

Post harvest handling and
marketing of garden fresh
SWEET CORN



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**OHIO AGRICULTURAL
EXPERIMENT STATION**

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POST-HARVEST HANDLING AND MARKETING OF GARDEN FRESH SWEET CORN

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Many consumers of fresh produce rarely have the opportunity to enjoy "garden fresh" sweet corn. The period of highest edible quality, under prevailing systems of harvesting and handling sweet corn from grower to consumer, quite frequently includes only the first few hours from time of harvest. Since the time required for marketing is apt to be 18 to 24 hours or more, it is obvious that the consumer cannot obtain sweet corn of the best edible quality as long as these systems are continued.

There are many factors which are associated with quality aspects of the marketing of sweet corn. Varieties, soils, fertilizer practices, insect and disease control, harvesting at proper stage of maturity, and care in handling to avoid mechanical injury to the harvested ears, are some of the problems which the grower must satisfactorily solve before he can market a high quality sweet corn. It is important to mention these factors, since a high quality sweet corn must be produced before improved post-harvest handling and marketing procedures can be considered economically feasible.

The chemical and physical changes which bring about a rapid reduction in quality of sweet corn following harvest, have been studied at various times during the past 30 years. The most significant result of these studies is the knowledge that the rate of these destructive changes in sweet corn quality can be controlled by the post-harvest holding temperature. High temperatures allow these unfavorable changes in quality to proceed at a very rapid rate. In recent years, therefore, there has been increasing interest in practical methods which might be used to obtain lower temperatures so that a better and more uniform quality of sweet corn could be marketed.

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This study was initiated in the spring of 1950 following a conference between representatives of the experiment station, sweet corn growers, retail handlers of sweet corn, and of the Ohio and National Associations of The Ice Industry. As a result of this conference, the following general objectives were included: (1) to study the relative effectiveness of certain methods of refrigerating and cooling sweet corn at the farm and in the marketing system, (2) to determine the value of the wet-strength paper as a container for iced sweet corn from the farm to the retail store, (3) to study the relative movement of iced and un-iced sweet corn under different merchandising methods, (4) to determine the relative quality changes in the sweet corn as influenced by the various handling procedures, by means of sugar and starch determinations, respiration studies, and careful analysis of temperature of the sweet corn from the farm to the consumer, (5) to study spoilage and mark-down losses under the different methods of marketing sweet corn, and (6) to study the costs of marketing iced and un-iced sweet corn.

REVIEW OF LITERATURE

Quality or quality evaluation of fresh fruits and vegetables has been the subject of investigations by horticulturists, bio-chemists, and plant physiologists during the past 30 years. The many attributes of quality, as well as personal interpretations by growers, consumers, and handlers of fresh produce, all tend to complicate the ease of measurement of this elusive and complex factor. Quite frequently, factors in the environment which contribute to poor quality are better known than the exact chemical or physical measurements which are associated with the poorer quality. With sweet corn, certainly there is substantial evidence which emphasizes the importance of temperature during the harvest and post-harvest period and its effect on sweet corn quality.

Temperature at Time of Harvest.—As early as 1919, Stevens and Higgins (11) reported that they believed the lower temperature prevailing at harvest time was the major factor in the higher quality of the canned sweet corn produced in the northern states.

Appleman and Eaton (2) in 1921 compared an early and a late planting of sweet corn and sampled the ripening ears at equal time intervals. The hourly mean temperature during the ripening period for the early crop was 65° F. and 83° F. for the late crop. From chemical analysis of the sweet corn samples, they estimated that the critical period of top quality was about two and one-half times longer for the

crop maturing at 65° F. as compared with the 83° F. hourly mean temperature. Culpepper and Magoon (4) in 1926 also showed that seasonal factors, particularly temperature, had a marked effect on the rate of development of sweet corn and through this on the quality of the sweet corn.

Influence of Temperature During the Post-Harvest Period.—Appleman and Arthur (3), 1919, harvested sweet corn in the milk stage and held certain lots at 32, 41, 50, 59, 68, 86, and 104 degrees F. Samples from each lot were taken at 24, 48, 72, and 96 hours and total and reducing sugars and sucrose were determined. The results included the following: (1) all lots regardless of treatment had some sugar loss; (2) the rate of loss was much greater at the higher temperatures; (3) the percent loss in total sugar was greater during the first 24 hours after harvest than during any of the subsequent 24 hour periods (this was probably due in part to the slow cooling of the sweet corn when first placed in storage, particularly in the lower temperature storages); (4) the depletion of sugar did not occur at a uniform rate, but became slower and slower until an equilibrium (starch-sugar) was reached; (5) the higher temperatures hastened the attainment of the equilibrium position which ultimately was the same for all temperatures; (6) respiration also accounted for a percentage of the sugar loss and the rate of respiration is known to decrease with the lower temperature.

Rose, Wright, and Witman (8) in 1933 reported that the optimum storage temperature for sweet corn was 31° to 32° F. and relative humidity of 85 to 90 percent. They also suggested that very rapid cooling of freshly harvested sweet corn in ice water before storing was very important. They recommended that sweet corn should not be handled or stored in large quantities in bulk because of its tendency to heat. Containers which allowed good air circulation to remove field heat and slow up respiration were the most desirable. The approximate rate of heat evolution in BTU per ton of sweet corn per 24 hours at 32° F. was 2,640; at 40° F. 3,806; and at 60° F. 8,118.

Platenius, Jamison, and Thompson (7) in 1934 emphasized the need for rapid pre-cooling in ice water before placing sweet corn in storage. Without the pre-cooling, the sweet corn inside the container would be several degrees higher than the air temperature in the storage. During this lag in time required to lower the temperature in the center of the container, there might be an appreciable reduction in the quality of sweet corn.

Marketing Studies.—In tests conducted in New York state by Scott and Hardenburg (9), displaying corn at retail mixed with crushed ice lowered the temperature of the corn an average of 18 degrees F. throughout the day and was very beneficial in conserving sweetness. Sweet corn displayed throughout the day with crushed ice had 43 percent more total sugar than similar ears displayed on non-refrigerated counter. Corn harvested in the late afternoon and iced overnight had about the same sugar content as corn harvested in the morning and retailed on ice throughout the day. Corn harvested in the afternoon, not iced overnight, or during the following day had only one-half as much total sugar as similar corn refrigerated with ice.

In studies conducted in Massachusetts, Snyder (10), concluded that where corn was harvested in the late afternoon for delivery the following day in Bruce crates, the most satisfactory method was the use of 15 to 20 pounds of crushed ice in the container.

In 1945 Morris (6) of California recommended that crushed ice be placed in crates of sweet corn shipped to market. He found that when 35 pounds of crushed ice was used per crate of 6 dozen ears, corn arrived at Los Angeles from the Coachella Valley at 40 degrees F. He maintained that temperatures below 50 degrees F. were needed if the initial high quality was to be maintained more than a few hours.

In 1947, Hivon (5) at Purdue reported that the sugar in sweet corn decreased 50 percent in 24 hours if held at room temperature while corn inbedded in crushed ice maintained nearly all of the sugar during a similar period.

PROCEDURE

Arrangements were made with one grower during the 1950 season and two growers during the 1951 season to supply a high quality sweet corn for the icing studies. Both growers carried on an intensive spraying program for the control of insects, as was their usual practice. The local grower who cooperated during the first year's study shifted entirely to icing and packaging during the second year, except for experimental shipments of un-iced corn. The other cooperator iced about one-half of his acreage during the 1951 season. Approximately 100 acres of sweet corn were included in the 1950 season and 200 acres during the 1951 season.

Varieties of sweet corn included in the study were Carmelcross and Golden Cross Bantam in the 1950 and 1951 seasons, while a small acreage of North Star was included only in the 1951 season.

In the 1950 season, the sweet corn was graded, packaged, and iced in the field, but was not pre-cooled. All of the sweet corn was harvested during the early morning hours, 6:00 to 11:00 o'clock. The graded corn was packed in wet-strength paper bags which held four dozen ears and about twenty pounds of crushed ice. Ten pounds of ice was placed over the first 2 dozen ears in the bag and an additional 10 pounds was placed over the upper 2 dozen ears. The bag was closed with a standard wire tie. The wet-strength paper bag used was a double-walled standard type (size 19, $19\frac{1}{4}$, \times $31\frac{1}{2}$ \times 36 inches) which is ordinarily used in Ohio by the ice industry for packaging crushed or cube ice.

The major cooperator, in the 1951 season, found it necessary to haul the harvested sweet corn from the field to his packaging and grading sheds for more efficient operation. To compensate for the delay in icing (one hour) the sweet corn was pre-cooled by means of a spray of well water (temperature 52° F.) for 20 to 30 minutes before being graded, iced and packaged. Both cooperators in 1951 harvested the corn in the early morning hours to take full advantage of the lower internal temperature of sweet corn. Since most sweet corn, in the Columbus area, had been marketed in 5 dozen lots for many years, both cooperators obtained a larger wet-strength paper bag which held 5 dozen ears plus 20 or 25 pounds of ice. This bag was approximately six inches longer than the bag used in 1950 and was closed with the standard wire tie.

In both the 1950 and 1951 seasons, the sweet corn following icing and packaging was hauled to the chain-store warehouse, where the loads were made up for delivery to the cooperating retail stores. These cooperating retail stores received the iced sweet corn during the night for retail sales the following day. With the expanded icing program in 1951, additional lots of sweet corn were delivered to two wholesale commission houses for resale during the next morning. Records of these sales were obtained and are included under Wholesale Sales in "Results and Discussion".

The study of acceptance of high quality corn by consumers was made in six stores of a national chain store organization located in Columbus. In three of these stores, the high quality corn iced at the farm was merchandised in refrigerated cases; and in the other three stores the corn was displayed on islands with crushed ice. Three additional stores, which handled un-iced sweet corn purchased on the open market, were used as check stores to compare the relative movement of iced corn and corn which had not been iced.

While prescribed procedure in merchandising was followed in the six stores selling iced sweet corn, no attempt was made to alter the usual practices followed by produce managers in the three stores handling the non-iced corn. The corn was sometimes husked and packaged in transparent bags by store personnel, but more frequently it was displayed in dry racks at room temperature.

Daily records were kept of the sales, spoilage and mark-down losses in each of the nine stores during both seasons. In addition, the internal temperature of the sweet corn was recorded at various intervals from time of delivery through the display period in each store. "Internal Temperature" was obtained by removing a portion of the cob at the base of the ear with a cork borer and inserting a thermometer for two minutes and then recording the reading. All temperature readings reported in 1950 and most of those reported in 1951 were made as "internal temperature" readings. In the 1951 studies, there were several instances where the temperature was determined by means of thermocouples placed inside the husk.

TEMPERATURE, RESPIRATION, AND CHEMICAL ANALYSIS

The sweet corn which was used in obtaining information on temperature changes, respiration rates, and chemical analyses, under controlled storage conditions, was obtained as a random sample from the field in 1950 and from the packaging shed in 1951.

Five bags of sweet corn (two iced and three un-iced) were picked up within 30 minutes of harvest from the field in 1950 and were taken immediately to the storage. Air temperature in the field and the internal temperature of the sweet corn as harvested was recorded. Two bags, one iced and one un-iced, were placed in a 70° F. storage, and two additional bags, one iced and one un-iced, were placed in a 40° F. storage. The third bag of un-iced sweet corn was stored at room temperature (70° to 85° F.). Sample lots for controlled storage studies were taken at four different harvest dates during the 1950 season on July 28, August 3, 8 and 16.

In the 1951 season four bags, two iced and two un-iced, were obtained from the packing shed at eight different harvest dates—July 16, 19, 23, 26, 30, August 2, 6, 13 and 22. Thermocouples were placed in each of these bags of corn so as to determine temperatures of the corn in the lower, middle, and upper portions of each bag. Temperatures in each of the bags were determined at certain intervals over a 48-hour period with the use of a potentiometer and the wired (copper) thermocouples. Two bags, one iced and one un-iced, were placed in storage at 45° F. and the other iced and un-iced bags were stored at 70° F.

Replicated samples (three) of husked sweet corn (six ears per sample) were obtained from the iced and un-iced lots from the different storage temperatures. These replicated samples were used in determining the rate of respiration of each lot of sweet corn. The respiration apparatus and the methods used have been described in a previous publication by Alban and Ford (1). Respiration rates of the sweet corn are presented as milligrams of carbon dioxide evolved from a kilogram sample during a one-hour period at a given temperature, i.e. mg/kg/1 hour at 70° F.

The sweet corn used for chemical analysis was obtained from each harvest and storage lot at the same time the samples were taken for respiration studies.

For the chemical analyses, three ears of sweet corn were husked and the kernels cut off with a paring knife. Two 100 gram lots of the cut kernels were weighed from each sample and immediately placed in boiling alcohol. The two preserved lots from each sample were subjected to duplicate analyses, involving the determination of reducing and total sugars, easily hydrolyzable polysaccharides, soluble solids and alcohol insoluble solids. Official Analytical Methods of the American Association of Agricultural Chemists were used in the extraction and analyses of the duplicate lots of the sweet corn samples.

PRE-COOLING STUDIES

In the 1950 season, there was no attempt made to pre-cool the corn before icing and packaging. Based on the results of the 1950 season, and the known information on value of pre-cooling, plus the need for pre-cooling the sweet corn from the major cooperator in 1951, the following studies were initiated.

Certain lots of sweet corn were packaged (five dozen ears) with 15, 20, 25, or 30 pounds of ice but were not pre-cooled. Additional lots of corn were pre-cooled for one hour by means of a spray of well water (52° F.) and then packaged with the 20, 25, and 30 pounds of ice. A third lot of sweet corn was pre-cooled by means of immersion of ears in ice water (35° F.) for thirty minutes and then packaged with 20, 25, and 30 pounds of ice.

Internal temperature of the sweet corn, at time of harvest and just prior to packaging was obtained with all lots. Thermocouples were placed inside the husks, as the corn was packaged, and the temperature was determined at certain intervals from the time of delivery of the corn to the wholesale warehouse until it arrived at the retail store.

RESULTS AND DISCUSSION

EFFECT OF ICING ON TEMPERATURE OF SWEET CORN

Temperature Changes from Field to Consumer.—Both growers who cooperated in this study attempted to harvest the sweet corn during the early morning hours to take advantage of the cooling effect of the lower night temperature. That this practice was warranted was substantiated by the comparison of internal temperature of the sweet corn at the time of harvest as compared with the air temperature in the field. During both seasons, the internal temperature of the corn at harvest time was 3 to 10 degrees lower than the air temperature in the field.

During the 1950 season, the air temperature in the field averaged 76° F. and the internal temperature of the sweet corn averaged 70.4° F. as the corn was harvested in the morning. All of the sweet corn included in the storage studies and most of the shipments to the cooperating retail stores were included in obtaining the above averages during the four-week period of study. The sweet corn was iced within an hour or two of harvest. In general the higher the temperature of the corn at harvest, the higher the temperature of the corn after twenty-four hours of storage. This fact was readily apparent under the controlled storage temperatures but was somewhat less significant with the sweet corn shipped to the retail stores. Variation in the holding and delivery practices during the twelve to twenty hours following harvest probably accounted for these differences.

In the 1951 season, the sweet corn was harvested during the morning hours but was then hauled several miles to a packing and grading shed where it was partially pre-cooled before being iced. The air temperature during harvest through the 8 week period of study, varied from 70° F. to 85° F. and the internal temperature of the corn at harvest was 3 to 6 degrees lower than the air temperature.

Carmelcross in both seasons and North Star in the 1951 season were generally harvested under slightly cooler conditions than the Golden Cross Bantam sweet corn due to the lower temperatures prevailing at the time of maturity of the earlier varieties.

Temperature on Arrival at Retail Stores.—It was not possible to determine the temperature of all lots of the iced sweet corn which were marketed through the various wholesalers and retailers during the 1950 or 1951 seasons. The temperature information obtained from the retail stores included in the special study did indicate the wide variation that

might be possible. The 43° F. to 77° F. range of temperature readings for the iced sweet corn, when checked the morning following harvest at the retail store, emphasized the need for improved and uniform handling methods to assure a more uniform product. The average temperature of 62° F. for all lots of iced sweet corn as compared with the un-iced corn which arrived at the store with an average temperature of 77° F. provided excellent information on the value of the icing program. In addition, all iced lots of sweet corn were almost immediately placed in crushed ice displays or in refrigerated cases in the stores. In most instances the temperatures recorded for the iced lots of sweet corn soon after delivery at the retail store probably represented the peak temperature from the time of effective icing through the handling period and eventual consumer purchase.

Temperature of Sweet Corn and Method of Display.—The average temperature of samples of the sweet corn inspected under the iced display conditions was 57° F. for ears displayed on the upper surface and 43° F. for the ears covered with ice. The average temperature of sweet corn inspected under refrigerated case display was 63° F. for the ears on top and 48° F. for the ears on the bottom. Sweet corn displayed on dry racks (not previously iced) ranged from 70° F. to 85° F. with an average of 76° F.

Temperature Under Controlled Storage.—The temperature of the iced and un-iced lots of sweet corn was determined in both seasons at 40° F. and 70° F. in 1950 and 45° F. and 70° F. in 1951. There was little difference noted between varieties, but there was some indication that the size of the ear and husk might be of some consequence in pre-cooling and rate of cooling with a given amount of ice. Carmelcross, which has a larger and slightly heavier husk than either Golden Cross Bantam or North Star (central Ohio conditions) required an additional hour or two to reach the same low temperature with 20 pounds of ice as compared with the other two varieties.

The average temperature of the iced and un-iced lots of sweet corn, under the controlled storage temperatures, are presented in Table 1 (1950) and Table 2 (1951).

The results of the temperature studies with iced sweet corn indicated that the addition of ice was an important factor in lowering the temperature of the packaged sweet corn at least during the first 5 to 10 hours after icing. However, in most instances within 24 hours, the value of the ice was almost completely dissipated when the temperatures

of the iced and un-iced sweet corn stored at 70° F. were compared. It is important to note that the sugar loss was significantly reduced during this 24-hour period with iced sweet corn as compared with un-iced corn. (Tables 3 and 4).

The value of refrigerated storage to supplement the benefits of the previously iced corn were readily apparent. In the 1950 studies, where the iced sweet corn was stored at 40° F., the temperature was much more favorable for the preservation of quality as compared with the iced sweet corn stored at 45° F. in the 1951 studies. Several investigators, as previously mentioned, have shown that the optimum temperature for holding sweet corn is approximately 31° F. to 32° F. Thus while ice can be an invaluable aid in reducing field heat and cooling sweet corn during the first few hours after harvest, it would seem essential to increase the amount of ice used initially or to replenish the ice or to use some additional method of refrigerating to retain the benefits of the initial icing.

TABLE 1.—The effect of icing, and storage after icing, on the temperature of sweet corn compared with un-iced sweet corn. 1950

Hours after harvest	Stored at 40° F.		Stored at 70° F.		Stored at Room Temp.
	Iced	Not Iced	Iced	Not Iced	70-80° F., Not Iced
Golden Cross Bantam, harvested August 3, 1950					
At harvest	73.0	73.0	73.0	73.0	73.0
Four hours	47.0	75.5	47.0	75.5	75.5
24 hours	41.5	46.7	70.5	73.3	79.7
48 hours	45.4	51.5	73.0	74.7	81.7
Golden Cross Bantam, harvested August 8, 1950					
At harvest	68.7	68.7	68.7	68.7	68.7
Four hours	48.0	70.7	48.0	70.7	70.7
24 hours	43.8	48.5	71.0	76.2	78.2
48 hours	47.9	54.3	73.4	75.6	80.9
Golden Cross Bantam, harvested August 16, 1950					
At harvest	71.0	71.0	71.0	71.0	71.0
Four hours	42.3	78.1	42.3	78.1	78.1
24 hours	42.0	49.5	72.3	80.0	82.6
48 hours	48.8	53.3	74.5	77.5	84.4

There was a tendency for the iced lots of sweet corn which had been stored at 70° F. to show a slightly higher temperature as compared with the un-iced lots of corn after 18 to 24 hours of storage held at the same temperature. The husks of the iced lots of corn also revealed slightly more discoloration (yellowing) after twenty-four hours storage

TABLE 2.—The effect of icing, and storage after icing, on the temperature of sweet corn compared with un-iced sweet corn. 1951

Hours after packaging	Stored at 45° F.		Stored at 70° F.	
	Iced	Not Iced	Iced	Not Iced
North Star, harvested July 16, 1951				
One hour	63.2	72.3	65.6	71.8
Seven hours	51.8	57.2	66.2	70.2
19 hours	43.0	45.9	71.0	69.9
44 hours	45.3	46.1	74.3	72.7
Carmelcross, harvested July 19, 1951				
Two hours	61.5	70.3	60.9	74.7
Eight hours	49.3	57.5	60.5	75.2
24 hours	48.5	51.9	71.6	72.0
48 hours	44.0	46.1	72.0	71.3
Carmelcross, harvested July 23, 1951				
Two hours	60.9	77.5	67.6	80.7
24 hours	52.1	60.2	72.9	82.2
48 hours	49.0	48.9	75.2	75.0
Golden Cross Bantam, harvested July 26, 1951				
One hour	60.0	80.5	62.0	80.5
Four hours	59.9	75.3	53.0	77.7
20 hours	40.4	61.7	64.8	79.1
40 hours	47.9	58.1	72.2	74.4
Golden Cross Bantam, harvested July 30, 1951				
One hour	56.3	71.4	53.3	78.7
17 hours	52.2	60.8	70.0	82.8
23 hours	52.5	57.0	71.5	81.2
41 hours	47.5	52.9	72.4	77.7
Golden Cross Bantam, harvested August 6, 1951				
Three hours	55.8	71.5	52.1	84.6
24 hours	39.7	50.7	64.9	77.5
44 hours	41.0	58.4	73.8	77.5

at 70° F. as compared with the un-iced corn under the same condition. Both of these facts tend to emphasize the need for continuous cooler temperatures for holding previously iced or wet sweet corn.

Effect of Icing on Respiration and Total Sugars of Sweet Corn.—

In previous discussion, the importance of temperature control in regard to the destructive processes which result in a lower quality of sweet corn has been repeatedly stressed. Platenius et al (7) as well as others have reported that the rate of these destructive processes proceeds at a much faster rate immediately following harvest. During this period for approximately every 18 degree F. rise in temperature (in the 30° to 80° F. range) the rate of these processes is doubled. The results of chemical analyses and respiration rates of the sweet corn included in these studies are in agreement with the previous results.

The chemical analyses of the sweet corn samples in both seasons revealed fairly close agreement in relation to quality measurements as indicated by reducing and total sugars, alcohol insoluble solids and soluble solids. The total sugar (expressed on fresh weight basis percentage) content of the sweet corn samples which had been iced or un-iced and stored at 45° F. or 70° F. revealed the importance of temperature in influencing the retention of these sugars. The total sugar values at the twenty-four and forty-eight hour time intervals from time of harvest were all statistically significant in comparing icing vs. non-icing and the different storage temperatures. Easily hydrolyzable polysaccharides were also determined for all samples but there was a greater variation in these measurements than was true for the other chemical measurements.

There are of course many other factors influencing quality of sweet corn such as pericarp toughness, varietal differences in sugar content, pericarp, and other inherent differences. However, assuming a quality sweet corn is produced and harvested at the proper stage of maturity, control of temperature through icing or refrigeration or a combination of the two can influence the holding quality of this corn.

The respiration measurements of sweet corn that had been iced after harvest and determined approximately 8 hours later at a temperature of 70° F. averaged 316 milligrams of carbon dioxide per kilogram of corn per hour. The respiration measurements of sweet corn that had not been iced after harvest and determined approximately eight hours later at 70° F. averaged 431 milligrams of carbon dioxide per kilogram of corn per hour. The measurements of the respiration rate of all lots of sweet corn followed roughly the curves for the total sugar analyses

(Tables 3 and 4). There was a tendency for the iced lots of sweet corn held at 70° F. to show a slightly higher rate of respiration at the twenty-four hour period than the non-iced corn held at 70° F. Part of this increase could be explained through the greater substrate reserve (as influenced by icing) but this does not seem sufficient to account entirely for this higher rate of respiration.

TABLE 3.—The effect of icing and storage following icing on the reducing and total sugar content of Golden Cross Bantam and Carmelcross sweet corn. 1950

Treatment and time of sampling	Carmelcross		Golden Cross Bantam					
	Harvested 7/28		Harvested 8/3		Harvested 8/8		Harvested 8/16	
	Red.*	Total†	Red.	Total	Red.	Total	Red.	Total
	sugars %	sugars %	sugars %	sugars %	sugars %	sugars %	sugars %	sugars %
4 hours after harvest iced in field	1.28	2.59	0.82	4.64	0.91	4.95	1.05	5.24
4 hours after harvest not iced in field	1.30	2.67	0.85	4.76	0.92	4.93	1.12	5.46
24 hours after harvest iced in field stored at 40° F.	0.90	1.72	0.52	3.87	0.72	2.76	0.51	2.94
24 hours after harvest not iced in field stored at 40° F.	0.59	1.22	0.36	2.09	0.51	2.69	0.21	2.66
24 hours after harvest iced in field stored at 70° F.	0.52	1.02	0.37	1.83	0.46	1.76	0.41	1.91
24 hours after harvest not iced in field stored at 70° F.	0.50	0.87	0.30	1.38	0.32	1.13	0.35	1.37
48 hours after harvest iced in field stored at 40° F.	0.48	0.87	0.33	2.45	0.36	2.11	0.43	1.25
48 hours after harvest not iced in field stored at 40° F.	0.43	0.76	0.27	1.84	0.31	1.31	0.34	0.89
48 hours after harvest iced in field stored at 70° F.	0.27	0.70	0.21	1.33	0.30	0.83	0.27	1.37
48 hours after harvest not iced in field stored at 70° F.	0.25	0.53	0.17	0.98	0.26	0.60	0.23	0.87

*Reducing sugars.

†Total sugars.

TABLE 4.—The effect of icing and storage on the total sugar content of North Star, Carmelcross and Golden Cross Bantam sweet corn. 1951

Treatment	Storage temperature	Total sugar percent days after packing		
	°F.	0	1	3
North Star, harvested July 16, 1951				
Iced	45	3.97	3.93	3.11
Not Iced	45	3.73	3.45	2.58
Iced	70	3.97	3.02	1.53
Not Iced	70	3.73	1.87	1.36
Carmelcross, harvested July 19, 1951				
Iced	45	2.98	3.21	1.77
Not Iced	45	3.10	2.66	1.82
Iced	70	2.98	1.70	1.10
Not Iced	70	3.10	1.50	.98
Carmelcross, harvested July 23, 1951				
Iced	45	4.48	3.29	2.78
Not Iced	45	3.86	2.55	2.21
Iced	70	4.48	2.71	1.33
Not Iced	70	3.86	2.36	1.38
Golden Cross Bantam, harvested July 26, 1951				
Iced	45	2.92	3.79	2.78
Not Iced	45	2.93	2.94	2.07
Iced	70	2.92	3.34	1.64
Not Iced	70	2.93	1.53	1.46
Golden Cross Bantam, harvested July 30, 1951				
Iced	45	4.32	4.40	3.06
Not Iced	45	3.84	3.22	2.81
Iced	70	4.32	2.91	1.99
Not Iced	70	3.84	2.02	1.32
Golden Cross Bantam, harvested August 2, 1951				
Iced	45	4.61	4.31	4.72
Not Iced	45	5.17	3.36	3.98
Iced	70	4.61	2.94	1.37
Not Iced	70	5.17	1.69	1.27
Golden Cross Bantam, harvested August 13, 1951				
Iced	45	4.76	3.42	3.68
Not Iced	45	4.04	3.69	3.43
Iced	70	4.76	2.89	1.24
Not Iced	70	4.04	2.21	1.08

PRE-COOLING STUDIES

Several investigators, Appleman and Eaton (2), Platenius and Thompson (7) as well as others have pointed out the importance of rapid cooling of sweet corn immediately following harvest so as to minimize the loss of sugars and to retard the rate of other quality-destroying processes. In the 1950 studies, it was noted that there was a lag of two or more hours in maximum cooling as influenced by field-icing of the freshly harvested sweet corn. So in the 1951 studies, where it was necessary for the major cooperator to follow a pre-cooling schedule, it seemed advisable to obtain more information on the value of pre-cooling before icing and packaging the sweet corn. As the 1951 studies on pre-cooling progressed, it also seemed advisable to determine the value of increased quantities of ice which might be used in the container, on the holding temperature of the sweet corn during the normal marketing period.

The major results of the pre-cooling studies and the addition of various increments of ice, in the package, are included in Tables 6, 7, and 8. These results include specific temperature measurements under the variable pre-cooling temperature or quantities of ice used for a

TABLE 5.—Average values for rate of respiration and total and reducing sugars for three harvests of Golden Cross Bantam Sweet Corn. 1950

Hours after harvest	Iced			Not Iced		
	Rate of respiration*	Reducing sugars	Total sugars	Rate of respiration*	Reducing sugars	Total sugars
40° Storage						
		Percent	Percent		Percent	Percent
Four to eight	365.03	0.43	4.94	446.61	0.96	5.05
24	323.31	0.58	3.19	311.55	0.36	2.45
48	267.64	0.41	1.94	253.65	0.32	1.35
70° Storage						
Four to eight	365.03	0.93	4.94	446.61	0.96	5.05
24	313.37	0.37	1.83	306.34	0.31	1.29
48	250.73	0.26	1.18	245.92	0.22	0.82

MgCO₂/Kg/hour at 70° F.—milligrams of carbon dioxide per kilogram of corn in a one hour period. All respiration rates were determined at 70° F. All lots, regardless of previous treatment, were taken from storage and placed in respiration chambers for 30 minutes. Carbon-dioxide-free air was forced through the chambers during the thirty minute period and then the respiration runs were made immediately afterward.

TABLE 6.—Comparison of two pre-cooling methods with sweet corn, packed five dozen ears per bag with twenty pounds of ice, on the temperature (F.) at certain intervals after packing*

Hours after packing and icing	Pre-cooled in ice water 36° F. for thirty minutes				Pre-cooled in well water 52° F. for one hour			
	Top	Center	Bottom	Average	Top	Center	Bottom	Average
1.0	40	45	43	42.3	52	50	48	50.0
2.5	38	42	40	40.0	50	49	46	48.3
6.5	39	43	39	40.3	52	50	48	50.0
10.5	41	41	41	41.0	54	53	51	52.7
16.5	44	43	42	43.0	58	56	54	56.0

*Sweet corn stored at room temperature (75° F.) during study.

single study. The results, as presented, include only the data for any given experiment. However, the results are typical of several additional experiments which are not included in these three tables.

The temperature data presented in Table 6 indicate the more or less minor differences in temperature of sweet corn in the package, as influenced by position of a single ear in the container. These temperature data were obtained by means of wired thermocouples attached to single ears at the various positions in the container. Inspection of the data reveals the value of pre-cooling the corn in ice-water as compared with pre-cooling in well water. Based on the previous discussion of

TABLE 7.—The effect of 20, 25, and 30 pounds of ice packed with five dozen ears of sweet corn per bag, on the temperature at certain intervals after harvest. Sweet corn pre-cooled in ice water for 30 minutes*

Hours after packing and icing	Average temperature of the sweet corn		
	20 pounds of ice	25 pounds of ice	30 pounds of ice
1.0	45	42	41
2.0	43	40	39
3.0	41	39	38
7.0	39	37	37
11.0	40	39	39
18.0	44	41	40

*Sweet corn stored at room temperature (75° F.) during study.

temperature relationships, it is obvious that the corn pre-cooled in ice water and then packaged with twenty pounds of ice should be of higher quality than the corn pre-cooled in well water and packaged with twenty pounds of ice. It is also readily apparent that differences between location of ears in the package are minor as compared with effect of temperature of the water used in pre-cooling of the corn. However, the data for sweet corn which was not pre-cooled revealed a greater difference in temperature as influenced by the position of the corn in the package, i. e. the sweet corn in the upper portion of the package was usually several degrees higher than ears in the lower portion after eight or more hours.

The temperature data presented in Table 7 reveal the relatively minor importance or value of increased increments of ice, used in the package, when the sweet corn was pre-cooled in ice water. The trend toward lower temperatures with the increased amounts of ice used, however, are still apparent, although not nearly as significant as compared with sweet corn pre-cooled at a higher temperature and then iced with various amounts of ice, as in Table 8. As pointed out previously, there is no question that the temperature of the sweet corn at the time of icing is very important in determining the expected period of effective temperature control with a given amount of ice. It should also be noted that the holding temperature (75° F.) for the iced and packaged corn is higher than considered desirable but is typical of usual holding temperatures.

The temperature data presented in Table 8 include comparisons of two pre-cooling temperatures, as well as three increments of ice used in packaging after pre-cooling. During the first four or more hours after

TABLE 8.—The effect of three rates of icing and two methods of pre-cooling on the average temperature of sweet corn, packed five dozen per bag, at certain intervals after packing and icing*

Hours after packing and icing	Pre-cooled in ice water 36° F. for thirty minutes			Pre-cooled in well water 52° F. for one hour		
	Ice used in package			Ice used in package		
	15 lb.	20 lb.	25 lb.	15 lb.	20 lb.	25 lb.
1	42	41	40	54	50	50
2	38	38	37	53	48	47
4	37	37	36	50	45	44
18	69	67	53	65	54	53

*Sweet corn stored at room temperature (75° to 80° F.) during study.

pre-cooling and icing, it is readily apparent that pre-cooling in ice water was superior to pre-cooling in well water. However, by the end of the eighteen hour period, it is also obvious that a certain amount of the pre-cooling advantage has been lost and that the amount of ice used in packaging takes on a greater significance in regard to temperature control.

To fully evaluate the results in Table 8 on the basis of high quality corn, it is essential to keep in mind that chemical and physical destructive processes were held in check for a longer period of time with the ice water pre-cooled corn as compared with the well water pre-cooled corn. The data also indicate that the amount of ice used in the package can have a marked effect on the ultimate quality of the sweet corn sold to the consumer.

Throughout this study, it was recognized that the major factors influencing the quality of sweet corn sold to the consumer were influenced by the number of hours from harvest to consumer and the holding temperature of the sweet corn during this interval. The use of field-icing and packaging and the use of ice or refrigerated displays all contributed to superior quality of corn as compared with normal shipping or display without adequate icing or refrigeration. The results of the pre-cooling studies only tended to emphasize the importance of initial cooling to increase the effectiveness of the ice and container used in relation to supplying the wholesaler and particularly the retailer with sweet corn that more nearly approaches the "garden fresh" appearance and quality which the consumer wants.

IMPORTANCE OF SWEET CORN SALES IN EXPERIMENTAL STORES

Relative to Total Produce Sales.—Sweet corn sales were measured as a percentage of the total produce sales. The success or failure to move a given fruit or vegetable in different stores probably can best be measured by its importance relative to all produce sales rather than actual volume of the product due to differences in volume between stores.

Relative to total produce sales, sweet corn accounted for a greater proportion of the total sales in stores selling iced corn on iced displays than in stores selling iced corn in refrigerated cases, or check stores selling corn which had not been iced (Table 9). This relationship, with a few exceptions, existed during each week in both years. During the

1950 marketing season, sweet corn made up about 5.6 percent of the total sales in stores using iced displays as compared with only four percent in stores using refrigerated cases and about three percent in the check stores. Sales with these different types of treatments in 1951 amounted to 4.2, 3.4, and 3.1 percent respectively of the total produce sales.

Sales in the stores selling high quality sweet corn from iced displays and refrigerated cases were somewhat less important during 1951 than 1950. This can probably be accounted for in part by the fact that on several occasions the stores were unable to buy high quality sweet corn and were forced to purchase sweet corn in the open market which had not been iced. Since their reputation was built up after handling iced sweet corn for several days, and the store found it necessary to handle lower quality corn for a short period, several days lapsed before sales could be built up again.

These data seem to indicate a decided preference for iced corn over that which had not been iced. Further, it would seem that by providing the consumer with high quality corn consumption might be stimulated. Another point of interest was that sales of high quality corn in

TABLE 9.—Relative Importance of Sweet Corn Sales, by Method of Display, Nine Stores, Columbus, Ohio, 1950 and 1951 Seasons

Week*	Sweet corn sales as a percent of total produce sales by type of display					
	Iced Displays		Refrigerated Case		Check Stores	
	1950	1951	1950	1951	1950	1951
1	—	4.58	—	4.37	—	5.00
2	6.64	4.54	4.72	3.86	3.14	2.87
3	6.09	4.51	4.54	3.79	3.45	2.77
4	6.52	5.19	4.10	4.26	2.70	3.66
5	4.54	3.40	4.30	3.45	2.34	2.83
6	4.45	3.69	1.99	2.06	2.39	—
7	—	4.15	—	2.89	—	—
8	—	4.19	—	2.50	—	—
9	—	3.72	—	2.21	—	—
Season average†	5.58	4.22	3.95	3.44	3.05	3.05

*Week one is the week beginning July 9, 1951. The ninth week is the week beginning September 3.

†Includes five comparable weeks in 1950 and 1951 for all stores, except control stores, in which case four comparable weeks are included.

stores using iced displays declined less as the season progressed than in stores merchandising corn of comparable quality in refrigerated cases, especially during the 1951 season when the study was conducted during most of the marketing season for local sweet corn. In interpreting these data, it must be recognized however that differences in cost exist between different methods of displaying in the stores and that they do not serve to indicate the net return realized by retailer.

Dozens Sold.—During 1950, the average number of dozens sold per week varied from 146 to about 182 in stores using iced displays, compared with from about 92 to 171 in the stores using refrigerated cases (Table 10). Sales in check stores varied from an average of about 47 to 79 dozen. During the last two weeks of the study, sales volume was lower than during the previous two week period. This was to be expected since the novelty of fresh corn became less of a factor as the season progressed, roadside sales probably took a larger percent of the total business and home gardens became a more important factor. One point of significance from Table 10 is that while sales in all stores declined during the last two weeks of study, sales in stores using iced displays were only about eight percent below the preceding two weeks, compared with 27 percent in stores using refrigerated cases and 30 percent in check stores. A week to week comparison of actual dozens sold during 1951 was not possible due to the fact that supplies were erratic because the stores were unable to obtain supplies for one or two days during several weeks. Therefore, it was necessary to measure acceptance in 1951 in terms of the relative importance of sweet corn sales compared with total produce sales.

**TABLE 10.—Average Number of Dozens of Sweet Corn Sold per Week
Nine Stores, Columbus, Ohio, July and August, 1950**

Week beginning*	Type of Display Used		
	Iced display island†	Refrigerated case†	Check‡
	(dozen)	(dozen)	(dozen)
July 24	155.7	154.7	79.3
July 31	181.8	171.0	66.7
August 7	164.8	145.3	47.2
August 14	146.0	91.7	55.8

*Week beginning July 17 excluded because sales were for only four days.

†Corn was iced in the field immediately after harvest.

‡Corn which was not iced.

Spoilage and Mark-down Losses.—Information was obtained from each store of the daily spoilage losses and the amount of corn marked down in price in order to move it.

Average spoilage losses did not amount to as much as five percent of the corn handled in the various types of display in either 1950 or 1951 (Table 11). While spoilage losses were greater in the check stores than in stores selling iced corn, the average difference was less than two percent between different types of displays.

There was considerable difference in mark-downs between 1950 and 1951. During the 1950 season, 7.1 percent of the corn sold in the stores using iced displays was marked down in price compared with 5.6 percent in the check stores, where the smallest proportion was marked down in price. During the 1951 season a relatively small proportion of the iced corn was marked down in price, while the proportion of un-iced corn marked down in price was greater than in 1950.

In interpreting this information one must recognize that there are other factors which affect spoilage losses and mark-downs other than the quality of the product received. The ability of the produce manager to anticipate the needs of his trade and to avoid over-ordering is a very important factor affecting both the spoilage and mark-down losses. Another important consideration is the type merchandiser in question and his interests. Some produce managers will mark a product down in price whenever they realize that they cannot move the amount ordered for sale that day, while others will hold the product for sale during the following day, maintaining their price and in many cases giving the consumer an inferior product which may, in the long run, reduce sales.

TABLE 11.—Average Spoilage and Mark-Down Losses of Sweet Corn, Nine Stores, Columbus, Ohio, 1950-51 Marketing Seasons

Type of display	Treatment of sweet corn	Percent of total handled			
		Spoilage		Marked down in price	
		1950	1951	1950	1951
Iced	Iced at farm	3.1	4.0	7.1	3.9
Refrigerated cases	Iced at farm	3.9	3.5	6.0	1.2
Check	Not iced	4.8	4.8	5.6	7.6

Icing and Package Costs.—The growers who cooperated in the study in 1951 graded and packaged on an assembly line. Since the major cooperator iced and packaged his entire crop in paper bags it was possible to compare this cost with that of packaging in crates or other types of containers.

During the 1950 marketing season a double walled wet strength paper bag $19\frac{1}{4}'' \times 31\frac{1}{2}'' \times 36''$ was used for packing the corn. This bag held four dozen ears and about 20 pounds of ice and cost about 6 cents (F.O.B.) Cincinnati. Several people in the trade were of the opinion that the package should be large enough to hold five dozen ears, plus the ice. During the second year a bag approximately six inches taller than the one used the first year was used. This bag was of sufficient size to hold 5 dozen ears and about 20 pounds of ice. The cost of this bag was approximately seven cents (F.O.B.) Cincinnati without labels. As will be shown later, experience with the larger bag during the 1951 season would indicate that it might be advisable for growers to consider use of the bag containing four dozen ears in preference to a larger package containing five dozen ears or to use a triple wall or heavier bag. In addition to difficulties with breakage, the smaller bag is a standard size which is used by the Ice Industry and some advantages in terms of cost and availability might be realized.

During the first year of the study an average of about 4.5 pounds of ice was used by the grower at a cost of about 2.25 cents per dozen. During the second year growers used about the same amount of ice per bag of five dozen ears with an average of about four pounds of ice at a cost of approximately two cents per dozen.

The cost of icing between stores varied considerably. The average amount of ice used per dozen in stores during the 1950 marketing season was 3.1 pounds, while an average of 4.6 pounds was used during the 1951 marketing season. Average cost per dozen, based on a price of 70 cents per hundred pounds, was 2.25 cents during the first year and 3.3 cents during the season year. During the 1950 season, the average amount of ice used per dozen was varied from 1.9 pounds in the store using the least amount, to 4.9 in the store using the largest amount. During the 1951 season, one store used 1.7 pounds of ice per dozen ears, another 9.0 and the third store used 7.4 pounds. The store using the smallest amount of ice sold by far the greatest volume of sweet corn. The explanation for these rather illogical results apparently could be explained by the fact that where larger quantities of ice were used the sweet corn could not be seen as well as where the smaller quantities of ice had been used in the display.

Returns for the Retail Operation.—A premium of five cents per dozen was paid by the chain organization for the corn which had been iced and packed in paper bags during the first year. During the second year this premium was established fairly early in the marketing season at the wholesale level and remained about constant throughout the marketing season regardless of the level of corn prices. During the 1950 season the iced corn offered at retail was sold at the same price as the un-iced corn during the first two and one-half weeks in which the study was conducted. During the next two weeks five of the six stores sold iced corn at a five cent differential above that in the check stores. A six cent differential was charged during the last week of the study. During 1951 the chain which cooperated in this study sold all corn at the same price.

The margin taken on the corn during both years after allowing for costs of ice used in the stores with iced displays was as follows:

Type of Display	1950	1951
	Percent	Percent
Iced	14.7	20.7
Refrigerated case	19.6	25.4
Check	22.7	31.0

The margins taken during the 1951 season were considerably greater than those during the 1950 marketing season. While the margins were greater in the check stores than in the store handling iced corn during both years, the net returns to the company were considerably greater in the stores handling iced corn. As indicated earlier in this report, the sales of sweet corn were much more important relative to total produce sale in the stores handling iced corn than in the other stores. As a result, the profit was considerably greater in the stores handling iced corn than in the check stores. For example the total gross profit for handling sweet corn in 1951 was \$42.50 per week in the three stores using iced displays after deducting cost of ice. Comparable returns for stores using refrigerated cases without deducting for the cost of operating the refrigerated cases was \$43.13. Gross profit in the check stores was \$29.74 per week or about 30 percent below that of the three stores using refrigerated cases. The difference was even greater during the first year of the study when the gross profit realized in the check stores was only slightly more than 50 percent of that realized in the stores selling iced corn.

WHOLESALE SALES

Records were obtained on the movement of nearly sixty thousand dozens of iced corn sold by two commission firms in Columbus during the 1951 marketing season. Nearly two-thirds of the total sales were made to chain store organizations while the second most important group of buyers was wholesalers who purchased corn for sale to retailers or others. Total sales were made to the different groups of buyers as follows:

	Percent of Total Sales
Chains	62.4
Wholesalers	15.5
Fruit and Vegetable Stores	12.1
Central Market Stand Operators	4.1
Independent Retailers	3.6
Hucksters	.4
Miscellaneous	1.9

The proportion of the various types of buyers who repeated purchases was greater in the case of chains than other types of buyers (Table 12). Six of the eight chain store organizations purchased iced corn six or more times compared with approximately 45 percent of the wholesalers and fruit and vegetable store operators and 36 percent of the independent grocers.

TABLE 12.—Number of the Various Types of Buyers Who Purchased Iced Corn at Wholesale by Frequency of Purchase, Columbus, Ohio, 1951 Marketing Season

Buyer	No. that handled iced sweet corn	Percent that purchased		
		Once	2 to 5 times	6 or more times
Wholesalers	25	32.0	24.0	44.0
Independent grocery store operators	33	33.3	30.3	36.4
City market stand operators	29	27.6	51.8	1.6
Fruit and vegetable store operators	22	22.7	31.8	45.5
Chain store buyers*	8	—	25.0	75.0
Hucksters	6	33.3	50.0	16.7

*Included buyers who purchased for all types of chains, including buying units of two or more stores.

It is apparent from the above that this sweet corn which for the most part sold mostly at a five cent per dozen premium was well accepted by the trade. A total of 12 out-of-town buyers handled this corn. About eight percent of the total was purchased by these buyers. The corn was moved to the following cities, listed in the order of number of times purchased by the buyers from that city: Mt. Vernon, Westerville, Gahanna, Delaware, Cambridge, Zanesville, Lancaster, Toledo, Bellefontaine, and Dayton.

DEALER ATTITUDES, EXPERIENCES, AND PRACTICES

Near the end of the marketing season in 1951 a list of all dealers who had purchased iced sweet corn on the wholesale market was obtained, and an effort was made to interview each of these operators to determine his reaction to this corn. It was possible to interview most dealers except hucksters and out-of-town buyers. Those interviewed included wholesalers who had purchased iced corn from the two commission houses, stand operators selling on the city markets, independent retailers and operators of specialized fruit and vegetable stores. A total of 91 operators were interviewed, including 14 wholesalers, 23 stand operators, 20 specialized fruit and vegetable operators and 34 independent retailers.

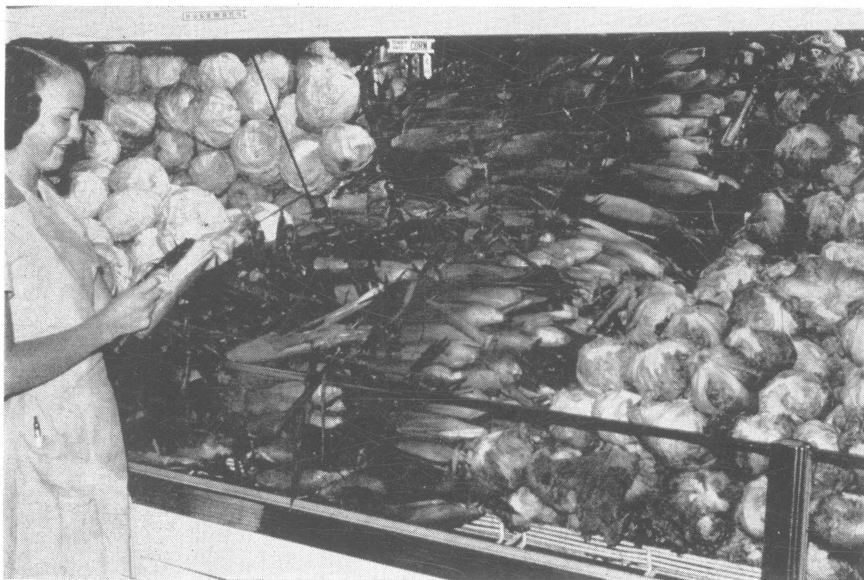


Fig. 1.—Refrigerated case display used in the retail stores selling the high quality iced sweet corn.

Premium Warranted.—After selling iced corn all operators were asked whether they thought a premium was warranted for this corn and if so, what premium. Of those replying to this question, 69 per cent or more of each group considered that a premium was warranted except for the stand operators. Replies were as follows:

	Percent Indicating Premium Warranted:
Fruit and Vegetable Stores	80
Wholesalers	82
Independent Store Operators	69
Stand Operators	50

About the same percentage indicated that a 10 cent premium per dozen was warranted as indicated that a five cent premium was warranted. About 40 percent indicated that a 10 cent premium was warranted compared with 38 percent indicating a five cent premium was warranted. About 16 percent indicated a five to 10 cent premium. The remainder indicated a larger premium was justified for this corn. The wholesalers and independent grocers generally favored a larger premium than the city market stand fruit and vegetable store operators.



Fig. 2.—The crushed ice display used in the retail stores selling the high quality iced sweet corn.

Method of Display.—One of the problems encountered by growers who attempt to provide consumers with iced sweet corn through retail stores is the lack of proper refrigeration. Retailers were asked to indicate how they had displayed the iced sweet corn which they had purchased. Of the 68 reporting, 18 or about 26 percent had either displayed the corn in a refrigerated case or had used ice to keep the corn cool while on display. Most of these were independent grocery store operators. Nearly one-half of the independent grocery store operators either displayed the corn in refrigerated cases or on a counter with ice as the refrigerant. Most of these retailers used a refrigerated case. Only a few of the operators of fruit and vegetable stands or stores kept the corn cool. Of the 17 fruit and vegetable store operators reporting method of display, only one used a refrigerated case and one used an iced display. Most of the remainder displayed corn in front of their store without refrigeration. Of the stand operators in the city markets, all displayed sweet corn on counters and only one used ice to keep the corn cool.

Another problem involved in marketing this corn during the 1951 season was breakage of bags. This was noticed early in the season in the experimental stores, where a relatively large percentage of the bags were broken in some of the test shipments. As a result of the problems with test shipments, retailers were asked to indicate the extent of bag breakage experienced. Of the total number of operators, other than wholesalers, who were interviewed, 28 or about 36 percent indicated that they had had trouble with bag breakage. The problem was great, especially with the fruit and vegetable store operators and independent grocers, where 13 of the 34 independent operators and 10 of the 20 fruit and vegetable store operators indicated a problem with bag breakage.

Since breakage was not a problem during the 1950 season when the bag containing four dozen ears was used, operators of different types of stores were asked to indicate whether a four dozen container would be satisfactory. The majority of all types of operators, except wholesalers either indicated a preference for the four dozen unit or said that it made no difference to them whether the corn was packed in units of four or five dozen ears. More than three-fifths of the independent grocery and city market operators indicated that they either preferred a four dozen package or that the size of the unit made no difference to them. Representatives of the corporate chains who handled a large proportion of the corn were asked to indicate their reaction to a four dozen package. All indicated that a four dozen package would be satisfactory

provided all growers icing corn would use this size of package. In other words, their concern was not so much over the size of the package as that a standard size be adopted.

SUMMARY

This study was conducted in Franklin County during the 1950 and 1951 sweet corn seasons. The purpose of the study was to determine the practicability of marketing high quality iced sweet corn as related to costs and general acceptance by growers, wholesalers, retailers, and consumers; and also to make quality determinations of the sweet corn at various intervals during the marketing period.

Sweet corn was packed in wet-strength paper bags with about 20 pounds of ice, moved through the wholesale market and through the chain store warehouse. Sales of corn iced at the farm and merchandized on iced displays were much greater (about 83 percent in 1950) than those of similar sweet corn not iced and sold from non-refrigerated displays. Sales of sweet corn iced at the farm and merchandized in refrigerated cases ranked second in importance.

In both seasons, the quality of the sweet corn as measured by total and reducing sugars and respiration rates, was significantly higher with the iced packaged lots of sweet corn as compared with the non-iced lots. Supplemental icing or use of other refrigeration was found to be necessary, eight to twelve hours after the initial icing, to maintain the lower temperatures necessary for a better quality sweet corn. Pre-cooling the sweet corn in cold water, before packaging and icing, increased the effective cooling period with the twenty pounds of ice used.

Spoilage or throwout loss was relatively small in stores selling both iced and un-iced corn, amounting to less than five percent in both 1950 and 1951, with the highest spoilage loss in stores selling corn which had not been iced.

An average of about 4.5 pounds of ice at a cost of 2.25 cents per dozen ears was used by growers during the 1950 season, compared with about four pounds at a cost of about two cents per dozen during the 1951 season. An average of 3.1 pounds was used at retail during the 1950 season compared with 4.6 pounds during the 1951 season. In general, the twenty pounds of ice used with the five dozen ear container in 1951 was not as satisfactory as the use of twenty pounds of ice with four dozen ear containers in 1950.

While the margins taken on iced corn was considerably lower than those taken on un-iced corn, the gross returns after icing costs were much greater in stores handling iced corn.

Of the iced sweet corn handled by commission firms, about two-thirds was purchased by chain store organizations. The second and third most important types of buyers were wholesalers and fruit and vegetable store operators, accounting for about 16 and 12 percent of the sales respectively.

Of the attitudes or reactions expressed by retailers, a large percentage indicated that a premium was warranted for iced corn and the majority of the retailers indicated that a four dozen package was either preferred to the standard five dozen package or that the size of the package made no difference.

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