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UNIVERSITY OF WYOMING
AGRICULTURAL
EXPERIMENT STATION

NATRONA COUNTY SUNFLOWERS

SUNFLOWERS
THEIR CULTURE AND USE

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Sunflowers—Their Culture and Use

A. F. VASS

INTRODUCTION

Wyoming is primarily a livestock state, which makes the question of forage a most important one. As one rancher has said, "it is not so much the low price he receives for his critters," as the high price that he must pay for feed during the drought years that makes the livestock business the gamble that it has been. Overstocking followed by drought years and severe winters has been the cause of most of the failures in the stock business.

The changes that the livestock business has undergone in its stages of development are clearly set forth in an earlier publication by Knight (1905). In the initial stage, the forage was accepted as it was found. No attempt was made to improve it in quality or quantity. The object was simply to develop and control enough stock to consume it. The range was absolutely open and the stock roamed at will, unmolested but for the annual and semi-annual round-ups. The limit was soon reached by overstocking which resulted in disastrous losses. The stockmen realized that something must be done to increase the forage supply. Naturally the first thought that suggested itself was the control and irrigation of certain favorably situated lands. These irrigated areas were fenced off and used as winter pasture. This was the second stage in the development of the industry. It required a number of years to develop the fact that it would pay to put up hay, and it was first used as an emergency measure to carry stock through adverse conditions. Gradually, the stockmen realized that they must produce more winter feed. This, the fourth distinctive period in the business, saw most of the lands upon which water could readily be placed, enclosed and occupied. With these conditions, the handling of stock demanded new methods. The public domain was denuded on the approach of autumn. The fifth period, the one we are now in, is one in which
the rancher has become both a producer of livestock and of crops. The animals are run on the range during the summer and fed during the winter. This calls for forage crops with good yields and feeding qualities for winter feed. Especially is this necessary for dairy animals and young stock.

Corn, the great grain and forage crop of the Middle West, is not such a good yielder in the Rocky Mountain region where the high altitude shortens the growing season. The man who wishes to use a silo in order that he may save more of his feed for winter use, finds the corn plant a low yielder. What he wants is a high yielding crop with good feeding value. The one that seems to come the nearest to fulfilling these requirements is the sunflower. It is the best yielder of any crop grown for silage in the West.

Our stockmen have, in most cases, considered the growing and feeding of silage an unprofitable undertaking, but the time is near at hand when the silo is to be closely associated with profitable dairying and livestock feeding in this state. When hay is cheap and readily available, it is no doubt a more economical feed when used alone than when used with silage, for carrying range stock through the winter, but hay is not always cheap. The stockmen must figure on years of scarcity for they will come very often. It is these occasional years of high hay prices that take the profits of previous years and turn them into loss. A silo means a saving in hay, and a saving each year in hay means a surplus to carry the stock through the adverse year.

The winter losses due to starvation may be prevented to some extent by the use of the silo. The severe losses of cattle in the state due to exposure (starvation) in 1903 were sixty-seven per thousand; in 1910, forty per thousand; in 1912, eighty-one per thousand, and in 1916, fifty-one per thousand. The losses of sheep for the same periods were $115, 125, 150, and 70 per thousand, respectively. These severe losses, which in many cases, meant financial ruin for the stockmen, took place in the winter following unusually dry summers. They were, in most cases, the result of overstocking and lack of feed preservation. The rancher must in such cases, hold over some feed from the good years to carry him through the lean ones. The silo is a great aid in this
DESCRIPTION

The sunflower (Helianthus annuus) belongs to the order Compositae, and is an annual plant, meaning that it completes its life in one season. It is a tall, strong and large-flowered annual, familiar to many as an ornamental plant, or a weed. The plant has a stout, erect, herbaceous stem, one to three inches in diameter and five to twenty feet high, rough, hairy, a hispid, often purple-mottled, often without branches until near the top. Leaves are alternate except near the base of the stem, with rather stout petioles four to ten inches long, and three ribbed heart-shaped blades four to ten inches long and about two-thirds as wide, rough on both surfaces, coarsely and irregularly toothed on the margins and pointed at the apex. The plant produces from one to six heads, varying with the number of branches, and the heads range in diameter from four to twenty inches. The yellow ray flowers around the edge of the head vary in number from forty to eighty and these surround a center of dark or brown florets.

HISTORICAL

The wild sunflower (Helianthus annuus), from which the cultivated variety has been developed, is a native of North America. Wiley (1901) gives it as occurring in the Great Plains region from Nebraska to Northern Mexico. Many of the earlier botanists and writers of the present day credit it to Peru, but there is little evidence to support this view.

De Lobel (1576) gives a very good description of the sunflower and credits its origin to Peru. His description corresponds to our present garden variety which would seem to indicate that it was cultivated and used at that early date.

Geraide (1597) gives a very excellent description of the sunflower. He attributes its origin to Peru and states that in Spain and other warm regions the plants reach a height of 24 feet in one season.
Bauhin (1671) in his studies of the sunflower, reports the finding of 2,362 seeds in one head.

Gray (1883) concludes from his studies of the history of the plant that the present large or garden type must have been largely developed by the Indians before being introduced into Europe. That there has been little improvement or development in the sunflower is shown by the writing of Camerarius (1586). At that time the seeds measured 6 to 10 mm. in length, as large as those of ordinary varieties at the present time.

The New York Agricultural Experiment Station (1883) carried on some tests in regard to seed production. The kernels were planted four to a hill 42 by 44 inches apart and were cultivated the same as corn. They were planted the 18th of May, harvested in September and the seed taken out and measured in October. The yield was 50 bushels, weighing 23 pounds per bushel. Difficulty was experienced in curing the heads.

The Nebraska Experiment Station (1889) did some work but no yields were reported.

Crawford (1892) gives a very interesting account of the sunflower industry of Russia. The sunflower is sown either broadcast, or in rows; in the latter case the seeds should be placed about six inches apart. The huge heads, the thick stalks, and the large leaves of the sunflower would lead one to conclude that it would greatly impoverish the soil on which it is extensively grown, but the practice of many years proves to the contrary. Many Russian farmers report better yields of wheat following the sunflower than following other crops. The author points out the value of the long strong roots of the plant reaching the lower depth of the subsoil making it porous and thus distributing the richness of the earth below even better than by plowing. He estimates that the roots leave 2,000 pounds of manure per acre in the soil. A peculiarity of the plant is that the leaves remain green even after the seeds are ripe. It is claimed the sunflower cultivated in low, unhealthy swampy or malarious districts prevents spreading of miasmatic diseases.

The Vermont Agricultural Experiment Station (1893) carried on some investigations using the sunflower head for silage. The number of green pounds harvested per acre was 11,350 con-
sisting of 8,612 pounds of water and 2,738 pounds of dry matter. A chemical analysis of the dry matter was made. The plants were grown to furnish a portion of the fat for the Robertson mixture ensilage. They state that the stalks were too woody for use.

The experimental farms of Canada in 1893 reported on the chemical analyses of stalks and leaves and heads with seeds. Dr. Shutt concludes from his analyses that the stalks and leaves contain little nourishment, being low in albuminoids and fat, and containing a larger per cent of water. In later reports (1893-94) they give the yields of sunflower heads.

Bartlett (1895) in his report on sunflower heads and black peas as a silage crop gives the analysis of sunflower heads as compared to red clover, peas, and field corn. He concludes from his experiments that sunflower heads are not nearly as profitable a crop to raise as corn. The following year (1896) the same author reported the yield of sunflower heads at 13.5 tons per acre and of the entire plant at 24.4 tons per acre. The whole plant of the sunflower was used in mixtures with corn and beans. The author reported that the silage was well preserved and the cattle relished the large coarse sunflower stalks as much as they did the corn and concludes from his feeding experiment and chemical analysis that the sunflower (whole plant) should have a favorable position among coarse fodder plants for silage material. This is the first report we have on the use of the whole sunflower plant for silage.

Wiley (1901) concludes from his investigations that the sunflower makes a considerable draw on the elements of soil fertilizers; therefore, it should be cultivated with proper attention to fertilization in order that the fertility of the soil be maintained.

The oil of the sunflower is very palatable and makes, without refining, an excellent salad dressing.

The sunflower was first grown for ornamental purposes and occasionally for poultry feed. In Russia its seeds have long been used as a staple article of diet, because of the oil they contain. They may be eaten raw or roasted as peanuts are in America. Between 1830 and 1840 the sunflower oil began to be manufactured on a commercial scale in southern Russia and since that time a series of important industries based on the production of
oil and oil cake have been developed there. This has led to more prolific seed producing varieties. From this has arisen the name and variety, Mammoth Russian Sunflower.

As the result of the demand for plants having a high percent of oil, three leading varieties have been produced and generally grown in Russia—one with large white seeds, which is perhaps the best oil producer; one with small black seeds, which are sweeter and regarded as best for eating; and an intermediate form with striped seeds used both for eating and for the production of oil. Wiley reports that in the United States three principal varieties are grown for the production of seed. The common sunflower, with no distinguishing varietal name, has long been cultivated here, and is now found in gardens in all parts of the country. Its nodding heads are 8 to 16 inches in diameter, producing chiefly grey-brownish or striped seed. The Mammoth Russian is a recently introduced variety with heads 15 to 20 inches in diameter, producing seeds about one-half inch long, with black and brownish stripes or sometimes all white. The black giant, another variety, has heads 16 to 22 inches in diameter with rather thick black seeds about three-eighths of an inch long.

The sunflower has long been grown in this country for ornamental purposes and the wild form has been used by nature to give the boy, raised on the farm in the Middle West, employment during the summer months, for it is the weed that requires so much hand labor to eradicate. Although a native of the New World, we learned its real value from the experience of the farmers in Russia.

Waldron (1913) gives the following report on sunflowers grown at the Dickinson Sub-Station, North Dakota: "In the spring of 1913, Russian sunflower seed secured from Curve Brothers, Milwaukee, Wisconsin, was sown May 17th in rows three feet apart. On August 27th, a row of sunflowers was harvested and made a yield of field cured stalks and seeds of 4,356 tons per acre; the greatest weight of plants produced by any crop at the Dickinson Sub-Station any year. The clean seed yielded an equivalent of 606 pounds per acre or about 7% of the air cured material. The seed was found to weigh 25 pounds per bushel; 43.1% of the seeds was hulls and 56.9% kernels. They concluded
that there was very little use for the heavy amount of roughage
or sunflower stalks produced.

Arnett and Tretsven (1917) in their preliminary report, give
the results secured with sunflower silage. They found during the
short test that it was run that 3 3/4 pounds of sunflower silage was
equivalent to 1 pound of choice clover hay. No comparative
tests were made using other silage crops. No objectionable
flavors or changes in the milk could be detected.

An article appearing in the Farmer (1917) gives a discussion
of the sunflower plant. It is considered an exhaustive plant so
far as potash is concerned. An analysis of the ash shows the fol-
lowing constituents: potash 48, lime 10, magnesia 5, and phos-
phoric acid 10 per cent. The leaves may be used for fodder, fresh
or dry. The oil from the seed is of great value.

Audas (1918) gives some of the results that have been
secured by other investigators. The author recommends seeding
in rows three feet apart with plants 12, 18 or 24 inches apart in
the row.

In the tests made at Wisley (1917) it was found that the
plants grown on fairly rich soil made vigorous growth; whereas
those in the poorer soils made less growth. No records were
made by the committee due to the fact that most of the stocks of
red sunflower failed to come true from seed, and that none were
of conspicuous merit.

Linfield (1918) gives the results secured at the Montana
Station in 1916 and 1917. Yields of from 22 to 25 tons per acre
were secured. The author concludes that the Russian sunflower
makes a satisfactory forage for cattle whether fed as a soiling
crop or as ensilage. That it is our largest yielding forage crop,
producing fully two and one-half times as much forage as will
corn in our high valleys. It is, moreover, a crop that can be cul-
tivated, and later so thoroughly shades the ground that weeds get
a very poor chance to grow. It has one drawback in that it must
be run through an ensilage cutter before it can be used to advan-
tage as forage for cattle, and can only be cured in the silo for
winter use.

Knight (1918) secured yields of 23 tons per acre in com-
parison to about 14 tons of corn silage in the same experiment.
After harvesting, the sunflower was cut into pieces about \( \frac{3}{4} \) of an inch long with an ensilage cutter and placed in the silo. Later, it was fed in connection with alfalfa hay and rolled barley, to the University dairy herd with excellent results. The coarse stems and heads, including the seed, went through the proper stages of fermentation and worked up into a mealy, succulent pulp which was very palatable, and was entirely consumed by the stock.

Hopper (1919) gives the results secured in New York with sunflower silage. In the Otsego county tests, the sunflower was equal or almost equal to corn silage in sustaining milk flow. In three herds there was a slight increase in milk flow in passing from sunflowers to corn. In no case was there an increase in passing from corn to sunflowers. In one or two cases, the sunflower was not relished as much as the corn silage. The Lewis county tests showed that the sunflowers could stand considerable frost with little or no damage. A killing frost on September 10th, which took everything, struck the sunflowers so that on the following morning their heads were drooping badly. In a few days, however, the plants had straightened up and were apparently as good as ever, except for the lower leaves, which were killed. The author concludes from his limited tests that the sunflower is a crop that grows well under discouraging and adverse conditions; that it starts quickly and is sooner beyond the cultivator than corn; that it is not damaged, though retarded, by light frosts, and resists frosts better than corn; that it yielded \( 2\frac{1}{4} \) times the tonnage in silage per acre over corn; and that cows hold to their milk equally well. It does not flavor the milk in any way that can be noted. As between corn silage and sunflower silage, the cows will take the corn by preference.

Beverley (1919) recommends the growing of more sunflowers in New Zealand. He advises taking a crop of peas or potatoes first, and letting the sunflowers be the second crop off the land in the one season. The heaviest plant weighed in the Weraroa crop gave a total weight of 9 pounds, 7 ounces, made up of root, 1 pound, 5 ounces; stem, 4 pounds, 2 ounces; head, 4 pounds; 1,500 seeds from this head weighed 12 ounces. The author did not consider the advisability of using the stalks for silage.
Ray (1919) gives the results that have been secured by Colorado farmers. They seem to prefer a mixture of sunflowers and corn for silage. Fine cut silage is preferable. More care should be used in packing sunflowers than in packing corn. The sides should be kept about two feet lower than the center and well packed.

Stratton (1919) gives some of the results that have been secured with Russian thistle, sunflower, cactus, yucca and similar plants. One ton of sunflower silage was estimated to be worth one-third of a ton of alfalfa hay.

Webster (1919) gives the results secured by Montana farmers. Very favorable results were secured, both in yield and feeding value. The silo and sunflower will enable the dry-land farmer to not only keep more and better stock but will enable those who have never thought it possible to engage in dairying to do so with good results. He concludes that the sunflower is the coming forage crop for the Northwest or indeed for the whole world, as it seems to grow abundantly in all the places where it has been tried.

Vaux (1919) reports very favorable results in the feeding of sunflower silage to breeding ewes. The ewes were run on dry-land alfalfa and native grass pasture until about the first of January when they were brought into winter quarters and grazed on native grass during the day and returned to the sheds about 4 o'clock and then fed corn or sunflower silage. The sheep seemed to relish the sunflower silage even better than the corn. No difference could be noted in their condition.

Colley (1919) reports the work of the Demonstration Farm of the Canadian Pacific Railway at Strathmore, Alberta, which harvested 34.6 tons of sunflower per acre. This was the best yield reported from Western Canada, and was secured in a very favorable year under irrigation. They were also grown with great success on land not under irrigation. Professor G. H. Hutton of the Canadian Pacific Railway secured results that seemed to indicate the superiority of sunflower silage over corn, and oat and pea silage.

Neidig (1919) studied the fermentation of sunflower silage. His results showed that under proper conditions, sunflowers will
produce an acid ferment similar to that of corn. Abnormal fermentation took place when air was allowed to enter the sunflower silage, resulting in the formation of butyric acid instead of lactic acid. Chemical analysis showed that the sunflower silage compared very favorably with corn silage, and that it was a good substitute for the latter.

Atkinson (1919) reports the successful and satisfactory use of the sunflower for both feeding and silage purposes. Silage made from plants that were 30 per cent in bloom compared favorably in total digestible nutrients with corn silage made from immature corn. Little difficulty was experienced in getting stock to eat the sunflower silage. 2.5 to 3 pounds of sunflower silage were required to replace one pound of hay. Chopped green sunflowers, 30 to 40 per cent in bloom, were equal to chopped green corn in the roasting ear stage as a feeding crop for dairy cows.

Dean (1920) reporting on the work at the Oregon sub-station, found that under irrigation, the yield to the acre of the sunflowers was 28.4 tons, while the average for some 51 varieties of corn was 10.8, showing an increase of 163% in the amount of silage when the sunflower was used.

Harrison and Elles (1920) report some of the results secured at the Manitoba Agricultural College. Yields of from 30 to 40 tons per acre were secured. The silage was fed to the dairy cows in a feeding experiment, the cattle being fed on corn silage for one period, then the sunflower silage for the following period, followed again by the corn silage. The cows ate 40 pounds of the sunflower silage per head per day, and the milk flow showed a slight increase in favor of the sunflower ensilage, over the corn ensilage. The authors noted that the sunflower ensilage had a tendency to cause scouring of the stock unless carefully fed, and until the animals had become accustomed to it. They considered sunflowers a promising substitute for corn where the latter cannot be grown successfully.

The results that have been secured at the Manitoba Agricultural College (1920) show that (1) sunflowers, when mature to the extent of the seed being formed at the time of cutting, make a very succulent, palatable, and nutritious silage; (2) sunflower silage freezes more readily than corn silage due to the
large amount of moisture in the former. This may be a disad- 
vantage when out-door feeding is practiced; (3) sunflower silage 
packs more readily than the corn silage and is less likely to mold; 
(4) dairy cows maintain their milk flow and body weight at least 
equally as well on sunflower silage as on corn silage.

Dowell and Friedemann (1920) made a comparative study 
of the composition and digestibility of Sudan grass, dorso, dorso 
silage, broom corn seed and sunflower silage. Small amounts of 
sunflower silage were consumed by the sheep compared with the 
amounts of dorso silage and other feeds consumed. It was 
thought that the sheep lost weight during the experiment due to 
the small amount of sunflower silage consumed. It was impos- 
sible to get one sheep to eat the sunflower silage and all of them 
ate very little of it at first and only a small amount after they 
became accustomed to it.

The cattle feeding investigation of Blizzard (1920) showed 
that when sunflower silage was combined with corn, cottonseed 
meal and alfalfa hay, good results were secured. It proved to be 
slightly superior to dorso silage. The cattle receiving sunflower 
silage made a remarkable ship, shrinking only 5.33 pounds per 
head, while those receiving dorso silage showed a shrinkage of 
21.5 pounds per head. The calves ate sunflower silage with relish 
and it had no bad effects other than causing an apparent increase 
in urine, and a slight tendency to scour.

Anthony and Henderson (1920) in their comparative study 
of sunflowers vs. corn for silage, found that sunflowers yielded 
much heavier than corn per acre, and that it was as easily cut 
and preserved in a silo as corn. Cows, after becoming accustomed 
to the sunflower silage, which required from 2 to 5 days, ate it as 
readily as corn silage. The sunflower silage did not, in any way, 
injure the quality or flavor of the milk, but it did not keep up the 
flow quite so well as the corn si'age.

H. H. S. Handy (1920) gives the results of two years' work 
with sunflower silage near Syracuse, N. Y. The sunflowers were 
relished by the cattle. However, it took a day or two to become 
accustomed to the different feed. No change in milk flow was 
noted in changing from sunflower to corn silage.
Putnam (1920) gives the results secured with different rates and times of seeding. The earlier seeding of May 26th gave the best results. This was the earliest date tried. Rows 24 to 36 inches apart gave the best returns. The 30 to 42 inch rows gave the highest yields. 6 to 8 pounds per acre gave the most satisfactory returns.

Hutton (1921) gives the yields per acre in green weight, dry matter and moisture content:

<table>
<thead>
<tr>
<th>Kind of Crop</th>
<th>Yield per Acre in lbs.</th>
<th>Per Cent Moisture</th>
<th>Yield per Acre in lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunflowers</td>
<td>79,200</td>
<td>82.41</td>
<td>12,034</td>
</tr>
<tr>
<td>Corn</td>
<td>27,980</td>
<td>78.72</td>
<td>5,745</td>
</tr>
<tr>
<td>Peas and Oats</td>
<td>14,000</td>
<td>62.64</td>
<td>5,230</td>
</tr>
</tbody>
</table>

Comparative feeding tests were in favor of the sunflower silage over the oat and pea silage. In the rate of seeding tests, the best results were secured with five pounds per acre.

The results secured with the use of sunflower silage in wintering ewes are given by Joseph (1921): 2.75 to 3.0 pounds of silage were required to replace 1 pound of alfalfa hay. A small amount of silage was used to good advantage in wintering ewes.

The U. S. Sheep Experiment Station at Dubois, Idaho, reports very good results using 2 pounds of sunflower silage, 1 3/4 pounds alfalfa hay and 1/4 pound corn. At the close of the silage feeding experiment, the ewes were in excellent condition for lambing.

Zavitz (1921) gives the results of eighteen years' work with the sunflower at the Ontario Agricultural College. The result of eighteen years shows averages as follows: height, 98 inches; diameter of heads, 7 inches; yield per acre of heads, 5.6 tons; of whole crop, 18.2 tons; and of ripened seed, 1,453 pounds. The Mammoth Russian was the variety used. The Black Giant has proved to be a very heavy yielder. The average results of the analyses of the sunflower compare very favorably with those of corn, being particularly rich in protein and fat.

In the experiments to determine the best rate of seeding, rows 36 inches apart and 6 inches between the plants in the row, gave the best results. This would require about 7 pounds per acre.
Sotola (1921) in his work on the digestibility of sunflower silage, found that it contained 12.55 pounds of digestible nutrients per 100 pounds, as compared to 19.04 pounds digestible matter for each 100 pounds of corn silage. This gave sunflower silage a value of 66 per cent of the value of corn silage. The crude protein was more digestible in the case of sunflowers; however, the crude fiber of the sunflower silage was about 40 per cent less digestible than the crude fiber in corn. The nitrogen free extract was 18 per cent less digestible in sunflower silage than in corn silage.

Schafer and Westley (1921) secured double the yield from sunflowers that they did from corn on the experiment fields at Pullman. The wheat yields following sunflowers were 16 per cent less than those following corn. They found sunflower silage less palatable than corn silage but considered that it was fairly satisfactory and could be substituted for corn silage in rations for dairy cattle, beef cattle and sheep.

LeClair (1921) reports the results secured by farmers in Wisconsin and Michigan. The work at the Chatham Station in upper Michigan, showed that there was no change in milk flow when the cows were changed from oat and pea silage to sunflower silage. The crop is thought to work well into the rotation and is no more exhaustive on the land than is corn.

Forbes (1921) gives the results of one of the Illinois farmers in their tests of sunflower silage. He considers it a much better yielder than corn and equal to it in feeding value. In changing from corn and soy-bean silage to sunflower silage, they noted little difference in the way the stock took to it, with the exception of the pure-bred bulls in the barn, which were on a full feed. Some of them did not eat it as well as they did the corn and soy beans.

Boss (1921) reports some very interesting results from the Minnesota Experiment Station. The yield for the sunflowers varied from 8½ to 12 tons per acre. In this respect, it compared favorably with corn. The yields in St. Louis County and Itasca County were slightly larger. No difficulty was experienced in getting the cows to eat the silage. A combination of 3 parts corn, 1 part sunflowers and 1 part soy beans proved to be a very good...
mixture. The author did not see the value of trying sunflowers where corn did well.

R. E. Neidig, R. S. Snyder and C. E. Hickman (1921) found that the sunflower silage fed at the Idaho Agricultural Experiment Station compared very favorably with corn silage. The nutritive ratio was somewhat narrower in sunflower than in corn silage. Sheep utilized slightly more nutrients in sunflower silage than in corn silage. Where both corn and sunflowers can be grown, the selection of a silage crop should depend upon comparative tonnage per acre and cost of harvesting.

Show and Wright (1921) made a careful study of the sunflower and corn plants at different stages of growth. The dry matter in each increased gradually and consistently throughout the entire period of growth. There was no great difference in the percentage of proteids, but it is slightly in favor of the corn plant. The per cent of starch is small in the sunflower. The chief difference between the two plants at the silage stage lies in the amount and character of the carbohydrates. Their results seem to indicate that the best stage of maturity for ensiling the sunflower plant is when the rays of the plant become dry and are falling.

Hays (1921) found in his feeding investigations that sunflower silage was equivalent to oat and pea silage, and resulted in good gains, provided the sunflowers were harvested at the proper stage of maturity. The plants that were badly frosted gave rather poor results.

**CHEMICAL COMPOSITION**

A comparison of the chemical analysis of sunflower and corn silage shows very little difference. Table I shows the chemical composition of sunflower silage, oat and pea silage, and corn silage. The moisture and ash content is slightly higher and the nitrogen free extract lower in the sunflower. The chief difference between the sunflower and corn silage occurs in the carbohydrates.


<table>
<thead>
<tr>
<th>State</th>
<th>Water %</th>
<th>Ash %</th>
<th>Crude Protein %</th>
<th>Crude Fiber %</th>
<th>N. F. Extract %</th>
<th>Fat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>75.2</td>
<td>2.1</td>
<td>3.4</td>
<td>7.5</td>
<td>10.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Idaho</td>
<td>78.5</td>
<td>2.4</td>
<td>2.4</td>
<td>5.8</td>
<td>9.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Montana</td>
<td>78.6</td>
<td>1.6</td>
<td>2.1</td>
<td>8.8</td>
<td>10.4</td>
<td>.5</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>81.3</td>
<td>1.6</td>
<td>1.8</td>
<td>5.8</td>
<td>8.7</td>
<td>.8</td>
</tr>
<tr>
<td>West Virginia</td>
<td>76.4</td>
<td>2.33</td>
<td>1.86</td>
<td>7.45</td>
<td>10.43</td>
<td>1.18</td>
</tr>
<tr>
<td>Wyoming</td>
<td>77.85</td>
<td>2.37</td>
<td>2.18</td>
<td>6.55</td>
<td>10.63</td>
<td>.62</td>
</tr>
<tr>
<td>Washington</td>
<td>77.98</td>
<td>2.16</td>
<td>1.72</td>
<td>6.52</td>
<td>9.96</td>
<td>1.76</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>71.96</td>
<td>3.23</td>
<td>2.96</td>
<td>8.76</td>
<td>12.36</td>
<td>.81</td>
</tr>
<tr>
<td>Average</td>
<td>77.18</td>
<td>2.22</td>
<td>2.30</td>
<td>6.90</td>
<td>11.30</td>
<td>1.06</td>
</tr>
</tbody>
</table>

### OAT AND PEA SILAGE

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyoming</td>
<td>67.70</td>
<td>2.66</td>
<td>3.22</td>
<td>9.39</td>
<td>15.71</td>
<td>1.33</td>
</tr>
</tbody>
</table>

### CORN SILAGE

<table>
<thead>
<tr>
<th>State</th>
<th>Water %</th>
<th>Ash %</th>
<th>Crude Protein %</th>
<th>Crude Fiber %</th>
<th>N. F. Extract %</th>
<th>Fat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyoming—Archer</td>
<td>78.40</td>
<td>1.29</td>
<td>2.08</td>
<td>5.77</td>
<td>12.07</td>
<td>.39</td>
</tr>
<tr>
<td>Wyoming—Torrington</td>
<td>71.85</td>
<td>1.77</td>
<td>2.02</td>
<td>4.91</td>
<td>15.43</td>
<td>.92</td>
</tr>
<tr>
<td>Henry—Feeds &amp; Feeding</td>
<td>72.70</td>
<td>1.70</td>
<td>2.10</td>
<td>6.30</td>
<td>15.40</td>
<td>.80</td>
</tr>
</tbody>
</table>

There is a marked variation in the composition of the silage from different sections of the United States. A comparison of the corn silage grown under adverse conditions, as were the sunflowers, shows very little difference in the chemical composition. Where sunflowers were grown under conditions favorable for the growing of corn, as in West Virginia and Oklahoma, the results were very similar to corn silage. If we are to compare sunflowers with corn, we should use the chemical analyses of the crops grown in the same locality, and not use corn belt analysis of corn to compare with the analysis of sunflowers grown under more or less adverse conditions. Our results from this station indicate very little difference when the two crops are grown under similar conditions.

Not enough work has been done on the digestibility of sunflower silage to determine definitely its feeding coefficient.

### FEEDING VALUE

Our feeding results at this station indicate that sunflower silage can be used to good advantage as winter feed for both cattle and sheep, as it has given equally good results with dairy cows,
beef animals, breeding ewes and fattening lambs. The nutritive value of sunflower oil-cake for cattle has long been recognized in European countries. The sunflower produces heavy yields of seed that are high in oils and fats. This makes it a much better balanced ration than corn.

It is commonly figured that three pounds of silage will replace one pound of hay in the ration. This may be true in case of actual food values, but a small amount of silage in the ration cannot be measured in actual food value. It has a greater value, that of keeping the digestive organs of the animal in a healthy condition. Silage acts as green grass, and improves the general physical condition of the animal. It is this thing that has made it so popular with the dairyman, and will increase its popularity with the breeder, and feeder.

Most of the winter feed in this state is from our native meadows, and they are at the present time yielding little more than one-half ton per acre. This means that if we wish to develop the livestock industry, we must develop the supply of winter feed. This is where the silo will play an important part. Yields of from 12 to 20 tons per acre of sunflowers should be secured with little or no difficulty. This would be equivalent to 4 to 7 tons of hay per acre. The number of livestock will be materially increased on our ranches when the silo has come into more general use.

On the dry-land farm, the silo saves what little feed there is during droughty years and aids in carrying the stock through the severe winters. Our dry-land experiments have shown the superiority of sunflowers over other forage crops in matter of yield.

The project work of the county agents with the farmers in the various counties, have, with one exception, reported very favorable results with the sunflowers both in yield and feeding value.

Marston of Johnson County reports the excellent results that have been secured by Horton, Irving, Hampton, Rothwell, Watt and others. The work that has been done from both the experimental and practical standpoints leaves no doubt as to the feeding value of sunflower silage.
The Government Sheep Experiment Station, maintained at Dubois, Idaho, secured very good results in wintering ewes, using the following ration: 2 pounds sunflower silage, 1 1/4 pounds alfalfa and 1/4 pound corn. At the close of the silage feeding period, the ewes were in excellent condition for lambing.

ADAPTATION

Like most plants, sunflowers do best on a rich loam soil, but they will adapt themselves to a wide range of soils and climatical conditions. Their growth in this state depends largely on the amount of water received. On the dry-land farm their growth is limited, but it is still more than that of any other forage plant. They respond readily to irrigation and out-yield all other plants on our irrigated farms. They will endure frosts in the spring and fall with little or no damage, making them very superior to corn in our regions of high altitudes and short growing seasons. They will endure drought, which makes them a crop well adapted to dry-land farms. In fact, there is probably no section in the state where farm crops can be grown, that will not yield larger amounts of sunflowers per acre than of any other crop.

They are, however, heavy feeders as is shown by the ash content and should be grown in rotation with other crops. Rich
calcareous soils, or soils containing a large per cent of potash are very suitable for their growth.

**VARIETIES**

The commercial varieties of the sunflower that have been grown extensively are Mammoth Russian, Black Giant and White Beauty. They may be identified by their seeds.

The Mammoth Russian has striped seeds which are high in oil. The plant grows to a height of about eight feet with heads averaging 7 inches in diameter. This is the variety that has commonly been grown in this country, and the one that has been used in all silage tests.

The Black Giant is slightly larger than the Mammoth Russian and a heavier yielder. The seeds are small, black, sweeter and serve much the same purpose in Russia that the peanut does in this country. This variety should be given a trial in this state.

White Beauty has large white seeds and is a good oil producer. The plants do not reach as great a height as the other two varieties and the yield of forage is somewhat lighter. It seems to be better adapted to oil than silage purposes. In yield of grain, it ranks above the Black Giant.

**YIELDS**

The yield of the sunflower plant varies from 10 to 40 tons per acre, depending on the soil, moisture, method of seeding and cultivation.

The “rate of seeding” results secured at the Wyoming Experiment Station were as follows:

<table>
<thead>
<tr>
<th>Width of Row Inches</th>
<th>Apart in Row Inches</th>
<th>Av. Weight per Row Lbs.</th>
<th>Yield per Acre Lbs.</th>
<th>Yield per Acre Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>3</td>
<td>723.6</td>
<td>64,328</td>
<td>22.2</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
<td>649.0</td>
<td>57,691</td>
<td>20.8</td>
</tr>
<tr>
<td>30</td>
<td>9</td>
<td>541.0</td>
<td>48,095</td>
<td>17.3</td>
</tr>
<tr>
<td>30</td>
<td>12</td>
<td>501.3</td>
<td>45,507</td>
<td>16.1</td>
</tr>
<tr>
<td>36</td>
<td>3</td>
<td>636.0</td>
<td>47,114</td>
<td>16.6</td>
</tr>
<tr>
<td>36</td>
<td>6</td>
<td>617.0</td>
<td>45,507</td>
<td>16.1</td>
</tr>
<tr>
<td>36</td>
<td>9</td>
<td>537.0</td>
<td>39,781</td>
<td>14.9</td>
</tr>
<tr>
<td>36</td>
<td>12</td>
<td>532.0</td>
<td>39,410</td>
<td>14.7</td>
</tr>
<tr>
<td>42</td>
<td>3</td>
<td>750.0</td>
<td>47,625</td>
<td>16.9</td>
</tr>
<tr>
<td>42</td>
<td>6</td>
<td>661.0</td>
<td>41,973</td>
<td>14.0</td>
</tr>
<tr>
<td>42</td>
<td>9</td>
<td>533.0</td>
<td>33,844</td>
<td>11.9</td>
</tr>
<tr>
<td>42</td>
<td>12</td>
<td>526.0</td>
<td>33,401</td>
<td>11.7</td>
</tr>
</tbody>
</table>
The thicker rates of seeding gave the better returns, both in total yield and quality. If the plants are too far apart in the row, it may result in large growth and the development of too much fiber in the large stems.

Similar results were secured at the Michigan Station with the different rates of seeding. The best results were secured with 30 inch rows using 6 to 8 pounds to the acre. The data secured at the Ontario Station indicates that rows 36 inches apart with the plants 6 inches apart in the row, give the best results. Yields of 20 tons per acre were secured at the above station without irrigation. Corn under similar conditions yielded from 13 to 16 tons per acre.

Boss of the Minnesota Station reports the yields of sunflowers at from 8½ to 12 tons per acre or about the same as corn. Their late seeding there may account to some extent for their low yields.

The experiments conducted at the Nevada Station gave a yield of 23 tons of sunflower silage per acre in comparison to about 14 tons of corn silage per acre under the same conditions. No direct comparisons have been made at the Wyoming Station as corn is not a possible silage crop.

The writer is not recommending sunflowers for the corn-belt regions but for those regions in which corn cannot be grown successfully. The fact that yields of 32 tons of the sunflowers per acre can be secured, in regions where not even the earliest types of sweet corn can be grown to the roasting ear stage successfully, shows the superiority of the sunflower over the corn in all sections of the state where the altitude is above 5,000 feet.

PLANTING

Sunflowers should be seeded several weeks earlier than corn. Light frost does not injure them as it does corn. This is the thing that makes them superior to corn on both the dry-land and high-altitude farms. On these farms, they are able to make more efficient use of the early spring rainfall, and may mature before the drought has hit them. On the high altitude farms (which are usually irrigated) the early spring growth permits them to mature without frost damage in the fall.
The first light frosts of the fall that may kill corn have little or no effect on the sunflowers. In Russia, where they have been cultivated for many years, they are seeded in the spring as soon as the frost is out of the ground. In some cases, they are seeded in the fall and allowed to be in the ground until spring, when they start with the first warm weather. April should be the logical month for seeding in most sections of the state. Sunflowers are very rapid growers and may be seeded after corn has failed, in the lower altitudes, and still make a satisfactory silage crop.

The rate and method of seeding depends on the amount of moisture available. Under irrigation, the best results have been secured when planted in rows 30 to 36 inches apart with the plants 3 to 5 inches apart in the row. On the dry-land farms, rows 36 to 42 inches apart, with the plants 6 to 12 inches apart in the row, give good results. The corn planter is an excellent tool for seeding sunflowers. Where it is not available the grain drill may be used, leaving the fourth, fifth or sixth hole open depending on the width of row desired. Five to ten pounds of seed is sufficient for the above rates of seeding. Six pounds of the average size seeds is required to plant an acre with the rows 3½ feet apart and the plants 3 inches apart in the row. One must know the moisture conditions, and the size and germinating power of the seed in order to determine the number of pounds per acre. It is a good plan to have the sunflower seed tested for purity and germination as it is not uncommon to find diseased and weak seeds on the market. A poor lot of seeds may mean a loss of the silage crop for the year. Samples of seed will be tested without charge if sent to the Dairy, Food and Oil Commissioner at Cheyenne.

The seeds should be planted at a depth of 1½ to 3 inches. The deeper seeding should be used on the lighter types of soil. Early spring seeding should be shallower than late seeding. The depth of seeding should be determined by the moisture content, type of soil, and time of seeding.
CULTIVATION
The crop responds to cultivation as quickly as does the corn crop, and the method of tillage is much the same. On the dry-land farms where the lister is used for corn, the same may be used for sunflowers, followed by the harrow, weeder and cultivator. The first cultivation should be rather deep with shallower cultivating thereafter. The effect of cultivation is to conserve moisture and destroy weeds. The amount of cultivation necessary will depend on these two factors. After the sunflowers get a good start, weeds are not likely to bother.

HARVESTING
Our experimental results indicate that the best time to harvest the sunflower for silage is when the seeds are in the dough stage, or when the rays are dry and falling. If cut too early, the high moisture content may result in a water-logged, high acid silage of poor quality. On the other hand, if the seeds are allowed to mature, the plant will lose many of its leaves and the stalk will become so hard and woody that it will be difficult to pack it enough to prevent molding. The best results are secured when the plant contains about 75% moisture. If harvested when the plants start to flower, which is a common practice in this state due to late seeding, the moisture content will average about 85%. This high moisture content does not result in the best grade of silage. The plant will endure light frosts in the fall with little or no damage. For this reason the harvest need not start as early with sunflowers as with corn.

The ordinary corn harvesting machinery is, in most cases, satisfactory for the harvesting of sunflowers. The corn binder does very good work, and may be used to advantage where the stalks are not too coarse. The bound bundles are easier to handle and feed into the cutter. A one or two row corn sled works very well. The runners are 24 to 30 inches apart with the platform 24 to 30 inches wide in front, tapering to 42 to 56 inches wide in the rear. Knives are attached to each side and two men stand on the platform gathering the sunflowers in. When the stalks are too large for corn harvesting machinery the corn knife may be used.
FILLING THE SILO

The sunflowers should be allowed to reach the dough stage before harvest, unless there is too large a loss of leaves taking place. Any kind of green material can be preserved in a silo, if the silo is air-tight and the green material contains the right amount of water and is well packed. In order that the green material may undergo the proper fermentation, it is essential that the air be excluded. This means that the material must contain enough moisture to pack well and not enough to cause water-logging, though the excess moisture will drain through the floor of the silo without serious damage to the silage.

A moisture content of 75% will give very satisfactory results. The sunflower in the dough stage contains approximately this amount. When the plant first starts to bloom, it contains approximately 84% moisture which is rather high for best results. Low, flat-topped wagons are desirable for hauling the sunflowers from the field to the silo. They should be hauled to the cutter immediately and cut into short pieces of about \( \frac{3}{4} \) inch in length. Care should be used in packing the material firmly so as to exclude the air. In the large silo, two men should be employed to pack the silage. Due to the high moisture content of the plants they seldom require the addition of water to aid in packing, differing from oats and peas in this respect.

PLACE AND VALUE IN THE ROTATION

The sunflower works well in the rotation with the small grains where a cultivated crop is needed to clear the growth of weeds. The cultivations given the crop during the early period of its growth will destroy the weeds, and as soon as the plants are large enough to shade the ground, the weeds do not have a chance. In most sections, the crop will come off the ground in sufficient time to allow the seeding of the winter grains.

The sunflower is a heavy feeder, and uses large amounts of the plant food elements, especially potash. In Russia, where the crop is grown chiefly for its seed, the stalks are scattered over the ground as a fertilizer. Where the entire stalk is removed from the field, as in the case of silage, a large amount of plant food is removed from the soil. The value of a cultivated crop is
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... in part measured by its effect on the following crop. The results secured at the Washington Station indicate a decrease in yield of wheat following sunflowers, compared to wheat following corn. It was probably a question of moisture rather than one of plant food. Yields of over 100 bushels of barley per acre were secured at the Wyoming Station this year on land that grew sunflowers the previous season. Under irrigation and with proper methods of tillage, it does not seem that the soil fertility question is a serious one. The following rotation is recommended for the irrigated farms. The sunflowers should follow the hay crops, such as alfalfa or sweet clover, and may in turn be followed by the small grains for one or more years. If potatoes or sugar beets are grown on the farm, they should follow the hay crop, and in turn be followed by the sunflowers. On the dry-land farms, the sunflowers should follow the legume crop, and in turn be followed by the small grain crops. Where there is manure available on the farm, it should be applied to the sunflower crop where it will give excellent returns.
SUMMARY

The sunflower will yield twice as much silage as will corn on our high altitude farms, and the crop can be handled with approximately the same amount of labor per ton of silage.

The crop can be handled with the same machinery that is used for corn. If no corn planter is available the grain drill may be used for seeding.

Seeding of the sunflower should take place several weeks earlier than the seeding of corn. The plant is able to endure light frosts with little or no damage.

The most satisfactory yields have been secured at the Wyoming Station when seeded in rows 30 to 36 inches apart with the plants 3 to 6 inches apart in the row. Six to 8 pounds of seed are required per acre.

The sunflower crop should be harvested when the seeds are in the dough stage and the rays are dry and falling. The plant should contain approximately 75% moisture for best results. In case there is danger of loss of leaves by freezing, harvest at an earlier period.

In the comparative tests of oat and pea vs. sunflower silage at the station, the sunflower silage was found to be equivalent to the oat and pea silage in feeding value. Three pounds of sunflower silage replaced one pound of alfalfa hay in the tests. The animals that were given silage showed better gains.

The sunflower is a heavy feeder and should be grown in the rotation where it will receive the largest amounts of plant food and water.

The use of sunflower silage on our farms and ranches means the saving of hay, and this in turn means the saving of livestock during the drought years that are bound to come. A ton of hay saved during the good years means several times its original value during the drought years.
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