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# The Use of Water Bowls in the Dairy Barn

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## SUMMARY

1. Dairy cows, watered by means of water bowls, drank approximately 18 percent more water and yielded 3.5 percent more milk and 10.7 percent more butterfat than cows that were watered twice per day at an outside tank.

2. Cows watered with water bowls drank an average of about 10 times in each 24 hours. Approximately two-thirds of the water was consumed in the daytime, that is between 5 a. m. and 5 p. m., and the other one-third at night.

3. Cows watered at the outside tank frequently drank but once per day. This occurred about 30 percent of the times the cows were offered water. This refusal to drink more than once per day was distributed among all of the cows, although certain cows showed a greater disposition to drink but once per day than did others. The inclination to drink but once per day was not consistently correlated with the quantity of milk yielded.

4. One unusual observation was that when the cows were watered with water bowls, they usually yielded not only more milk but milk containing a higher percentage of butterfat. A mathematical treatment of the data shows that the probability is only about 4 in 100 that a result as large and consistent could have come by chance alone.

5. The temperature of the water apparently did not influence the water consumption as greatly as did atmospheric temperature. The relative consumption of water increased as temperature rose.

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# The Use of Water Bowls in the Dairy Barn

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The relation of water consumption to the yield of milk of dairy cows is a problem vitally connected with the management of every dairy herd. It is a well recognized fact that a dairy cow must have an ample supply of water in order to successfully produce large quantities of milk. Babcock (2) has clearly pointed out the essentiality of water in such a physiological process. Studies made at various stations as to the relationship between the yield of milk and the quantity of water consumed show that the amount consumed in addition to that contained in the dry feed usually has been between 300 and 400 pounds for each hundredweight of milk produced. Eckles (3) pointed out that with the cows he used, the water consumption increased or decreased with milk production so that the ratio between them remained practically constant.

Cows on green feed need less drinking water than those on dry feed. McCandlish and Gaessler (8) showed that when cows were on soiling crops the cows drank 350 pounds of water per hundred pounds of milk produced, while the total water consumed (including that in the feed) amounted to 550 pounds per hundredweight of milk produced. Armsby and Caldwell (1) fed a cow on fresh grass and found her drinking water consumption to be 234 pounds per hundred pounds of milk produced, while her drinking consumption rose to 421 pounds per hundred pounds of milk produced when fed the same kind of grass after it had been dried.

The Beltsville Station (10) compared the yield of cows allowed water at will with those watered twice per day and once per day. They found that the cows allowed water at will yielded 2.8 percent more milk and 2.1 percent more fat than when they were watered twice per day. When they were watered twice per day the yield of milk was 1.0 percent higher and the fat 1.4 percent higher than when the cows were watered only once per day. The cows that were watered twice per day drank 1.5 percent more water than when allowed to drink at will and 13.3 percent more than when watered once a day. The Beltsville workers observed that high producers received more benefit from the more frequent waterings than did the low producers.

In Great Britain (11) groups of dairy cows allowed to drink from water bowls while in the stable were compared with other groups which were not allowed water while in the stable. All the cows were given free access to water during the time they

were outside the barn. Some of the results showed an advantage was derived from the use of the water bowls, while in one of the trials the milk yield was less with water bowls than without. No general conclusions as to the value of water bowls were drawn from the results.

At the South Dakota Experiment Station (7) dairy cows were watered every 8 hours, every 24 hours and every 60 hours. In addition cows in one group were allowed only one-half their usual allowance of water each 24 hours. It was found that, "The amount of milk given is affected by frequency of watering, but not so much as would naturally be expected. When supplied only one-half amount of water, there was a daily decrease in the amount of milk of 4.2 pounds, or a decrease of about one-fourth." In these experiments there apparently was no variation in the composition of the milk that could be ascribed to the lack of water.

## OBJECT

This experiment was designed to determine the effect on yield of milk and butterfat when the cows were (1) watered at will through the use of water bowls and (2) watered but twice daily at an outside tank.

## EXPERIMENTAL PROCEDURE

Twelve representative cows were selected from the milking herd of the Iowa Agricultural Experiment Station and were divided into two lots of six cows each. An attempt was made in selecting the cows to make the two lots as nearly alike as possible. Data concerning them are found in table I.

The trial consisted of four experimental periods of 28 days each, and each experimental period was preceded by a preliminary period of 7 days. At the end of the third period two cows, one from each lot, cow no. 744 from lot A and cow no. 769 from lot B, were turned dry. The preliminary period preceding the first experimental period began at noon, Nov. 21, 1929.

The trial was conducted on the double reversal plan, that is, the cows in lot A were watered by use of the drinking cups during the first period, and at the tank outside of the barn during the second period. During the third period, lot A cows were again watered by means of the drinking cups, while in the fourth period they were switched to the outside watering tank. The cows of lot B had the opposite watering schedule, being reversed in each of the four periods with the cows of lot A.

For purposes of calculations these four experimental periods were grouped as if two separate trials were run. The first grouping was made of periods I, II and III and the second grouping was made of periods II, III and IV. The calculations from the

TABLE I. DATA ON COWS USED IN TRIALS.

Lot A						
Cow no. ....	906	750	787	744	796	933
Breed .....	Holstein	Holstein	Holstein	Jersey	Jersey	Guernsey
Age Yrs.-mo.-da. ....	9-1-13	3-8-17	3-8-8	3-9-8	2-2-16	6-9-27
Days fresh .....	133	83	94	170	101	54
Days bred .....	75	45	open	106	34	open
Previous lactations .....	unknown	1	0	1	0	unknown

Lot B						
Cow no. ....	763	833	675	769	817	749
Breed .....	Holstein	Holstein	Holstein	Jersey	Jersey	Guernsey
Age Yrs.-mo.-da. ....	3-7-11	6-0-3	5-4-15	3-5-7	5-1-24	3-8-18
Days fresh .....	165	197	79	311	140	60
Days bred .....	open	35	open	open	open	open
Previous lactations .....	1	2	3	0	unknown	1

second grouping were made on only five cows as one out of each lot of cows was dry part of the time. Although these dry cows were not used in the calculations of all of the tables they were nevertheless kept under constant observation during the entire experiment.

Throughout the trial all the cows were fed daily about 1.25 pounds of alfalfa hay and 2.5 pounds of corn silage for each 100 pounds live weight. In addition a grain mixture was fed consisting of:

Corn .....	3 parts
Oats .....	3 parts
Wheat bran .....	1 part
Linseed oilmeal .....	1 part
Salt (NaCl) .....	1 percent

It was fed at the rate of about 7 pounds for each pound of butterfat yielded. Besides the salt mixed with the grain, the cows had access at all times to salt blocks.

Two methods used in watering the cows were: (a) drinking cups where the cows had access to water at all times, and (b) a watering tank outside where the cows were offered water twice daily. The cows were allowed all the water they would drink.

All animals were turned into a bare exercise lot for approximately 1 hour each morning that it did not storm. The cows

were fed and milked twice daily. Complete daily records of all feed offered and refused were kept, while the milk yields were recorded at each milking and a composite sample taken, which was tested for butterfat each week.

The amount of water supplied each watering cup was measured by a separate meter, while a master meter measured the total water supplied all six cups. The meters were all checked for accuracy both at the beginning and after the first experimental period.

The water consumed by the cows watered outside was measured by a gauge made especially for this purpose. The tank was straight-sided with a level floor. The gauge was calibrated so that by putting it into the tank the quantity of water in the tank both before and after drinking could be accurately read (fig. 1).

Atmospheric temperatures both inside and outside the barn were taken continuously by means of recording thermometers, while water temperatures were taken twice a day at the same time the cows were watered outside.

The behavior of the animals was normal during the entire trial. They were healthy and had good appetites, and at no time was a cow really off-feed. No cow lost weight during the experiment, while most of them gained.



Fig. 1. Straight-sided tank from which cows were watered outside the barn and calibrated gauge for measuring volume of water.

## WATER CONSUMPTION

The free water consumption of dairy cows is largely influenced by three things: (a) The quantity of water in the feed eaten, (b) the amount of milk yielded, and (c) the surrounding temperature. The conditions of this experiment were such that each of these factors affected the cows in approximately the same way. All the feed given the cows came from the same sources so that the amount of water obtained by each lot from the feed was about the same. The lots were selected so that both gave approximately the same amount of milk. As the cows of one group were transferred to the stanchions of the adjacent group during alternate periods, and as all experimental cows were allowed in the yard outside of the barn at the same time and kept there the same length of time, the temperature factor probably influenced each lot in the same way. Besides, the barn temperature was maintained at a rather uniform level by means of a thermostatically controlled ventilating system.

From tables II and III it can be seen that the cows watered inside by means of the water bowls actually drank about 18 percent more water than did those cows watered only twice per day at an outside tank. Temperatures of the drinking water, taken both inside and out at the time the cows were watered outside, showed that the water in the drinking cups averaged about 11-12 degrees F. higher than the water outside. Many times the water outside was only a degree or two above freezing. Garillet (6) reports that very cold water frequently causes a stoppage of rumination and other troubles. We observed no such reaction in this trial.

The cows were constantly watched during five 24-hour periods. It was observed that the cows that had access to the drinking cups drank an average of 10.3 times in each 24 hours. A measurement of the water showed that 36.1 percent of the water was consumed between 5 p. m. and 5 a. m., while the remaining 63.9 percent was consumed between 5 a. m. and 5 p. m.

A study of the consumption of water by the cows watered outside (table IV) shows that they consumed the greater portion of their water in the morning. The consumption was consistently higher in the morning, although during period III the difference was not great. The outside temperature at the morning watering was usually lower than at night.

An examination of our records showed that on many days when the cows were watered at the outside tank they drank but once per day. Table V shows that for the entire four periods the cows drank but once a day during 29.6 percent of the time. All of the cows at some time refused to drink twice per day. Certain of the cows showed a strong disposition to drink only once per day. Cow no. 933 drank only once per day during 26

TABLE II. INDIVIDUAL CONSUMPTION OF WATER AND YIELDS OF MILK AND BUTTERFAT BY PERIODS.

	Water used gal.	Production			Water used gal.	Production			Water used gal.	Production			Water used gal.	Production		
		Milk lbs.	Fat lbs.	Fat %		Milk lbs.	Fat lbs.	Fat %		Milk lbs.	Fat lbs.	Fat %		Milk lbs.	Fat lbs.	Fat %
Lot A	Period I Water cups				Period II Outside tank				Period III Water cups				Period IV Outside tank			
906	477.6	1179.2	40.06	3.39	356.2	1027.8	31.59	3.07	369.3	802.9	27.83	3.47	316.7	384.1	14.47	3.77
750	324.7	850.4	27.39	3.22	254.8	698.1	19.34	2.77	288.4	610.3	19.52	3.20	267.3	431.5	13.57	3.14
787	380.7	1048.4	34.57	3.30	294.4	946.8	26.52	2.80	366.5	934.9	30.65	3.28	308.9	841.2	25.23	3.00
744	252.3	481.2	30.56	6.35	215.7	467.3	29.91	6.40	210.5	476.2	31.07	6.52	Dry	Dry	Dry	Dry
796	260.9	619.7	30.14	4.86	184.5	566.4	28.14	4.97	222.6	549.2	27.05	4.91	211.4	505.1	25.52	5.05
933	293.4	824.6	37.31	4.52	253.1	687.6	29.79	4.33	272.7	690.0	32.24	4.67	250.8	615.8	27.10	4.40
Total	1989.6	5003.5	200.03	3.99	1558.7	4394.0	165.29	3.76	1730.0	4063.5	168.36	4.14	1355.1	2777.7	105.89	3.81
Lot B	Period I Outside tank				Period II Water cups				Period III Outside tank				Period IV Water cups			
749	291.1	960.1	50.83	5.29	287.4	802.6	54.96	5.73	264.8	771.6	39.71	5.15	336.6	752.6	39.70	5.27
817	200.8	577.5	31.62	5.47	218.5	558.1	31.91	5.72	196.7	511.5	32.37	6.33	230.6	497.2	27.84	5.61
769	205.7	496.9	28.97	5.83	255.2	446.5	28.12	6.30	187.3	398.2	21.14	5.30	Dry	Dry	Dry	Dry
675	364.7	1113.2	35.83	3.22	427.9	1094.0	38.02	3.46	323.1	930.4	29.08	3.12	391.8	910.9	30.71	3.33
833	314.6	963.5	31.72	3.29	343.9	807.5	30.48	3.77	291.4	752.7	24.63	3.27	355.4	680.9	25.39	3.73
763	240.0	743.4	20.62	2.77	286.8	640.8	22.37	3.41	193.3	464.3	14.75	3.18	277.9	437.9	15.40	3.52
Total	1616.9	4854.6	199.59	4.11	1819.7	4349.5	196.86	4.53	1456.6	3828.7	161.68	4.22	1592.3	3279.5	139.14	4.24



TABLE III. AVERAGES AND SUMMARIES OF THE VARIOUS PERIODS.  
SUMMARIES OF PERIODS I, II AND III

Lot A	Method of watering	Water used gal.	Production	
			Milk lbs.	Fat lbs.
Average of periods I and III	Water bowls	1859.8	4533.5	184.19
Period II	Outside tank	1558.7	4394.0	165.29
Lot B				
Average of periods I and III	Outside tank	1536.7	4341.6	180.63
Period II	Water bowls	1819.7	4349.5	196.86
Average of lots A and B	Water bowls	1839.7	4441.5	190.52
Average of lots A and B	Outside tank	1547.7	4367.8	172.96
Differences		292.0	73.7	17.56
Differences in percent		18.86	1.68	10.15

SUMMARIES OF PERIODS II, III AND IV\*

Lot A	Method of watering	Water used gal.	Production	
			Milk lbs.	Fat lbs.
Average of periods II and IV	Outside tank	1349.0	3352.2	120.63
Period III	Water bowls	1519.5	3587.3	137.29
Lot B				
Average of periods II and IV	Water bowls	1578.3	3591.2	153.94
Period III	Outside tank	1269.3	3430.5	140.54
Average of lots A and B	Water bowls	1548.9	3589.2	145.61
Average of lots A and B	Outside tank	1309.2	3391.3	130.59
Differences		239.7	197.9	15.02
Differences in percent		18.31	5.84	11.50

\*Cows No. 744 and 769 not used in these calculations.

SUMMARIES OF BOTH LOTS AND ALL PERIODS COMBINED

Combined lots A and B in all periods	Method of watering	Water used gal.	Production	
			Milk lbs.	Fat lbs.
Average of lots A and B	Water bowls	3388.6	8030.7	336.13
Average of lots A and B	Outside tank	2856.9	7759.1	303.55
Differences		531.7	271.6	32.58
Differences in percent		18.61	3.5	10.73

TABLE IV. RELATION BETWEEN A. M. AND P. M. CONSUMPTION OF WATER WHEN THE COWS WERE WATERED AT OUTSIDE TANK.

Period	Group	Total water consumption gallons	Consumption a. m.	Consumption p. m.	Percent consumed a. m.	Percent consumed p. m.
I	B	1,616.9	922.3	694.6	57.0	42.9
II	A	1,558.7	989.5	569.2	63.5	36.5
III	B	1,456.6	741.4	715.2	50.9	49.1
IV	A	1,355.1	962.9	392.2	71.1	28.9
Total		5,987.3	3,616.1	2,371.2	60.4	39.6

of the 28 days in period II and 20 of the 28 days in period IV. The yield of milk from this cow during these two periods was slightly below the average for the entire group, while her fat yield was well above the average of the group.

To show that there was no consistent relationship between the frequency of refusal to drink twice per day and the milk yield, one needs only examine the record of cow no. 744. During periods II and IV she drank but once per day on 6 out of the 28 days of each period. During period II she yielded 467.3 pounds of milk. She was dry during period IV. As expected, her water consumption was larger during period II than during period IV in order to compensate for the additional water lost from her body in the milk she gave. The records show that she drank 7.9 percent more water during period II than in period IV, though the number of times she drank was the same.

#### MILK AND FAT PRODUCTION

The relationship between the consumption of water and the yield of milk is always interesting. An examination of tables II and III shows that while the water consumption was about

TABLE V. SHOWING NUMBER OF TIMES COWS DRANK BUT ONCE PER DAY WHEN WATERED AT OUTSIDE TANK.

Period	Group	Cow* days	No. times refused a. m.	No. times refused p. m.	No. once per day drinking	Percent
I	B	168	11	20	31	18.4
II	A	168	15	52	67	39.9
III	B	168	22	26	48	28.6
IV	A	168	14	39	53	31.5
Total		672	62	137	199	29.6

\*Obtained by multiplying the number of days in the period by the number of cows.

18 percent larger for the cows being watered by means of the water bowls, the corresponding milk yield was approximately 3.5 percent more and the butterfat yield was about 10 percent more than when the cows were watered at the outside tank. This means that during the 16 weeks of the trial the cows using water cups produced 271.6 pounds more milk and 32.58 pounds more butterfat than they did while being watered twice per day at the outside tank. If butterfat is worth 30 cents per pound, then the additional yield of fat made by the cows watered with the water cups was worth about \$9.77.

One interesting phase of these results is the apparent effect of the frequent waterings by use of the drinking cups upon the percentage of fat in the milk yielded. It will be noted from table II that in most instances the percentage of fat in the milk yielded was higher when the cows were watered from the water cups.

This increase was so striking that we thought it best to analyze the records of the individual cows. Statistical tests\* applied to these data show that the probability is about 4 in 100 that a difference as large and consistent as this could have resulted by chance alone. This is true whether one uses the method given in Fisher's example 19 (4), or his method of differences for which the variance is analyzed. Since both methods lead to the same conclusion, this experiment should be carefully run again with more animals if possible. There is no doubt that the cows used in this experiment produced milk with a higher fat content when watered inside from water cups than when watered from a tank outside. On the evidence of this one somewhat limited experiment, the probability is rather great that the differences are not merely random fluctuations, but that they are differences due to variation in treatment.

If these results could be explained or predicted, reasoning from a physiological basis, they would be highly significant. Since no good physiological explanation can be made, the level of significance secured is only great enough to warrant further test.

This change in milk composition due to a change in the method of watering is contrary to results obtained by Larsen, Hungerford and Bailey (7), who found that "the composition of milk remained remarkably uniform" even though their cows had a wide range in water consumption.

#### RATIO OF WATER CONSUMPTION TO MILK PRODUCTION

Eckles (3) states that, in general, the ratio of milk yield to consumption of water by dairy cows was about one to three.

\*The mathematical treatment of these figures was made by Prof. A. E. Brandt of the Mathematics Department, Iowa State College.

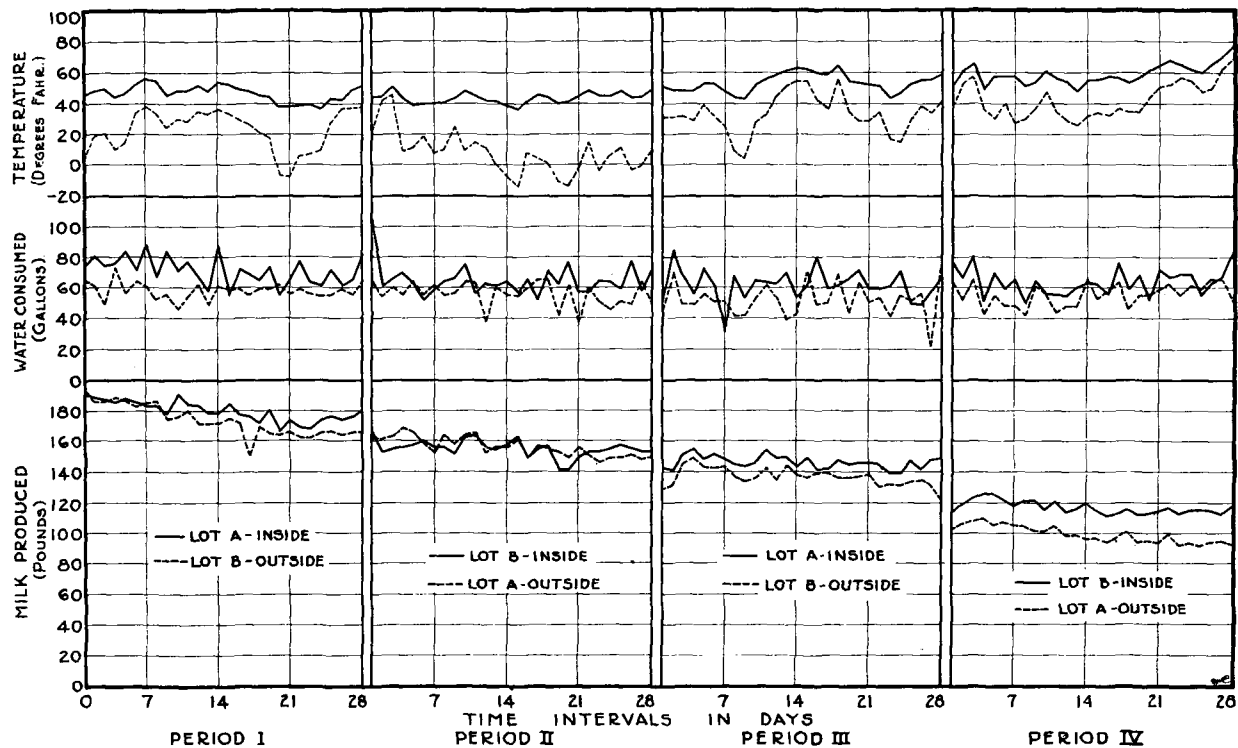


Fig. 2. Curves showing atmospheric temperatures, both inside and outside of barn; water consumption of cows watered from water cups and at outside tank; and milk yields of the cows.

Taking all the cows in this trial into consideration, it was found that when they were watered from the cups the relation of milk yield to consumption of water was in the ratio of 1:3.5. When they were watered outside the ratio was 1:3.1. These ratios indicate that the water consumption of the cows which were watered outside was probably not as large as it should have been. At least the cows did not drink as much outside in proportion to their milk yield as they did from the water cups inside.

The total yield of milk of both lots was compared with the total water consumption, which gave a ratio of milk yielded to water consumed for the entire group of cows of 1 to 3.3. This ratio is somewhat larger than that given by Eckles, but is under McCandlish and Gaessler's ratio (8) of 1:3.5, which was obtained from cows being fed soiling crops and grain.

In order to see more clearly the reasons for a larger consumption of water from the water bowls, we studied the temperatures of the water in the bowls as compared with the water in the outside tank at the time the cows had access to it. The water in the cups had an average temperature of 52.94 degrees F. This was about 12 degrees F. higher than the average temperature of the water outside.

If the temperature of the water at the time it was consumed influenced the amount taken, we could say that this difference in the temperature between the water inside and outside would partially explain the larger consumption of water from the cups. During the time of this trial a research problem involving the ventilation of the barn was in progress. To make conditions right for this latter investigation it was necessary to insulate the ceiling of the barn. After the change, the barn was maintained at a higher and more uniform temperature (fig. 2). This factor was probably responsible for the higher temperature of the water in the cups during the last part of the trial. It was noticed that the average difference in temperature between the water in the cups and that in the outside tank was greater the latter part of the trial. This difference varied from an average of 4.69 degrees F. in the second period to 17.87 degrees F. in the fourth period.

By combining the results of periods I and II and comparing them with the combined results of periods III and IV, it is possible to secure some measure of the effect of water temperature on consumption. The ratios of milk to water consumption for periods I and II are 1:3.4 for the cows watered with bowls and 1:2.9 for the cows watered at the outside tank, while for periods III and IV these same ratios are 1:3.8 and 1:3.5.

These ratios indicate that the water temperature probably had an influence on the consumption of water. The water temperature, however, apparently did not affect water consumption as

much as did the atmospheric temperature. In fig. 2 it can be seen that the difference between the atmospheric temperature inside and outside the barn was wider during periods I and II than during periods III and IV. The ratios of all milk yielded to all water consumed (3.1 for periods I and II and 3.6 for periods III and IV) indicate a smaller consumption of water during periods I and II than during periods III and IV. During these latter periods the atmospheric temperatures both inside and outside the barn were much higher, and the variation between the inside and outside temperatures was much less than in periods I and II. On the other hand, the differences in the temperature of the water in the bowls and in the outside tank were less during periods I and II than during periods III and IV. Even though the water temperatures were closer together during periods I and II than during periods III and IV, the ratios of milk produced to water consumed show a slightly greater consumption of water from the bowls during these first periods than during the second periods. This would indicate that atmospheric temperature had a greater effect on water consumption than did water temperature. This conclusion sustains the results of Moore and Bowling (9), who found "that as the average daily temperature rose, the water consumption also rose and vice versa."

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