now being commercially grown in Clatsop County, Oregon, near Astoria, and in Clackamas County, Oregon, near Oregon City. The production of seed has been increasing annually during the past five years and in 1947 was estimated at about 40,000 pounds in these two areas.

Eradication

Because the root system of Lotus major is somewhat like that of blue grass, bent grass, or quack grass, many questions have been raised as to whether it might be hard to eradicate. A few trials have been made in this connection and while it is not as easy to kill as some plants it does not compare to quack grass. Moderately deep fall plowing followed by spring cultivation before planting results in

Figure 15. Field of Lotus major in full flower and being heavily worked by honeybees. This is the second crop after removing first crop for silage.
killing most plants. A cultivated crop the year after plowing will clean it up very well. It is felt that it is not much harder to kill Lotus major on many of our soils than it is to kill white clover.

**Bee Pasture**

No definite experimental work has been done on the amount of nectar obtained from Lotus major, but it apparently furnishes much feed. Honeybees feed on it extensively and the honey is of fine quality. MacDonald (6) reports the only insects that cause pollination are bumblebees and honeybees. A field of Lotus major in full flower is almost a solid yellow as is shown in Figure 15.

**Diseases and Insects**

Lotus major thus far has not been beset with many enemies although they may probably be expected to increase as the acreage increases.

Stern rot has been observed on it but since this generally appears before seeding time it has not seriously affected the seedlings and by the next year the underground stems have started to spread. Many times it strikes a portion of the plant but does not kill the entire plant. It has not been severe enough to be considered a very serious factor.

The common garden slug has sometimes bothered seedlings but generally is not bad on spring seedlings. In one instance cutworms almost completely destroyed a small area of transplanted plants. Common control practices for these insects should be applied.

**Points to Remember in Growing Lotus Major**

- Lotus major starts slowly from seed and the plants may need some protection from being smothered or crowded out the first year. Grain nurse crops are not advised.
  - Inoculation is absolutely necessary.
  - A very firm fine seed bed is necessary. Seed shallow.
  - Spring planting is much better than fall planting.
  - It takes about a year for this plant to become well established.
  - It does not make much growth in the winter and may be hard to observe during the winter months.
Literature Cited

(1) McKee, Roland, and Schoth, H. A.
    1942. Birdsfoot and Big Trefoil, Cir. 625, U. S. Department of
    Agriculture.

(2) Levy, E. Bruce
    Illus.

(3) Levy, E. Bruce
    1937. The Conversion of Rain Forest to Grassland in New Zealand.

(4) McKee, Roland

(5) Silow, R. A.
    (Bul.) Series H; 12:234-240.

(6) MacDonald, H. A.
    1946. Birdsfoot Trefoil (Lotus corniculatus L), Its Characteristics
    and Potentialities as a Forage Legume, Cornell University
    Memoir 261.