SWEET CORN GROWING FOR MARKET AND MANUFACTURE

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Extent of Industry. Sweet corn occupies an important place in the list of vegetables grown for the open market and for manufacture. No information is available regarding the acreage of sweet corn grown in the United States for local marketing to cities, or for shipment, as this crop does not appear in the statistics of the United States Department of Agriculture in so far as car or truck shipments are concerned. Most of the sweet corn grown in the United States, other than that grown for canning and freezing, is produced largely for local markets, and this acreage of sweet corn has been comparatively stable for a number of years past. However, the acreage of sweet corn for processing in the U. S. in 1943 was 54 percent higher than the ten-year average of 1932 to 1941. During the latter period the annual mean acreage of sweet corn for manufacture was 322,010 acres. In 1943 this acreage had increased to 496,910.

In Oregon, sweet corn is grown for canning and freezing, for local marketing and for carlot shipping. U.S.D.A. reports indicate that for the ten-year period from 1932 to 1941 the average annual acreage of sweet corn for manufacture in Oregon was 2,000 acres. In 1943 it was estimated that there were 4,700 acres grown for processing, and that this represented approximately 57 percent of the total acreage of sweet corn for the state, the remaining 43 percent being planted for local marketing and for carlot shipping.

The estimated number of cases of sweet corn canned in Oregon in 1929 was 6,250, but in 1943 this number had increased to 212,035 cases.

It was estimated that the sweet corn frozen pack in Oregon-Washington* in 1934 was 500,000 pounds. This figure had increased in 1943 to 7,806,924 pounds which was more than one-third of the total frozen sweet corn pack of the U. S.

In comparison with the national canned corn pack of approximately 30 million cases in 1943, the western pack appears to be of comparatively minor importance but nevertheless it is of importance in supplying the demand of the Pacific Coast area.

In recent years an industry of shipping green corn from Oregon to markets outside of the state has been developed. In 1938, 51 carloads were shipped out of Oregon, and 150 cars in 1943, 109 of which were shipped in September and 40 in October. Practically all of the shipments originated in Marion county.

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* The data available are not segregated for the individual states.

The Plant and Its Relation to Production. Sweet corn bears both the male and female flowers on the same plant. The terminal portion of the main stem, the tassel, bears the male flowers and on the ends of lateral branches near the center of the main stem are the ears bearing the well-known silk or female organs. Leaf sheaths overlap and form the so-called husks which enclose the ears.

The sweet corn plant is naturally a warm weather plant during practically its entire growth. The young plants of the first early plantings may be injured by late spring frosts. Growth of the plant, particularly in its early stages, is retarded by cool, wet weather, but thrives in sunshiny, warm weather. During the period of ear production, however, high temperatures are not so desirable because during warm weather the kernels pass more rapidly from the early milk to the dough stage with corresponding change of desirable sugar into undesirable starch.

There is a popular belief that sweet corn grown and canned near the northern limits of its production is sweeter and of better quality than that canned further south. It has been shown, however, that the actual content of sugar in sweet corn differs comparatively little between that grown in the north and south, but the rapidity with which the sugar changes to starch in the field during the development of the ear or the rapidity with which the sugar is lost after harvest is in direct proportion to the temperature prevailing. Because of the lower temperatures which prevail in the northern areas during growth and harvest time, the rate of kernel development is slower. This obviously results in a product which retains its higher quality for a longer period during the harvest season.

Soils. For early production a warm sandy loam soil is valuable, especially if it is high in humus. Such a soil must be irrigated if it is to produce sweet corn of high yields and good quality. If irrigation is not available a heavier soil should be used which will be more retentive of moisture. The yield and quality of sweet corn during the dry period of the summer will be dependent upon the degree of soil moisture available. Most corn grown for processing and for car shipments is irrigated.

Corn will not grow nor yield well on impoverished land or that which is low in moisture content during the summer. The crop is sometimes planted in a rotation including a legume and some cultivated crop such as potatoes. Sod land is often undesirable because of the possible presence of wireworms.

Fertilizers. It is evident from the experience of various growers that good yields of sweet corn may be obtained by turning under a green cover crop, such as vetch, and supplementing it with the application of some commercial fertilizer. If available, an application of rotted manure is useful in providing organic matter and plant food, and it can be supplemented, if necessary, by an application of some commercial fertilizer.

In areas where good results have been obtained from the use of commercial fertilizers, the ratio of nitrogen to phosphoric acid and potash has been about 1-3-1 or 1-4-1. It is generally agreed that phosphate fertilizers are useful in stimulating early rooting and early maturity of the plants. A commercial fertilizer having an analysis of 4-12-4 or 4-16-4 has been used, and from 300 to 500 pounds of such material has been applied per acre, depending upon the manner of

application. Ammonium phosphate, 11-48, to which some potash fertilizer may or may not be added, would also be a suitable fertilizer.

While there may be some difference in the ratio of these plant foods to each other, there will also be variation in the manner in which sweet corn fertilizer is applied. In the earlier period of production of corn practically all of the fertilizer was broadcast but in recent years applications have been made economically and profitably by placing the material in a band to one side of the row at the time of planting. There is now considerable attention being paid to the application of the fertilizer by the plow-sole method. Thus far an insufficient amount of experimental data is available to substantiate this method of application. The application of fertilizer in a band, 2 to 2-1/2 inches away from the row, however, has proved to be an economical and efficient method of placement, and probably will continue to be used by growers until some other method has been found to be superior.

Because of their vigorous growth and large foliage, hybrid sweet corn varieties demand soil of good fertility. They will not produce well on land that might otherwise support some of the open-pollinated varieties having less vigorous growth.

Varieties. Varieties of sweet corn differ in season of maturity, size and shape of ear, color, size and shape of kernels, number of ears per plant, edible quality and commercial value. The most popular varieties of sweet corn are those having yellow kernels. White-kernel varieties which formerly constituted the earliest sweet corn have been largely displaced in recent years by yellow varieties varying in season from early to late.

The most outstanding progress in improving sweet corn as a vegetable has been made during the last twelve years in the breeding of hybrid sweet corn varieties and strains, several of which have largely displaced previously grown, open-pollinated varieties. The seed of a single cross hybrid, such as Golden Cross Bantam, is produced by the transfer of pollen from one inbred strain to the silks of another unrelated inbred. These two inbred lines are obtained by means of self-pollination of each of the inbreds for several generations. An open-pollinated variety, such as Golden Bantam, is one in which the seed is produced by natural cross fertilization in the field, in which case any of the plants in the field may act as male or female parent.

Hybrid varieties, such as Golden Cross Bantam, are superior to open-pollinated varieties, particularly for manufacture, in that they yield more heavily and mature more uniformly. Labor costs in harvesting are reduced because of fewer times of going over the field. Most fields of Golden Cross Bantam are now harvested once or at the most twice. There is likewise greater uniformity in all ear characteristics. Open-pollinated varieties are useful in home gardens, and in some cases in commercial market gardens where a greater spread in the maturity of the ears is desired.

By far the greatest acreage of sweet corn grown for manufacture is of the hybrid variety, Golden Cross Bantam (P39 x P51). Despite the introduction of hundreds of other hybrids this variety still remains the standard by which other

hybrids are compared. Most of the corn grown for shipping is likewise of this variety.

Other hybrid sweet corn varieties grown for manufacture include Seneca Golden, an early variety yielding well and of good quality, Carmelcross, about a week or so earlier than Golden Cross Bantam, and Ioana which is slightly later than Golden Cross Bantam and not of such good quality. Tendergold is a promising hybrid having good quality and tender kernels. Other hybrids are being grown and tested at the Oregon Experiment Station and a separate report on their performance is available.

Seed and Planting. It is important to grow a crop of sweet corn from seed obtained from ears carefully selected for type and production. The new hybrid varieties demonstrate the value of combining desirable and congenial male and female inbred lines.

There are two general ways of planting sweet corn, (1) the hill and (2) the drill method. The corn seed hill planter is somewhat undesirable in that when planting the seed in the hill the seeds are necessarily crowded and grow in a comparatively small space, both in relation to soil moisture and fertilizer. However, planting in checks makes possible cultivation in both directions. When this method is used it is probably undesirable to have more than three plants in a hill. The number, however, will depend on the soil type, its retention of moisture, the possibility of irrigation and the variety grown. Ordinarily about 8 pounds of seed are used per acre.

In the drill method the seed is sown so that the plants stand approximately 12 inches apart in the row. Plants are better distributed than in the hill system and can draw on a wider area of moisture in a dry season. By this method, of course, cultivation is possible only in one direction.

Soils in a higher level of fertility willbe able to maintain more plants per acre than less productive soils. Likewise more plants can be grown on irrigated than unirrigated lands, moisture being oftentimes the limiting factor in the growth of the corn. In some cases seasonal conditions may affect the development of the corn more than the spacing factor.

It is particularly useful to treat sweet corn seed before planting, particularly in case the season is late, cold or wet, or it is necessary to plant the seed in soil that is unusually moist. Seed treatment material will protect the seed during germination and will ordinarily effect a more uniform stand of plants and thus a greater uniformity of maturity of the crop at harvest time. The recommendation of Oregon Station Circular of Information No. 334 on "Vegetable Seed Treatment" is that Semesan Jr. be used at the rate of one ounce for 37 pounds of seed, or 1-1/2 ounces per bushel, or one teaspoonful to four pounds of seed.

The average depth of planting sweet corn seed is about two inches. Some growers drop it in a furrow, throwing the soil to the roots later on, but it has been demonstrated that the secondary root system establishes itself at about the same depth whether the seed is planted moderately deep or shallow. If the corn

seed is planted too deep, however, the young seedling may be exhausted before the leaves can start vigorous growth above ground.

In view of the variation in size of seed of different varieties of sweet corn, adjustments must be made to the seeder so that the proper stand of plants is obtained.

It is unwise to plant corn seed until danger of frost is about over and the ground has begun to warm up. Early varieties of corn are sometimes planted in late April, particularly for the open market, and then plantings continue successively through the spring to midsummer. Another method of providing successional harvestings for market is that of planting varieties maturing at varying dates. This is particularly desirable in the case of the market garden, the home garden, or sometimes even where corn is grown for canning and freezing. With irrigation available, planting may be continued up to late June or even early July. Such a planting will give a useful fall crop.

For sweet corn grown for processing, planting is usually made in May with varieties maturing in from 88 to 110 days from seeding.

Cultivation. The primary object of cultivating between rows of corn is to destroy weeds. It may also be of value in keeping the texture of the soil intact and preventing crusting; however, light soils quickly form their own mulch and it is improbable that frequent cultivations will assist in conserving soil moisture. Corn cultivation should never be deep. The tools used should preferably be those which will cut off weeds and form a light mulch. There is no necessity for cultivating corn if there are no weeds, no rain and the soil already has a satisfactory mulch.

Suckering. While it is generally true that the hybrid sweet corn varieties have a tendency to produce more suckers than the open-pollinated varieties yet there appear to be no definite advantages in removing suckers. Particularly from a commercial, economic standpoint this treatment is impractical.

Irrigation. If sweet corn land can be irrigated the advantages derived from watering warrant the application of water, provided it can be applied economically. The ears will usually mature somewhat earlier and more uniformly, and there will be a greater percentage of ears of better grade and quality with fewer nubbins or poor ears. Methods of irrigation include both the gravity or furrow method and the overhead system according to the area where the corn is grown. In western Oregon where corn is produced for manufacture and carlot shipping most of the irrigated corn is watered by slip-joint pipe and rotary sprinklers. One grower reported an increase of 100 percent marketable ears due to irrigation, with a net profit of over 3-1/2 times the cost of irrigation, labor, electricity and charges of interest and depreciation.

Insect Pests. The corn earworm is sometimes troublesome, particularly in the latter part of the summer. Dusting the silks with cryolite may be practical for the grower of market corn who may not be producing extensively, but there is little, if any, control work carried out where corn is grown on a large scale for processing. Extension Bulletin 551 should be consulted for details on dusting.

Station Circular of Information No. 312 discusses the control of the earworm by means of applications of mineral oil or oil containing pyrethrum extract.

The Western 12-spotted beetle may also be quite injurious at times in chewing the silks of the ears. The same dust mentioned above will act as a repellent to the beetles if it is used for earworm control.

The seed-corn maggot, often prevalent during a wet spring, can sometimes be an early menace to plants, especially if plantings are made on sod land or new land. There is no satisfactory control measure known.

Harvesting. Sweet corn rapidly approaches a stage of development for harvesting following the appearance of the silks. Usually this is about 20 to 22 days following silking, but the actual time will depend on the variety as well as weather conditions. There is a positive correlation between the temperature prevailing during this time and the rapidity of growth of the ear in reaching a state of harvesting.

It is desirable to harvest sweet corn when it has its best quality. Quality is closely associated with tenderness and the sugar content of the kernels. During the ripening process the sugar rapidly changes into starch, the kernels passing successively through the pre-milk, milk, early dough and dough stages. The difference between the characteristics of sweet corn in these different stages is shown in the following table.

Table 1. Variation in Sugar and Starch of Sweet Corn According to Development in Maturity of the Ear

Condition of Development of Ear	% Moisture	% Total Sugar	% Starch	Ratio Sugar to Starch
Pre-milk	85.10	6.26	3.29	1.903
Milk	80.16	5.79	7.72	.750
Early Dough	71.07	3.91	16.35	.239
Dough	64.00	3.17	21.62	.146

Best canning stage is between milk and early dough.

Corn may reach its highest point of sweetness 15 days or so after silking, but it is too immature and has an undesirable lack of body and flavor. If harvested too soon, also, the yield in tons of corn per acre and the cases of canned corn per ton will be low as compared with the corn which is picked at the stage between the milk and the early dough stage. When ready for canning, sweet corn has passed the highest point of sweetness but is in a prime condition insofar as texture and body are concerned. In the best canning state the sugar content is from 5 to 6 percent and the starch 10 to 11 percent or ratio of sugar to starch of .500 (See Table 1).

In canning corn there are two kinds of packs - "whole grain" and "cream style." The corn harvested for whole grain pack must be watched closely for degree of development. This is particularly true in the case of harvesting sweet corn for freezing.

Corn which is under or over the whole grain stage may be satisfactorily packed cream style.

The rapidity with which corn passes through the various stages of development is in direct relation to the temperatures prevailing. The higher the temperatures during harvesting time, the shorter the period during which the corn is in a suitable condition to be harvested. In this respect one can more readily appreciate the uniformity of maturity of sweet corn hybrids.

Another important fact in regard to harvesting is the loss of sugar of the corn after picking. The higher the temperatures under which corn is kept until processed the more starchy it will become and the greater the loss of sugar. During the first 24 hours after harvesting the loss of sugar at 86° F. is twice that at 68° F. Likewise if the corn can be kept at a temperature approximating 50° F. the loss will be considerably less than that at 68° F. It is desirable, therefore, to reduce the temperature of the corn or process it just as rapidly as possible after harvesting.

Determining Maturity. There are several ways of determining when sweet corn should be harvested; first, the ear will appear plump and well filled to the tip; second, the silks will have turned dark; third, a "feel" of the ear will indicate the kernel development and designate whether or not it is ready to be picked; fourth, the old-time thumbnail test consisting of penetrating the kernel with the nail to observe the consistency of the exudate; fifth, by means of recorded readings made by the tenderometer.

The tendency of some market sweet corn growers is to pick ears too mature rather than too young. Quality should not be sacrificed for fullness of ear or weight. No fine canning or freezing process can make a good corn pack out of an inferior or overmature raw product. This makes it imperative that the stage of development of the ear be very closely watched. In the market garden and home garden it is possible to go over the plantings frequently to harvest the ears in their prime stage, but in growing corn for canning or freezing harvesting may be done but once or twice. Uniform maturity of each planting is therefore of prime importance in production of corn for processing considering the fact that many fields are "stripped" at harvest-time, namely, the whole field picked at once.

Precooling. In growing sweet corn for shipping it is desirable to cool the ears just as rapidly as possible after harvesting. There are various methods of removing "field heat" from the product. A good deal of Oregon corn for shipment has been cooled by being put through a cold water bath in which case the crates of packed corn move slowly through an enclosed chamber where they are sprayed with iced water. Thence they are quickly loaded in the cars and the load top-iced.

In the case of corn for manufacture the ears are canned or frozen just as rapidly as possible after harvesting, consistent with the readiness with which they can be put through the factory. Rapid handling is just as important in manufacture as is the cooling process in car shipments.

Containers, Yields and Values. Market corn is usually packed in a standard six-dozen box. Processed corn is delivered in packages furnished by the cannery or may be hauled in bulk in trucks to the factory.

The number of ears harvested per acre may vary from 10,000 up to as high as 25,000. Probably an average of several varieties would be between 15,000 and 18,000. Some of the better strains of hybrid sweet corn produce up to 22,000 ears per acre. There is considerable evidence that strains of the same hybrid variety may vary considerably in production, and this is true at the present time among the various strains of Golden Cross Bantam as well as other hybrids.

In tons per acre, sweet corn yields vary from two to six tons. Some growers have produced more than the latter figure, but this is unusual. The average yield for the United States in the growing of sweet corn for processing over a 10-year period from 1932-1941 is 2.21 tons.

In the production of sweet corn for shipping, the yield per acre is less than that obtained for cannery corn due to the more rigid culling of ears.

Sweet corn for canning and freezing was estimated to be worth about $25.00 per ton in 1944. Early market corn may bring 65 cents or so per dozen ears at the early part of the season, with the price dropping rapidly under heavy receipts. Boxes of six dozen usually bring around $1.75 to $2.00 in midseason.