SUNFLOWER PLANT, 12 FEET 6 INCHES HIGH, GROWN IN WASHINGTON, D. C., IN 1897.

BULLETIN No. 60.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY.

THE SUNFLOWER PLANT:

ITS CULTIVATION, COMPOSITION, AND USES.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Chemistry,
Washington, D. C., November 12, 1900.

Sir: I transmit herewith, for your inspection and approval, the manuscript of a bulletin relating to the cultivation and uses of the sunflower in the United States and other countries. I recommend that it be published as Bulletin No. 60 of the Division of Chemistry.

Respectfully,

H. W. Wiley,
Chief of the Division of Chemistry.

Hon. James Wilson,
Secretary of Agriculture.

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THE SUNFLOWER PLANT: ITS CULTIVATION, COMPOSITION, AND USES.

INTRODUCTION.

The introduction and successful establishment of new agricultural industries can not fail to be of benefit to the general agricultural interests of the country, which as a rule are the more prosperous as they are more diversified. Numerous inquiries have been addressed to the Department of Agriculture in the last two years in regard to the growth of sunflowers for economical purposes and the manufacture of oil from their seed, indicating a large and growing popular interest in the subject. It has been found impossible to give the desired information to correspondents in an epistolary form. For the purpose of giving to those interested in the matter all the information available some investigations have been made in the composition of the sunflower, the methods of culture, and the manufacture of oil from the seed. The results of these investigations are contained in the present bulletin.

By the courtesy of the Statistician, a circular was sent to the correspondents of the Department for the purpose of ascertaining the acreage cultivated in sunflowers, and the disposition made of the crop. Many replies have been received in response to this circular, which have enabled us to definitely point out those areas in the United States in which the sunflower is now cultivated as an agricultural crop, and also to give some valuable data in regard to the methods of cultivation and harvesting employed. The answers to these circulars, however, failed to give any definite information in regard to the extraction of oil from the seeds of the sunflower for commercial purposes. It is not believed that any oil factory devoted exclusively to the manufacture of oil from sunflower seeds is in operation in this country. As will appear from a discussion of the data which have been collected, it is evident that the product of sunflowers at the present time, so far as seeds are concerned, is devoted chiefly to the feeding of birds and poultry, and in some instances to medicinal purposes for cattle and horses.

BOTANY OF THE SUNFLOWER.[1]

ORIGIN AND EARLY HISTORY.

The wild sunflower, *Helianthus annuus*, from which the cultivated variety has been developed, is native in the Great Plains region from Nebraska to northern Mexico. It was first cultivated in Europe in the gardens at Madrid, about the middle of the sixteenth century. This was soon after the Spanish expeditions to Peru and to Santa Fe, N. Mex. All of the earlier botanists and many writers of the present day credit its origin to Peru, but this is probably an error, as there is no evidence that the sunflower was cultivated by the natives in Peru, and it is not recorded as indigenous anywhere south of the northern part of Mexico.

One of the earliest records of the plant is that of De Lobel,[2] a Flemish botanist, who gives a good illustration and description of a sunflower with stout, erect stem, big leaves, and large, nodding head, like our present garden variety, and calls it "Solis flos Peruvianus" (Peruvian sunflower).

The works of several European botanists printed during the last quarter of the sixteenth century contain illustrations and descriptions of the sunflower. Most of them follow Dodoens in calling it *Chrysanthemum peruvianum*, and some of them refer especially to plants growing in the royal gardens at Madrid.

Descriptions and illustrations of four varieties given by Gerarde in 1597 indicate that the sunflower was well developed in Europe at that time. The following statement which he makes in regard to its origin and growth agrees well with the records of other writers of that time:

> These plants do growe of themselves without setting or sowing in Peru, and in divers other provinces in America. There hath beene seene in Spain and other hot regions a plant sowen and nourished up from the seede to attain to the height of 24 foote in one yeere.[3]

A case is cited by Caspar Bauhin[4] in 1671 in which 2,362 seeds from one head were counted.

The sunflower introduced into Europe was undoubtedly derived from plants cultivated and developed by the American Indians. When Champlain explored the region in the vicinity of Georgean Bay in 1615 he found the Indians there cultivating a "herbe des soleil" from the seeds of which they obtained oil used on their hair. Sunflower seeds were also used for food by the Indians in early times, as they are

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[1] The Division of Chemistry is indebted to Mr. L. H. Dewey of the Division of Botany for the botanical description which is made a part of this bulletin.

[2] Matthiae de Lobel. Stirp. Hist., 322 (1576).

[3] Gerarde, Herbal, 612–614 (1597).

[4] Caspar Bauhin, Theatri Botanici, Ed. II, 277 (1671).

by many tribes at present. Dr. Asa Gray, who carefully studied the history of the sunflower, makes the following statement:

> Judging from the breadth of the flower heads soon after its introduction into Europe, it must in aboriginal hands have assumed much of the abnormal development which distinguishes the cultivated sunflower from its wild original of the Western plains.[1]

DEVELOPMENT OF VARIETIES.

In western Europe and America, where the sunflower has been grown chiefly for ornamental purposes or occasionally for poultry food, there has been apparently little improvement or development in large varieties during the three and a half centuries of cultivation. Seeds 6 to 10 mm. in length, as large as those of ordinary varieties at the present time, were figured by Camerarius[2] in 1586. More varieties are grown purely for ornamental purposes than for the production of seeds, but several of the ornamental sunflowers are derived from other species.

In Russia, where the numerous religious fasts restricting the use of meat lead to a large consumption of vegetable oils and oily foods, the sunflower seed has become almost a staple article of diet. It is eaten raw or roasted as peanuts are in America, but much more extensively. Between 1830 and 1840 sunflower oil began to be manufactured on a commercial scale in the southern provinces of Russia, and since that time a series of important industries based on the production of oil and oil cake has been developed there. This has led to the development of more prolific seed-producing varieties.

FIG. 1. Akenes (seeds) of sunflower, showing variation in size and form; *a*, *b*, *c*, *d*, from cultivated plants; *e*, from wild plant; *f*, transverse section.

There are three principal varieties now cultivated in Russia—one with large white seeds, which are said to yield the largest amount of oil; one with smaller 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. There are numerous intergrading forms, as may be found in most plants long in cultivation.

In the United States three principal varieties are grown for the production of seeds. The common sunflower, with no distinguishing varietal name, has been long 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 gray-brownish or striped seeds. 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 or brownish stripes or sometimes all white (fig. 1, *a*, *b*). The

[1] Asa Gray, with J. Hammond Trumbull, Review of De Candolle's Origin of Cultivated Plants. Am. Journ. Sci. and Arts, 3 ser., 25–245 (1883).

[2] Camerarius, Epitome Plantis Utilissima, 503 (1586).

black giant, another variety, has heads 16 to 22 inches in diameter, with rather thick black seeds about three-eighths inch long (fig. 1, *c*).

BOTANICAL DESCRIPTION.

All of the annual varieties with large heads, cultivated for the production of seeds, are referred to one species, *Helianthus annuus*, which is characterized as follows: Annual, with rather stout, erect, herbaceous stem, 1 to 3 inches in diameter and 5 to 20 feet in height, rough-hairy or hispid, often purple-mottled, usually without branches except near the top, but occasionally branching freely throughout; leaves alternate except near the base of the stem, with rather stout petioles 2 to 10 inches long, and three-ribbed, heart-shaped blades 4 to 10 inches long, and about two-thirds as wide, rough on both surfaces, coarsely and irregularly toothed on the margins, pointed at the apex, and somewhat decurrent on the petiole; heads one to six or more in the smaller-flowered, branching forms, terminating the main stem and branches, 4 to 20 inches in diameter, with 40 to 80 yellow rays and brown or nearly black disk; chaff or scales among the disk flowers three-toothed; scales of the involucre under and surrounding the flower-head acuminate-pointed, more or less pubescent, and usually ciliate.

The akenes (fig. 1), commonly called "seeds," are variable in size and coloring. They are obovate oblong, somewhat flattened, and more or less diamond-shaped in transverse section.

The sunflower stem has rather strong bast fibers, as have nearly all tall, slender herbaceous stalks, and the plant has often been suggested as a source of fiber supply. The fiber is too weak and brittle, however, to be of value for cordage or textile purposes. Paper has been made from the stalks, but in the treeless regions, where it is most abundantly grown, the highest value is doubtless obtained in its use for fuel.

USES OF THE SUNFLOWER.

The sunflower has long been grown in this country for ornamental purposes. The beautiful yellow flowers, with dark centers, are particularly attractive in yards and gardens. In some of the Central States the sunflower, in a much smaller form than the cultivated plant, grows wild. In Kansas the borders of the wagon roads and railroads are frequently lined for miles with these flowers, which, in August and September, when in full bloom, form a very marked feature of the prairie landscape. The æsthetic influence of the sunflower has long been recognized in this country, but it is only of late years that we have realized that it has an economic importance which promises to be a source of wealth in the future. We have only just begun to learn from the experience of China and Russia the economic value of the plant itself.

The general interest in this subject, as has already been intimated, has been evidenced by the hundreds of letters which have been received in the last few years from all parts of the country, making inquiries in regard to the possibility of the economic uses of the plant. The part of the sunflower plant which has the chief value is the seed. The oil expressed from the seed is highly prized as an edible oil, and one which, more nearly than any other known vegetable oil, has the general properties of the oil of the olive. The oil cake left after the extraction of the oil by pressure is extremely rich in nitrogenous matter, and has a food value equal to the cake resulting from the expression of maize oil or linseed oil. In addition to this, it has the advantage of being more palatable, and therefore will be eaten with more avidity than the other oil cakes just mentioned. In some sources of information it is stated that the leaves of the sunflower have been used as a substitute for tobacco, but it is not probable that the adulteration of tobacco with sunflower leaves has ever been practiced to any extent in this country. The branches and stalk of the sunflower, when reduced to a sufficient state of fineness, possess nutritive properties of a high order, and furnish food suitable to the nourishment of many domesticated animals, such as horses, cattle, and sheep. The food values of the different parts of the stalk will be fully illustrated in the analyses given farther on in this bulletin (pp. 18–22, and 27.) Perhaps the most valuable of the products of the sunflower of a manufactured character is the oil, which, by reason of its palatability and sweetness, is well suited for table uses, and for this purpose can replace olive oil with better success than any other known substitute.

MEDICINAL USES.

It is undoubtedly true that the sunflower seed is a valuable food when mixed in proper proportions with other food products. It improves the digestion of the animal, and therefore is beneficial to its health. In fact the seeds are used to a large extent by horsemen and cattlemen for the purpose of keeping animals in excellent physical condition. The supposed efficacy of sunflower seeds for the cure of certain specific diseases (as rheumatism, for instance) is probably largely mythical.

There is a very prevalent notion that the growth of large quantities of sunflowers in malarial regions prevents the development of diseases of malarial origin.

Numerous inquiries in regard to the efficacy of the sunflower as a preventive of malaria have been received at the Department of Agriculture within the past few years. Inasmuch as the sunflower is a vigorous grower, absorbing large quantities of moisture, and consuming, under proper conditions of nitrification and oxidation, large quantities of organic matter, it is possible that the growth of it over

extensive areas may tend to correct some of the conditions in the environment which are supposed to be favorable to the development of malarial germs. That the plant itself, however, has any specific influence upon malarial diseases is undoubtedly an illusion.

SOIL AND CULTIVATION.

By study of the reports which have been received from numerous correspondents of the Divisions of Statistics and Chemistry in different parts of the United States, it is found that sunflowers grow best, for commercial purposes, in Kansas, Missouri, and the Ohio Valley. Many other parts of the country, however, are found peculiarly suitable to the growth of this plant. As a rule the soils which are best suited for the growth of indian corn produce the best crops of sunflowers. If the soil is not naturally fertile, liberal fertilization must be practiced in order to secure large crops. The character of the fertilization depends upon the nature of the soil and the deficiencies of plant foods therein. The kind of fertilization necessary to produce a good crop of maize will be found suitable to the sunflower. The soil should be prepared by careful plowing, and the surface of the plowed soil should be reduced to good tilth by the use of the harrow. Sunflowers are best planted by a drill in rows from 3 to 3½ feet apart. In order to secure a good stand the seeds may be placed by the drill 2 or 3 inches apart; but should they all grow, at least half of them should be cut out when the plants are thinned. The seeds should be planted deep enough to secure abundant moisture to germinate them; from 2 to 3 inches in depth, where the soil is not too heavy, will be found the best. With heavy, stiff soils, which are likely to become very hard on the surface after heavy rains, it is better not to plant the seeds so deep. The seeds should be planted as early as possible in the spring, as they endure very well a slight degree of cold. After the plants are well formed they should be thinned so as to stand at a distance of from 12 to 18 inches in the row. The cultivation should be of the ordinary kind, mostly superficial, and sufficient to prevent the weeds from growing and preserve the moisture during periods of drought. Where the production of seed is sought the best results are secured by limiting the number of seed heads on each plant to a very few. The superfluous heads when formed should be removed. No special directions need be given for the cultivation, since it is so much like that of maize as to be practically the same.

HARVESTING SUNFLOWER SEED.

The heads should be harvested before the seeds are quite ripe to avoid shattering and loss. After drying the seeds can be thrashed out and stored in bags in the usual way. The seeds may be beaten out with a flail, but where large quantities are grown this is a tedious

process. It is evident that if the sunflower be grown in this country over large areas for commercial purposes, special thrashing machines will be devised for the separation of the seed. Where, however, only a few bushels are grown, even if they are for sale, the farmer may employ some simple apparatus better than the flail for separating the seed. Such a simple apparatus is described by Mr. Ormsbee in the American Agriculturist of September 26, 1896. This machine (fig. 2) consists of a wooden disk mounted in a frame precisely like that for holding a grindstone and with a similar turning movement. In order to run easily it should be so constructed that the axle will roll on friction wheels. The wooden disk or wheel should be 2 inches thick and about 3 feet in diameter. This disk is prepared for its work of detaching the seed by driving nails through it near the periphery parallel to the axis and allowing them to project about half an inch on each side. The width of the band of nails should be about 6 inches, and the nails should be thick enough so that the finger can not be inserted between them. The ends of the nails should all project the same distance. The perimeter of the wheel should be secured by a heavy tire of iron, in order to hold it in shape and prevent it from warping. This heavy iron tire also acts as a fly wheel, helping to secure uniformity of motion. The wheel is kept in motion by working the treadle. It should revolve toward the operator. When the wheel is in full motion a sunflower head is held in each hand and pushed for an instant against the protruding nails on either side. In a very short period of time all the seeds will be detached. A man who has practiced a little with this machine is easily able to shell 12 to 15 bushels of sunflower seed in an hour. It is evident that instead of having a disk as indicated by the above figure, an equally effective machine would be secured by having the thrashing apparatus in the form of a cylinder, very much like that employed in thrashing wheat or oats, except that the spikes of the roughened surface should be very much more numerous. Such a machine works more rapidly than the simple disk, but requires more power, and can hardly be driven by hand or foot power. The seeds after separation should not at first be placed in large granaries, but in barrels or small bins, to avoid any danger of heating by fermentation.

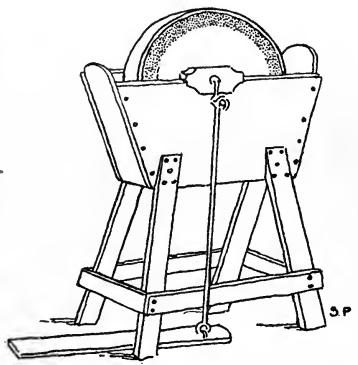

FIG. 2.—Machine for separating seeds from heads.

THE SUNFLOWER IN RUSSIA.

The sunflower has assumed an economic importance in Russia greater than in any other country. In fact, the variety of sunflower

which is most cultivated in this country at the present day for ornament and for production of seeds is known as "Russian." The sunflower finds various uses in Russia. The larger and finer sunflower seeds are highly relished as a delicacy by the Russians, even of the upper classes, and great quantities of them are eaten raw. In palatability and wholesomeness they are quite equal or superior to the nuts of common consumption. The poorer and less perfect seeds furnish an oil which is somewhat turbid and bitter and is of second quality, while the better and more mature seeds provide the edible oil so extensively used in Russia in replacement of all the vegetable oils formerly used in that country. The stalks, straw, and chaff of the sunflower are highly prized for fuel, furnishing in some localities of the Empire almost all the fuel employed.

The extent and importance of the sunflower industry in Russia was fully set forth in the report of Consul-General Crawford, of St. Petersburg, a few years ago.[1] This report gives the number of acres under cultivation in the different governments of Russia, the character of the soil and of the fertilizers used, and the methods of sowing and cultivating. The report also calls attention to the chemical composition of the plant and the lime, potassium, and phosphoric acid which it takes from the soil. The method of harvesting and thrashing the seed is also fully described, and attention is called to the use of the cakes, after the expression of the oil, as cattle food. It is stated that the oil produced from the seed is largely consumed in Russia, only a small quantity being exported. The largest amount exported in any one year was 1,490,000 pounds, worth $170,900.

The publication of this report in 1892 served to call the attention of the people of the United States to this valuable plant and also to encourage the cultivation of it on a much larger scale than had ever before been attempted in this country.

EXTRACTS FROM CORRESPONDENCE.

Sulzer Brothers, of Madison, Ind., dealers in sunflower seeds, in answer to an inquiry, wrote the following letter, dated September 3, 1895:

We are in receipt of your favor of August 26, and would have answered immediately, but have been awaiting the arrival of the first consignment of our new crop of sunflower seed. The same arrived to-day, and we send 1 pound each of the Striped Russian and the ordinary black. The Russian seed is what is wanted at present, having taken the place of the old-style black. Now, I have read several accounts of sunflower culture in Russia, and I think also in Italy, but am not certain as to the latter country. As to America, I can not find where the oil is being expressed or used. All the use that I can find for the seed is for feeding birds. If there is a mill in the United States that presses sunflower seed I am not aware of it. Last season we handled about 100 tons, and expect to double the quantity this season. It does

[1] See Consular Report, February, 1892, No. 137, pp. 233 to 246, inclusive.

seem that it is impossible for birds to consume the immense quantity raised. It may be used to adulterate some valuable oil. If such be the case, it is kept very secret. You can no doubt get some valuable information from our minister to Russia. Any information you may secure on this subject, we would be pleased to have you share with us.

Morris Brothers, of Madison, Ind., in response to inquiries sent from this office, write, under date of September 1, 1895, as follows:

In regard to sunflowers and their cultivation, I will say that in the spring, as soon as the frost is out of the ground, I cover the soil with a heavy coat of stable manure, plow from 7 to 8 inches deep, then roll with a heavy iron roller to pack the ground as much as possible. I then leave it until time to plant corn, which is from April 20 to May 10. I then use a rolling cutter disk harrow, followed with a smoothing harrow and a roller to thoroughly pulverize the soil. The ground is marked off in rows 3 feet 9 inches apart, and the seeds planted with a corn drill, with a special plate made for the purpose. When the plants are from 5 to 8 inches high, thinning commences, leaving the stalks 18 inches apart in the row. The crop is then ready for the hoe. After the hoeing it is plowed with a two-horse corn cultivator, having 3 or 5 inch shovels. The cultivation is much the same as for corn. When the stalk is in bloom I go through the field and pull off the excess of blooms, leaving only from three to four flowers on the stalk. This constitutes the principal extra expense of cultivating the crop. In regard to gathering the crop, I go through the field and gather the ripe heads, take them to the barn, and remove the seeds with a roller similar to that which is used to clean the seed from broom corn. The seed and chaff are allowed to dry thoroughly, after which they are put through a fanning mill. The seed must not be stored in large quantity in a bin, as it soon becomes musty. When stored it should be turned over twice a week, much the same as wheat. The average yield of the crop in this vicinity is from 800 to 1,000 pounds per acre.

In southern Indiana, near Madison, Jefferson County, sunflowers have been grown over considerable areas. One of the most prominent growers, W. S. Dean, in a letter to the American Agriculturist of May 2, 1896, says:

Early in the spring of 1894 I planted, on an old tobacco field in the Ohio River bottom, an acre of Russian sunflowers. They were planted with a corn drill, in rows 3½ feet apart, and were afterward thinned to 16 inches apart in the row. The plants were given the same cultivation as corn. The season was favorable, and I harvested 2,250 pounds of clean seed, or a trifle over 80 bushels, for which I received $2.75 per hundredweight, a total of $61.87 from 1 acre. During 1895 I planted several acres, but on account of the repeated ravages of cutworms the stand was very poor. Only 2 acres were harvested, and 2,500 pounds secured from the 2 acres. As the price had declined to $1 per hundredweight, I sold none, but determined to feed them instead. At the time I was feeding beef for my own use. To the other foods I added Russian sunflower seed, and killed a very fat beef of most excellent quality. I am now feeding the sunflower seed in connection with corn and oats, all ground together, to my ewes and lambs, and also have a separate department in my sheep shed, in which I keep a supply of the ground mixture, to which the lambs have free access. It is interesting to note how soon they learn to eat this feed and how rapidly they grow, all becoming fat and plump. I pour boiling water over the mixture and feed it to my hens every morning, getting an abundance of eggs in return. Some of my neighbors are feeding the seed to horses, hogs, and other stock, and report good results. The feeding should be done with care, and as the grain is very rich it should

be combined with other feeds. By referring to the Agricultural Department bulletin we find that corn has an average value of 10.3 per cent protein, 5 per cent of fat; wheat has 11.8 per cent protein, 2.1 per cent fat; whole sunflowers 16.2 protein and 21.2 per cent fat. Taking into account the area in which sunflowers may be grown, the yield per acre, the ease of cultivation, the value compared with other grains, their palatability, and the results in feeding so far as they have been tried, I can not see why they may not be grown with profit for feed, and thus help the farmer out of his present difficulties.

Mr. James D. Clemmons, of Elwood, Ind., who owns a farm on the Ohio River, in Jefferson County, Ind., has grown large quantities of sunflowers. He says:

For the past five years I have raised from 5 to 8 acres of sunflowers annually.

Soil of medium fertility seems better adapted to the growth of sunflowers, although they do well in both thin clay and rich bottom land. The seed must be planted very early. I plant in March in the river bottom and often have plants several inches high by corn-planting time. It is important that the plants should get large enough to shade the ground before the hot weather comes on. After they have attained this degree of growth no cultivation is necessary, as no grass or weeds can grow after the ground is well shaded. Plant the same as corn, using planter or corn drill, and if the plants are too thick they can be thinned, but will to some extent thin themselves. The cultivation is the same as that given to corn. Harvest about the 10th to 20th of September. Go through the field in a wagon, as in harvesting corn, and gather all the ripe flowers. In about a week this operation should be repeated and later a third gathering must be made, cleaning up the field. The growing of sunflowers crowds out the weeds and the ground is left perfectly clean after the harvest of the crop.

The thrashing is done by hand. I use a short, heavy stick for the purpose. Two or three blows will remove all the seeds. The flowers must be thrashed the same day as gathered, for if they are left in a pile or in the wagon bed they will heat. When thrashed the seed is shipped in sacks as soon as possible. From 600 to 800 pounds are produced to the acre.

When I began raising sunflowers five years ago the price of seed was 3 cents a pound, but now that more farmers are growing them the price has decreased and this year the seed is selling for 2 cents a pound.

Sunflowers are a good fertilizer. When they are planted on thin land the following crops are much larger than they were before the flowers were raised. I think the principal use of the seed now is for condition powders for cattle and horses. The oil is also expressed and makes an excellent soap, I am informed.

This statement respecting the fertilizing value of the sunflower plant is probably due to a misinterpretation of the meaning of the increased crops. It is not probable that the growth of the sunflower increases fertility.

Mr. H. H. Marsh, of Monte Vista, Colo., makes the following statement in regard to the growth of the sunflower in that State:

Sunflowers grow extremely well here, but there are not enough raised upon which a reliable report could be based. I believe I could get a crop of 100 bushels per acre.

Mr. A. M. Stratton, of Mount Vernon, Ill., gives the following information:

In reply to yours of October 17, I would say in regard to planting and cultivating sunflowers, and harvesting the seed, that they are planted and cultivated the same

as corn, and gathered, the heads being cut off, just as ears of corn are plucked from the stalks. The seed is thrashed out by several devices. One is by holding the sunflower head in the hand and scratching out the seed with a good currycomb; another is by beating it out with a stick. Where large crops are grown, a special machine, similar to that employed for thrashing broom corn, is used for removing the seed, which is then run through a fan mill to remove the chaff and dirt. Sunflowers are considered a profitable crop among many of our farmers.

The uses to which the seed is put are chicken feed and prepared stock food. Also, I understand, a certain kind of oil is made from the seed. The yield of seed is from 1,000 to 1,500 pounds per acre. The average price, one year with another, is about 2 cents per pound.

Mr. J. H. Marion, of St. Louis, Mo., under date of October 14, 1899, says:

It may possibly interest you to know that the growth of sunflower seed in Jefferson County, Ill., has been quite extensive the past summer. The industry has been promoted by a gentleman named A. M. Stratton, of Mount Vernon, Ill. Mr. Stratton furnished the seed to farmers, provided they would give him an option on the crop. About 100,000 pounds of seed have been produced under this plan. What disposition was made of it I have been totally unable to ascertain further than that it was shipped to New York. A farmer named Bennett, near Mount Vernon, sold Stratton 11,000 pounds of seed, grown from ten acres, for $156, a little more than $15 per acre.

INVESTIGATIONS OF SUNFLOWERS BY STATE EXPERIMENT STATIONS.

The sunflower has not occupied a great deal of attention in the agricultural experimental work at the stations in the United States, although a few isolated investigations have been made. Some work was done at the New York Agricultural Experiment Station in 1883, and the subject is discussed in the second annual report for that year, page 154. The objection which is urged in this report to the growth of the crop in New York State, based upon the fact that it matures late in the season, would not, of course, be tenable in more southern localities. The New York report referred to is as follows:

EXTRACTS FROM A NEW YORK REPORT.

From a late article in the Drug Reporter we obtain some statistics relating to the growing of the sunflower as a crop. In Italy its cultivation is confined to the neighborhood of Piove and Conegliano, in Venetia. In Russia the plant is most extensively grown in Kielce and Podolia, and the district of Birutch in Voronej. The production of seed is now estimated at 228,000,000 pounds from an area of 216,000 acres, or about 1,325 pounds to the acre. In Tartary and China it is cultivated in immense quantities, but no actual statistics are available. In Mysore, India, 1 acre of land gives 1,288 pounds of seed, which yields 45 gallons of oil, which is there compared to peanut oil and applied to the same use. The Russian seed is expressed on the spot, and the oil is largely employed for adulterating olive oil. The purified oil is considered equal to olive and almond oil for table use.

The chief industrial uses of the oil are woolen dressing, lighting, and candle and soap making. For the last-mentioned purpose it is superior to most oils. It is pale yellow in color, thicker than hemp-seed oil, and dries slowly.

Experimental culture in France gave a return of 1,778 pounds of seed, yielding 15 per cent of oil and 80 per cent of cake from an acre; but the product varies considerably according to soil, climate, and cultivation, and the average may be roundly stated at 50 bushels of seed from an acre, and 1 gallon of oil from 1 bushel of seed. The percentage of oil to seed ranges from 16 to 28, and that of husk to kernel from 41 to 60.

In Russia the seed is drilled into lines 18 inches apart, and the plants are thinned out to 30 inches apart in the rows, thus giving about 11,000 plants to an acre. The quantity of seed required for an acre is 46 pounds.

The station crop of 1883 occupied a plat of one-twentieth of an acre, was planted 4 kernels in a hill, the hills being 42 by 44 inches apart, and was cultivated during growth the same as corn. The soil received at the rate of 400 pounds of superphosphate to the acre. Planted May 18, vegetated May 31, harvested in September, and the seed beaten out and measured and weighed October 25, the yield being $2\frac{1}{2}$ bushels, or $57\frac{1}{2}$ pounds; expressed in acre yield, 50 bushels, or 1,150 pounds, the seed thus weighing 23 pounds per struck bushel.

From not having facilities at the station for expressing the oil we must be content with the results of analysis. Dr. S. M. Babcock found the seed to contain 20.52 per cent of the oil in the air-dry seed. One hundred seeds in air-dry condition weighed 187.7 grains, and contained 49.1 per cent of husk and 50.9 per cent of kernel. The complete analysis is as below:

Composition of sunflower seed.

Constituents.	Air-dry.	Dried.
	Per cent.	*Per cent.*
Water	12.68	.....
Ash	3.00	3.43
Albuminoids (N x 6.25)	15.88	18.19
Crude fiber	29.21	33.45
Nitrogen-free extract	18.71	21.43
Fat (ether extract)	20.52	23.50
Total	100.00	100.00

The sunflower crop, however, has difficulties in the way of curing. As the plant ripens late in the season the heads must be placed under cover to prevent waste, and they contain at this stage much water. We dried our crop by spreading the heads upon a floor without piling, and as soon as the seeds were sufficiently dry they were shelled out. As this has been a very late season, it is possible that in a more favorable year the seeds might be shelled off at the time of harvest.

RESULTS OF EXPERIMENTS IN MAINE.

The report of the Maine Agricultural Experiment Station for 1895 contains an article on sunflower heads and black-eye peas as silage crops. The yield of the sunflower heads which were used in the experiments was 12,720 pounds per acre in the fresh state, containing 2,040 pounds of water-free material. The composition of the sunflower heads and the peas used in the experiments and the yield per acre of nutrients per ton of 2,000 pounds are given in the following tables:

Composition of sunflower heads and peas.

FRESH PLANT.

Name of plant.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sunflower heads	84	1.16	2.18	4.21	5.96	2.49
Peas, whole plant	86.1	1.12	2.59	4.51	5.29	.39
AIR-DRY.						
Sunflower heads	7.27	6.73	12.63	24.4	34.56	14.41
Black-eye peas	7.57	7.45	17.19	30.0	35.18	2.61
WATER-FREE.						
Sunflower heads	.....	7.26	13.62	26.30	37.27	15.55
Black-eye peas	.....	8.06	18.60	32.47	38.04	2.83

Yield per acre of nutrients compared with Maine field corn and red clover.

Plant.	Dry substance.	Protein.	Carbohydrates.	Fat.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Maine field corn	4,224	385	3,469	156
Red clover	3,400	520	3,150	133
Sunflower heads	2,040	278	1,296	317
Peas, whole plant	1,861	249	1,312	53

Nutrients per ton of 2,000 pounds water-free substance compared with other fodders.

Nutrients.	Peas.	Sunflower heads.	Red clover.	Timothy.	Mature flint corn.	Immature Southern corn.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Protein	372.0	272.4	306	160	184	166
Carbohydrates	1,410.2	1,271.4	1,472	1,670	1,622	1,668
Fat	58.6	311.0	78	62	74	52
Total	1,838.8	1,854.8	1,856	1,892	1,880	1,886

Commenting on the above data, Mr. J. M. Bartlett, the chemist of the station, makes the following observations:

So far as is indicated by this experiment it would seem that sunflowers are not nearly as profitable a crop to raise as corn. With the same cultivation corn produces a third more protein and more carbohydrate matter per acre. From this very limited experience we are not favorably impressed with the sunflower as a profitable silage crop. The peas are not considered, as a fair average crop was not secured.

In the report of the Maine station for 1896 a supplemental report was made on sunflowers and English horse beans as silage crops. This report was also made by Mr. J. M. Bartlett, and is as follows:

For three seasons sunflowers have been grown on a small scale for a silage crop. In 1894 and 1895 very fair yields were secured, but the season of 1896 was very favorable, and an exceedingly heavy crop was the result.

Horse beans have been grown for two seasons, but owing to late planting and drought the crop of 1895 was not up to the average yield. In 1896 the seed was planted early for this climate—May 18. The plants grew well, attaining a height of 3 to 4 feet, and contained many matured pods when harvested. A good yield was secured, but it is possible that it could have been made somewhat larger, without impairing the quality, by planting somewhat closer. The plants stood about 1 foot apart in drills 3½ feet apart.

Both crops were harvested September 8–10, run through the silage cutter and mixed with corn in the silo, in the following proportions: One-fourth acre of sunflowers, one-half acre of horse beans, and one acre of corn. The whole plant of one-half of the sunflowers was put in the silo mixed with corn and beans. Of the remaining half the heads only were used.

Both mixtures were found to be well preserved when the silo was opened in January, and were greedily eaten by the cows. The stalks of the sunflowers were so large and coarse that it seemed doubtful whether the cattle would eat them, but after being ensiled the mixture was as well relished as the pure corn. The cost of growing these crops can be estimated to be about the same as that of corn. The land should be put in about the same condition, and the labor of caring for them is not materially different.

Yield per acre in pounds of sunflowers and horse beans.

Name of plant.	Weight as harvested.	Weight of dry matter.
	Pounds.	*Pounds.*
Sunflower, heads	27,040	3,767
Sunflower, whole plant	48,800	7,219
English horse bean, whole plant	20,160	3,497

Chemical composition of the plants.

Name of plant.	Fresh material as harvested.						Dry material (water free).				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sunflower, heads	86.07	1.10	1.93	3.79	5.62	1.49	7.89	13.87	27.20	40.33	10.70
Sunflower, whole plant	85.21	1.92	1.70	4	6.14	1.03	13.04	11.55	27.04	41.60	6.78
Horse bean, whole plant	82.65	2.09	3.88	3.71	7.18	.49	12.07	22.34	21.41	41.35	2.82

The very large yield of sunflowers (whole plant) per acre shown in the table above would apparently secure for them a favorable position among coarse fodder plants for silage material.

The yield of dry matter is slightly larger than has ever been obtained at the station from corn, but notwithstanding that fact it can not be considered as desirable a plant to raise for fodder where corn can be grown successfully. Its chemical composition is about the same as that of Southern corn grown in this climate; the exceedingly coarse, rough stalks and leaves of the plant make it less palatable as a fodder and, were it not ensiled, would be largely rejected by stock.

The chief value, therefore, of the experiment with this plant consists in showing the utility of the silo in saving such materials and preventing waste. Sunflowers and other coarse plants are often grown for seed or other purposes when only a small portion of the plant is used. The coarse parts that were formerly thrown away can be now utilized and made into palatable and nutritious food for stock by ensiling.

Horse beans are rich in protein and promise to rank well with plants of that class as forage crops. They have the ability, like most legumes, to gather nitrogen from the air, and consequently do not exhaust the soil of that element. At the present time, however, when the price of nitrogenous feeds, like gluten meal and cotton-seed meal, is so low, it is a question whether it is not more profitable for a farmer to give his attention largely to growing corn for coarse fodders and to buy nitrogenous feeds to balance up the ration.

RESULTS OF WORK WITH SUNFLOWERS IN VERMONT.

Sunflowers were grown at the Vermont Agricultural Experiment Station in 1893. The number of pounds of green fodder harvested per acre was 11,350, consisting of 8,612 pounds of water and 2,738 pounds of dry matter. The dry matter consisted of the following substances in pounds:

Crude ash	205
Crude protein	485
Crude fiber	642
Soluble carbohydrates	799
Ether extract	607
Nitrogen	78
Phosphoric acid	22
Potash	68

In connection with the analyses the following remark is made:

These plants were grown to furnish a portion of the fat for the Robertson mixture ensilage. The heads only were used, and it will be seen that nearly a ton and a half of dry matter and over 600 pounds of fat per acre were produced. The stalks, as shown by the analysis, are too woody for use.

The composition of the Robertson mixture ensilage is given in the eighth annual report of the Vermont Agricultural Experiment Station for 1894, as indicated in the following table:

Average analyses of certain ensilage crops as harvested and as fed.

Ensilage crops.	Original substance.		Composition of dry matter.							
	Water.	Dry matter.	Crude ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Corn ensilage, as harvested	75.75	24.25	6.50	7.87	20.00	62.51	3.12	1.260	0.356	1.401
Corn ensilage, as fed	76.05	23.95	8.55	8.60	25.37	54.95	2.53	1.376	.372	1.485
Corn for Robertson mixture	76.72	23.28	7.70	7.96	20.10	61.09	3.15	1.274	.329	1.393
Horse beans for Robertson mixture	82.47	17.53	10.95	22.73	18.75	44.11	3.46	3.637	.749	2.055
Soja bean (black) for Robertson mixture	68.38	31.62	7.56	13.68	23,10	51.72	3.94	2.184	.561	2.282
Soja bean (green) for Robertson mixture	69.88	30.12	7.95	11.35	23.88	52.75	4.07	1.815	.504	1.985
Sunflower heads for Robertson mixture	86.26	13.74	9.23	11.41	18.96	53.71	6.69	1.827	.789	2.929
Robertson mixture as put in	78.19	21.81	8.20	13.12	19.15	57.19	3.95	2.100	.487	1.860
Robertson mixture as put in	78.21	21.79	8.31	10.66	20.08	57.40	3.64	1.701	.431	1.599
Robertson mixture as fed	79.34	20.66	10.52	11.88	24.86	49.49	3.25	1.901	.443	1.984

Feeding experiments were conducted with the mixed ensilage containing the sunflower heads, and the results are given in the following extract from the report above mentioned:

Each of the ten cows was fed 10 pounds daily of fine early cut hay. While on corn ensilage they received 4 pounds bran and 4 pounds corn meal daily, while on the Robertson mixture 2 pounds grain less for every 50 pounds of ensilage fed. Professor Robertson states that as good results will be obtained with 4 pounds less grain per 50 pounds of ensilage fed, but on account of lower fat and protein contents of the mixture than contemplated by its originator, but 2 pounds less were fed. During the sixteen weeks each cow had eight weeks' feeding on each fodder, so that there were equal numbers of days' feeding equally distributed, the equivalent of three hundred and thirty-six days' feed for one cow.

Quantity and constituents of milk produced.

Kind of feed.	Milk.	Total solids.	Fat.	Solids not fat.	Total solids.	Fat.	Solids not fat.
	Pounds.	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*	*Pounds.*
Corn ensilage	4,007	14.32	5.04	9.28	574	202	372
Robertson mixture	3,978	14.50	5.15	9.35	577	205	372

Essentially the same amounts of milk and butter were given with the Robertson mixture ration with 2 pounds less grain per 50 pounds of ensilage as with the corn-ensilage ration. The difference in quality of the milk was too slight to lay stress upon.

ANALYTICAL RESULTS.

The following table shows the results of the analyses made:

Analysis of the sunflower stalks and leaves, 1892.

Constituents.	Stalks and leaves.	Heads with seeds.
	Per cent.	*Per cent.*
Water	84.45	75.62
Proteids	.96	2.35
Oil	.87	4.86
Soluble carbohydrates	6.12	7.88
Crude fiber	5.67	7.94
Ash	1.93	1.35
Total dry matter	15.55	24.38

Dr. Shutt, the chemist of the Canadian station, in commenting on the above analyses, makes the following observations:

The stalks and leaves contain but very little nutriment, being low in albuminoids and fat, and containing a large percentage of water. Though still green, their fiber was of a woody nature. Their food value is exceedingly low.

A marked difference is to be noted between the analysis of the heads and seeds and that of the stalks and leaves. The water is 10 per cent less, the albuminoids nearly three times higher, and the fat six times greater than in the stalks and leaves. The heads

with seeds would not furnish an ensilage as rich in albuminoids as that from beans, yet in this respect it would be considerably more valuable than that from corn alone. In fat, however, the ensilage is very much richer than that of either corn or beans. Granting that the fiber of the heads with seeds is fairly digestible, the indications are that a well-balanced and nutritious ensilage may be made by mixing the three crops—corn, beans, and sunflower heads with seeds—in the silo. The first would supply the large bulk of the carbohydrates, the second, the albuminoids chiefly, and the last, fat and albuminoids.

SUNFLOWERS FOR ENSILAGE.

In the report of the Canadian Experimental Farms for 1893 (on page 337) is found a statement of the results of experimental work with sunflowers for that year, which is as follows:

Five pounds of Giant Russian Sunflower seed was sown in May. It was sown at the rate of nearly 10 pounds per acre with a Planet, jr., seed drill in rows 3 feet apart, and thinned when about a foot high to about 12 inches in the row.

On October 16 and 17 the heads were taken off to mix with the corn in the silo. The weight of heads produced was 9, 690 pounds, or at the rate of over 8 tons per acre.

In the same report, the agriculturist, in connection with the chemist of the station, described an ensilage in which the sunflower heads and seeds were a component part. The sunflower heads with seeds employed in the making of the ensilage were the same as given in the preceding table.

In the series of feeding experiments on dairy cows with corn ensilage alone, and with a mixture of corn ensilage and sunflower heads, it was found that although the milk obtained with the mixture containing sunflower heads had a slightly less percentage of fat, the amount of butter recovered was slightly greater. The butter made from both systems of feeding, when examined, showed that that made from the feed containing sunflower was of a richer flavor and of a higher color than the other. The directions for growing the materials for the ensilage and making the ensilage of the Robertson mixture, as given to the Canadian farmers, are as follows:

Soil.—If a field with a drained, warm, loamy soil be convenient to the silo, and can be used, it should be selected in preference to a heavy clay or wet soil. In all cases, the land should receive a liberal dressing of manure, be plowed in the spring, and be harrowed to a state of fine tilth before the seeds are planted.

Time to plant.—The time at which indian corn for fodder may be planted with the best results is the best time at which to plant or sow these seeds also. In most districts that period is during the last ten days of May, or late enough in the season to escape frosts at night, and early enough to give the plants the advantage of as long a season for growing as is practicable. The horse beans and sunflowers are less liable to injury from frost than indian corn.

How to plant.—The indian corn and horse beans (which have been mixed) are to be planted in rows 3 feet apart, with from 2 to 4 grains per linear foot in every row. A horsepower corn planter or seed drill may be used for that purpose, or they may be planted in hills 3 feet apart both ways, with from 6 to 10 grains in every hill. A horsepower or hand corn planter may be used. If none of these implements and no other suitable planter be available, furrows 3 inches deep may be plowed 3 feet

apart. The seeds may be put in them and covered, after which the field should be rolled. The sunflower seeds are to be planted by themselves in rows 3 feet apart with not more than 3 or 4 seeds per foot in the row. They may be planted with a small hand planter, or by a method similar to the one which is used with the indian corn and horse beans. All the seeds should be planted to a depth of from 2 to 3 inches.

Cultivation.—Only in cases where a crust forms on the land, before or immediately after the plants come up, a light harrowing will prove helpful to the crop. The cultivation between the rows, when the plants are small, should be close to them; when the plants have grown to a height of 2 feet it should be more distant and shallow, in order not to injure the side roots.

Cutting in the field.—The crop is to be cut when the indian corn reaches the "glazing" stage of growth; that is, when the ears are just past the best condition for table use. The corn and beans may be cut by hand or by any of the devices in use for cutting fodder corn in the field. The heads only of the sunflowers are to be used. They may be cut off by a common reaping hook or other knife. They may be put directly into a wagon or cart, or into a basket, or into heaps, from which they may be loaded afterwards.

Putting into the silo.—When the indian corn has reached the "glazing" stage of growth, the crop is to be put into the silo without wilting or drying; but when it has not reached the glazing stage before frost comes, it is to be cut and left to wilt or dry in the field for about one day. The corn and beans (from 2 acres) are to be cut in lengths of from ½ inch to 1 inch and put into the silo; and the heads only (from half an acre) of sunflowers are to be cut with them. They may be fed through the cutting box with the corn and beans. A fairly even distribution of the mixture should be made in the silo while it is being filled. If the leaves and lighter parts are permitted to flutter into one place, and the stalks, ears, and heavier portions are allowed to settle by themselves, the ensilage will not keep well. The mixture is to be tramped thoroughly around the sides and in the corners of the silo. A thin layer of uncut cornstalks should be put between the Robertson mixture and the other contents (if any) of the silo, in order to mark the exact place in the ensilage.

After the silo is filled, the surface should be leveled and thoroughly tramped, and after the lapse of not more than one day it should be covered to a depth of 6 inches with cut straw or cheap fodder. If this be tramped occasionally, and a foot of cut straw be put on top of that a few days later, probably no waste ensilage will be found on the opening of the silo for feeding.

Feeding the ensilage.—The Robertson mixture is to be fed with 4 pounds less meal or grain per 50 pounds of ensilage than has been required with ordinary corn ensilage, to make an economical ration for feeding milch cows and fattening cattle.

COST OF GROWING SUNFLOWERS.

In the report of the experimental farms of the Dominion of Canada for 1894 is found, on page 100, an estimate of the cost of growing sunflowers, which will prove of interest.

Four acres of sunflowers of the Mammoth Russian variety were sown April 23, by using a Planet Junior seed drill, with 5 pounds of seed per acre, in rows 3 feet apart. The plants came up thick and were thinned when 2 or 3 inches high, so as to leave one plant every 12 or 18 inches in the rows. The heads were allowed to become almost ripe before they were cut; and they were in a drier condition than in former years. In 1892 the yield per acre was 7½ tons, containing 75.62 per cent of water. In 1894 the heads when cut contained on the average 69.3 per cent of water.

The following is a statement of the cost of labor for growing the four acres of sunflowers and putting the heads into the silo:

Rent of land, at $3 per acre	$12.00
Plowing, at $2 per acre	8.00
Harrowing, twice at 20 cents each time per acre	1.60
Rolling, at 20 cents per acre	.80
Seed, 20 pounds	2.00
Sowing, $1\frac{9}{10}$ days, at $1.25	2.00
Hoeing and thinning, $10\frac{1}{10}$ days, at $1.25	13.13
Hand-wheel hoeing, 2 days, at $1.25	2.50
Cultivating, $2\frac{9}{10}$ days, at $1.75	5.07
Cutting and putting into silos, $17\frac{1}{2}$ days, at $1.25	21.88
Horse and cart, drawing in, $6\frac{1}{2}$ days, at $1.75	11.38
Proportion of time of farm foreman	8.00
Total	88.36

These figures do not include any allowance for the use of farm machinery, nor do they include any amount as an equivalent for the exhaustion of soil. The cost for labor was $22.09 per acre. The average yield of heads, nearly all ripe, was 3 tons, 1,009 pounds, which gives an average cost of $6.30 per ton for labor of growing, including cost of seed and rent of land, etc., as in statements.

EXPERIMENTS CONDUCTED BY THE DIVISION OF CHEMISTRY.

The average height of the Russian sunflower as grown in the United States is probably about 6 feet, but occasionally plants of very much larger dimensions are produced. The largest plant which has been described grew in Washington during the summer of 1897, and a photograph of this plant, which is reproduced in Plate I, was made on the 3d of August, 1897. The circumference of the stalk of this plant at the surface of the ground was 8 inches, showing a diameter of almost 3 inches. The extreme height of the plant was 12 feet and 6 inches. It is evident that this large plant was produced under extraordinary conditions of fertility.

DIMENSIONS OF SUNFLOWER PLANTS.

Many discrepant statements have been published in regard to the dimensions of sunflower plants. These discrepancies have arisen chiefly from the fact that actual measurements have not been made, but simply approximate estimates. It is evident that often the plant attains a height of 10 or 12 feet, but the average height of the plants is not so

great, as will be seen from the measurements of 17 plants grown in the garden of the Department of Agriculture, given in the following table:

Measurements of sunflowers made July 29, 1897.

(All terminal flowers were fully opened unless otherwise stated.)

No. of plant.	Total height.	Total width.[1]	Width of leaf.	Length of leaf.[2]	Diameter of flower.[3]	Circumference of base of stalk.[4]
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1.....	68	50	16	17	11	6.75
2.....	77	47	17.5	16	11.5	6.5
3.....	63	45	15	14.75	9.75	5.25
4.....	73	40.5	14.25	13	10.75	5.75
5.....	71.75	43	14.75	14.25	10.5	6
6.....	60	46.75	17.5	15.75	12	5.75
7.....	54	49	18	17.5	11.5	6
8.....	85.5	50.5	19.75	16	9	7
9.....	78.75	53.25	21	19	10.5	6.5
10.....	103.25	54	19.5	[5]20	[5]5.25	7
11.....	93.5	46.25	15.5	13.75	7.25	6
12.....	101	52.5	19.25	17.75	9	7.25
13.....	65.25	49	18.25	17	10	6.5
14.....	84	49.75	17	15.75	10	7
15.....	85	50.75	17.75	[5]19	[5]11	5.75
16.....	98	49	17	15	4.25	8.25
17.....	76	49.75	17.75	17	8.25	6.25

[1] Measured from tip to tip of two opposite outstretched leaves which were selected at about one-half the height of the plant.

[2] Measured from beginning of the expansion of the petiole into the leaf skeleton to the tip of the leaf.

[3] Measured from opposite points of the circle marking the insertion of the yellow rays.

[4] Measured at the middle of the lowest internode.

[5] Not fully out.

Diameters of sunflower disks, September 13, 1897.

Number of plant.	Inches.	Number of plant.	Inches.	Number of plant.	Inches.
1.....	12	7.....	11½	13.....	12
2.....	9⅕	8.....	14⅕	14.....	12
3.....	10	9.....	11	15.....	12⅛
4.....	12	10.....	16⅕	16.....	13
5.....	10⅕	11.....	.....	17.....	12
6.....	11	12.....	13		

COMPOSITION AND CHARACTER OF SEEDS AND OTHER PARTS OF THE PLANT.

The sunflower seeds corresponding to serial No. 14183 were the striped Russian variety, procured from Sulzer Bros., of Madison, Ind., and those corresponding to 14184, the ordinary black variety derived from the same source. The following table shows the weight of 100 of the seeds and the relation between the kernel and the shell of each variety:

Weight of seeds, kernels, and shells.

	Serial numbers.	
	14183.	14184.
Weight of 100 seeds ..... grams..	6.99	10.60
Weight of 100 kernels ..... do....	3.39	5.50
Weight of 100 shells ..... do....	3.60	5.09
Per cent, by weight, kernels	48.47	51.93
Per cent, by weight, shells	51.53	48.08

From the above data it will be seen that the total weight of the seeds is about evenly divided between kernel and shell. Inasmuch as the shell is rather an absorbent material, it is important, in the expression of the oil, that it should be removed so as to avoid the absorption which otherwise would take place.

The composition of the various parts of the sunflower plant is shown in the following table:

Composition of the various parts of the sunflower plant.

Serial No.	Sample.	Moisture.	Ether extract.	Crude fiber.	Protein.	Ash.	Carbohydrates by difference.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14219	Sunflower seeds	4.43	27.08	29.17	14.97	3.41	20.94
14220	Sunflower stalks	8.79	1.83	43.30	4.47	9.12	32.49
14221	Sunflower leaves	12.51	4.09	13.16	10.15	21.26	38.83
14222	Ten heads after removal of seeds and husks	7.40	5.07	18.44	9.91	19.39	39.79
14223	Sunflower husks	8.32	5.23	17.74	6.13	11.08	51.50
14277	Sunflower kernels from No. 14219	4.89	45.21	2.67	26.85	4.32	16.06
14278	Sunflower seed shells from No. 14219	6.16	1.67	63.75	3.00	2.20	23.22

It will be noticed from the above data that the content of ash is very uniformly distributed throughout the different parts of the plant. The leaves appear to contain the greatest percentage while the smallest is found in the shells of the seeds. The percentage of protein is high, as would be expected, in the kernels of the seeds. In the shells of the seeds and in the stalks it is low. The content of oil in the seeds, after the removal of the husks, is very high.

THE ASH OF THE SUNFLOWER PLANT.

In order to determine the distribution of the various ash constituents in the several parts of the plant, the ash coming from the seeds, the stalks, the leaves, the seed heads, the husks or chaff, the seed ker-

nel, and the seed shells was subjected to separate analyses. The data obtained are found in the following table:

Composition and distribution of the ash.

Constituents.	Seeds 14224.	Stalks 14225.	Leaves 14226.	Heads—seeds and husks 14227.	Husks 14228.	Seed kernel 14279.	Seed husk 14280.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Potash (K_2O)	29.02	38.94	8.04	54.24	55.66	25.50	47.36
Soda (Na_2O)	1.12	3.84	.94	.42	1.65	.81	.99
Lime (CaO)	9.43	24.08	44.00	16.61	20.08	6.58	20.91
Magnesia (MgO)	17.90	19.88	21.52	10.01	9.47	14.70	15.88
Oxid of iron (Fe_2O_3)	.46	1.22	2.77	.67	.91	.42	1.09
Phosphoric acid (P_2O_5)	38.40	1.54	3.28	4.44	3.73	50.84	6.83
Chlorin (Cl)	.54	7.30	1.47	8.62	4.59	.03	1.50
Sulphuric acid (SO_3)	2.87	3.53	4.46	5.50	2.94	.97	4.98
Silica (SiO_2)	.38	1.31	13.85	1.43	2.00	.15	.80
Sum	100.12	101.64	100.33	101.94	101.03	100.00	100.34
Oxygen=Chlorin	.12	1.64	.33	1.94	1.03	.....	.34
Corrected Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00

It will be noticed from the above table that potash is the principal mineral ingredient of the ash of the sunflower from whatever part of the plant it is derived, with the possible exception of the leaves, where the content of potash is comparatively low. Lime is an important constituent of the ash in all cases, but especially of the leaves. Magnesia is found in about the same abundance as lime, being larger in quantity than the lime in the ash from some parts of the plants and lower in others.

The principal acid in the pure ash is phosphoric, although the content of this acid is quite low in the stalks and naturally high in the seeds. If the kernels and hulls of the seeds be studied separately it is found that the percentage of phosphoric acid in the ash of the kernels is 50.84, while in the hulls of the kernels it is only 6.83.

It is evident from the above data, including the composition of the sunflower itself, that it is a plant which makes considerable drain upon the three principal mineral plant foods, viz, nitrogen, phosphoric acid, and potash.

COMMERCIAL MANUFACTURE OF SUNFLOWER OIL IN THE UNITED STATES.

Many inquiries have been received asking for information in regard to the manufacture of sunflower oil on a commercial scale in the United States, and a diligent search has been made to discover any factories engaged in this enterprise. The addresses of several milling companies were secured, which it was thought might have information in regard to the matter, and letters were addressed to them for

information. D. I. Bushnell & Co., of St. Louis, dealers in flax, castor, hemp, sunflower, and other oil seeds, in response to my inquiry, write as follows:

Answering yours of the 20th instant, I do not think there has ever been any sunflower oil made in the United States. Some years ago it was tried, but without success. The porous shells of the seeds absorb the greatest portion of the oil, and therefore we think sunflower seed as grown in the United States hardly suitable to the manufacture of oil.

In response to a request for information in regard to the manufacture of sunflower oil in the United States, the Oil Seed Pressing Company, of New York, sent the following letter:

Your esteemed favor of the 5th duly received, and in reply to same would state that we have never engaged in the practical manufacture of oil from sunflower seed. We pressed up one or two small lots, but the result was very unsatisfactory, and it was done so long ago that we forget the details, and did not retain either the cake or oil.

Any other information we have bearing on this subject we have obtained from a report of the United States consul to Russia. We do not think that the manufacture of sunflower oil will ever become an industry in the United States, as we have not found or seen samples of seed containing a sufficient quantity of oil to pay the cost of manufacture.

The large product of cotton-seed and corn oils, with their low prices, seems to fill the wants of the people, and not to leave room for anything new.

It is seen that the general impression which prevails in the minds of many to the effect that sunflower oil is manufactured in a commercial way in the United States is erroneous. The impression, however, is shared by the Board of General Appraisers at the port of New York, which decided that sunflower seed was imported into this country for oil-making purposes, and therefore was dutiable. The opinion of the General Appraisers is as follows:

The General Appraisers have decided that these seeds are entitled to free admission, under paragraph 656, as a flower seed. They were assessed for duty at 30 per cent ad valorem under paragraph 254 as seed "n. s. p. f." The General Appraisers held that they are a flower seed, and therefore free, the law providing that flower and grass seeds n. s. p. f. are free.

It is our opinion that these seeds are imported for the purpose of expressing oil which we believe to be used for adulteration of some kind. The reason for this opinion is that it is very difficult to ascertain what becomes of the seed. We do not believe that the sunflower is raised for its beauty, but rather that the seeds are cultivated for some such purpose as above indicated. I would therefore respectfully recommend that the Department of Agriculture be asked to make this merchandise the subject of special investigation.

To this request the Secretary of Agriculture made the following reply:

NOVEMBER 24, 1899.

The SECRETARY OF THE TREASURY.

SIR: I have the honor to acknowledge the receipt of your letter of the 21st instant, inclosing a communication from the United States appraiser at the port of New York in re sunflower seed.

Investigations made by the Division of Chemistry of this Department have shown that sunflower seed is not used for the expression of oil in this country, but is extensively used for poultry feeding and for the food of horses and cattle not in the best of health. The admixture of sunflower seed with the ordinary food of these animals tends to restore them to health, and puts their systems into excellent condition. There is in this country quite a large commerce in sunflower seed used for this purpose.

Careful investigation made by the Division of Chemistry has failed to find any factory in this country in which the oil is expressed from these seeds. Experimentally, the Division of Chemistry has demonstrated that this seed yields an excellent oil, suited for table uses, in the replacement of olive and cottonseed oil. Dr. Wiley, the Chemist of the Department, has informed me that he has tried this oil, and has found it to be of most excellent quality. It is believed that eventually the industry of making oil from the sunflower seeds will be developed in this country.

The Chemist of the Department is now preparing a bulletin on the subject, in which detailed information of which a summary has just been given, will be contained.

I think that the Appraiser of the port of New York can safely be guided by the above statements, inasmuch as I think the large quantities of sunflower seed imported into this country are used for poultry food and for the feeding of cattle.

I have the honor to be, sir, very respectfully, your obedient servant,

JAMES WILSON, *Secretary.*

SUMMARY.

(1) The sunflower is a plant which can be grown successfully over large areas in the United States.

(2) From the chemical analysis of the whole plant it is evident that it is a crop making a considerable drain 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.

(3) One of the most valuable constituents of the plant is the oil which exists in large quantities in the seeds. This oil is formed by direct synthesis in the process of growth, and does not diminish to any great extent the fertility of the soil. On the other hand, the protein matter which exists in large quantities in the seeds is derived almost exclusively from the nitrogenous elements in the soil or added in fertilizers. There is no evidence that the sunflower plant has the property possessed by the Leguminosae of assimilating free nitrogen by means of symbiotic organisms attached to its roots.

(4) The economic production of the sunflower plant is now confined almost exclusively to Russia, where it is an agricultural industry of considerable importance.

(5) In the United States the sunflower is grown as an ornament and for the production of seeds which are used chiefly for poultry and bird feeding, and for condimental and medicinal properties with farm animals.

(6) The oil of the sunflower seed is not produced commercially in the United States. It is very palatable and makes, without refining,

an excellent salad dressing. The residual oil cakes have a high nutritive value, quite equal if not superior to that possessed by flax-seed and cotton-seed cakes.

(7) In the cultivation of the sunflower the methods pursued for growing indian corn are to be followed, and the plant is capable of cultivation over almost as wide an area as indian corn.

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