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Environmental Physiology And Shelter Engineering

With Special Reference to Domestic Animals

XXV. The Effect of Wind on Milk Production, Feed and Water Consumption and Body Weight in Dairy Cattle

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ABSTRACT

Although changing the rate of air movement affected some of the physiological reactions, as will be reported in two subsequent publications, the European-evolved cows adjusted themselves so that no appreciable effect of air movement was observed on milk production, water consumption, or body weight at environmental temperatures 18°, 50°, 65°, and 80° F. While the feed consumption data do not show it directly, indirect evidence given in the text suggests that increasing air velocity at 18° F increases feed consumption as well as heat production.

At 95° F milk production and feed consumption in the large, high-producing Holsteins and Brown Swiss were more depressed at low than at the high air velocity. The reactions of the lactating Jerseys at 95° F were uncertain as the two cows reacted in opposite ways. The dry Brahmans and Jerseys showed no significant differences.

ACKNOWLEDGMENTS

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Report on Department of Dairy Husbandry
Research Project No. 125, Entitled
"Climatic Factors"

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ORIENTATION

The first two years of this project, 1948-50, were given to measuring the effects of changing dry-bulb temperature from 50° down to about 0° F and from 50° up to 105° F on milk production and other reactions in dairy cattle, while holding relative humidity (about 68%) and air movement (about ½ mph) approximately constant.[1] The third year, 1950-51, was similarly devoted to investigating the effect of humidity[2] at environmental temperatures 12°, 40°, 75°, 85°, 95°, and 100° F. The fourth year, 1951-52, was given to study of the effect of wind at 0.5, 4 to 6, and 8 to 9 mph at temperatures 18°, 50°, 65°, 80°, and 95° F and at 60 to 70 percent relative humidity. This and the following two bulletins will report results on the effect of wind.

This report presents the chronological details of the temperature, air velocity, and humidity levels (Table 1); description of the cows (Table 2); and the effect of changing environment on hay, TDN (total digestible nutrients) and water consumption, milk production, and changes in body weight (Tables 3 to 10 and Figures 1 to 6).

PROCEDURES, ANIMALS, AND METHODS

As shown in Table 1, this experimental year was divided into two periods, October to February 1951-52, with temperatures 50° and 18° F; and February to May 1952, with temperatures 65°, 80°, and 95° F. Different cows were used in each of the two groups. Each of the temperature periods was sub-divided into three air velocities: Low (0.4

[1]Univ Mo. Agric. Exp. Sta. Res. Buls. 425. 433, 435, 436, 449, 450, 451, 460. 461, 464, 471, 473, 479, 481, 488, 489, 497, 515.
[2]Univ. Mo. Agric. Exp. Sta. Res. Buls. 484, 521, 522, 531.

TABLE 1 -- TEMPERATURE AND AIR VELOCITY CALENDAR

Period (3 p.m. to 3 p.m.)	No. Days	JERSEY AND BRAHMAN Temp. °F	Velocity[1] Miles/hr.	Relative Humidity, %	HOLSTEIN AND BROWN SWISS Temp. °F	Velocity[1] Miles/hr.	Relative Humidity, %
		October 25, 1951, to February 14, 1952					
Oct. 25 to Nov. 8	14	50	.4*	69	51	.4*	72
Nov. 8 to Nov. 22	14	51	4.2	66	51	4.5	67
Nov. 22 to Dec. 6	14	50	6.0	65	50	.4*	58
Dec. 6 to Dec. 20	14	50	.4*	52	50	8.1	68
Dec. 20 to Jan. 3	14	31 (Temp. range 46 to 12)	.4*	57	30 (Temp. range 49 to 13)	.4*	63
Jan. 3 to Jan. 17	14	15	3.8	61	18	3.4	60
Jan. 17 to Jan. 31	14	17	7.6	62	19	.5	56
Jan. 31 to Feb. 14	14	19	.5*	55	18	10.0	61
		February 23 to May 29, 1952					
Feb. 23 to Mar. 6	12	66	.5*	69	64	.4*	71
Mar. 6 to Mar. 20	14	66	6.2	64	66	8.8	60
Mar. 20 to Mar. 27	7	64	.4*	65	65	6.4	64
Mar. 27 to Apr. 3	7	66	8.5*	60	67	4.8 } 5.6	65
Apr. 3 to Apr. 10	7	66	8.5	60	64	.4*	65
Apr. 10 to Apr. 24	14	80	7.7	64	80	4.5	66
Apr. 24 to May 8	14	80	4.7	64	80	8.7	62
May 8 to May 18	10	80	.4	64	80	.4	62
May 18 to May 20	2	94	.4	63	81	.4*	66
May 20 to May 22	2	89	.4*	64	95	8.8	62
May 22 to May 25	3	80	.4*	62	78	.4*	63
May 25 to May 27	2	95	8.9	58	80	.4*	71
May 27 to May 29	2	76	.4	72	94	.4	62

[1]These values are measurements of turbulent air movement taken with hotwire or Pitot tube anemometers with cows out of stall.

*Values are estimates made from measurements taken during similar periods.

mph), medium (4 to 5 mph), and high (8 to 9 mph). With the exception of the 95° F period, the cows were exposed for two weeks to each of the specific environmental conditions. At 95° F the periods had to be reduced to three days at the low and high air velocity levels (no test made at medium velocity).

One chamber housed three lactating Holstein and three lactating Brown Swiss cows; the other chamber contained two lactating and two dry Jerseys and two dry Brahmans (Table 2).

As in the preceding experiments, the cows were machine-milked twice daily. Alfalfa hay chopped in approximately ¾ to 1-inch lengths was fed *ad libitum;* the left-over hay was air dried before weighing and deducting from the amount fed. Water was available in individual drinking cups and the amount drunk was automatically recorded. The cows received 4 pounds of dry beet pulp twice daily. The grain mix, including cod liver oil supplement, was the same as in previous studies.[3] The amount fed was based on the previous milk production, with a minimum of 5 pounds daily (with the exception of the dry Brahmans which received 5 pounds of grain during the 1951-52 winter period and 4 pounds during the 1952 spring period).

[3]Univ. Mo. Agric. Exp. Sta. Res. Bul. 425 (Table 3).

TABLE 2 -- HISTORY OF THE COWS

Cow No.	Birth Date	Date of Last Calving	Number of Previous Lactations	Date of Last Breeding	At Beginning of Expt. Approx. Age Years	At Beginning of Expt. Approx. Body Weight lbs.	Average During Oct. 1951, or Feb. 1952 Milk lbs/day	Average During Oct. 1951, or Feb. 1952 Butterfat %
				Winter 1951-52				
Jersey								
999	May 10, 1944	Feb. 10, 1951	4	Aug. 29, 1951	7½	900	dry	
548	Mar. 25, 1948	July 31, 1951	1	Dec. 14, 1951	4	860	17.0	5.9
549	Apr. 13, 1948	Sept. 30, 1951	1	Dec. 12, 1951	4	830	24.6	4.3
264	Feb. 20, 1948	Apr. 23, 1951	1	----------	4	790	dry	
Holstein								
132	Sept. 14, 1944	Sept. 24, 1951	4	Apr. 1, 1952	7	1250	39.0	3.2
178	Dec. 12, 1946	Oct. 6, 1951	2	June 19, 1952	5	1170	28.8	3.9
184	Feb. 13, 1947	Sept. 23, 1951	2	----------	5	1130	48.8	3.0
Brahman								
209	May 6, 1947	June 29, 1950	2	----------	4½	1070	dry	
189	Feb. 13, 1947	June 19, 1951	2	----------	5	990	dry	
Brown Swiss								
9	Mar. 27, 1948	Sept. 26, 1951	1	Oct. 21, 1951	4	1090	50.0	---
41	Dec. 6, 1947	May 18, 1951	2	Aug. 15, 1951	4	1100	25.0	---
47	July 26, 1948	Oct. 18, 1951	1	----------	3½	990	32.0	---
				Spring 1952				
Jersey								
548	Mar. 25, 1948	July 31, 1951	1	Dec. 14, 1951	4	860	dry	
994	Oct. 20, 1943	Dec. 9, 1951	5	----------	8½	820	32.8	7.5
205	Oct. 7, 1944	Jan. 21, 1952	5	----------	7½	970	30.0	5.8
549	Apr. 13, 1948	Sept. 30, 1951	1	Dec. 12, 1951	4	870	dry	
Holstein								
144	June 11, 1945	Feb. 2, 1952	4	----------	7	1310	44.5	4.9
154	Dec. 25, 1945	Jan. 19, 1952	3	Aug. 3, 1952	6	1370	56.6	4.7
118	Dec. 13, 1943	Jan. 13, 1952	4	Aug. 3, 1952	8	1300	56.0	4.5
Brahman								
209	May 6, 1947	June 29, 1950	2	----------	5	1080	dry	
189	Feb. 13, 1947	June 19, 1951	2	----------	5	1020	dry	
Brown Swiss								
22	May 1, 1948	Oct. 30, 1951	1	Jan. 3, 1952	4	1290	29.2	4.8
23	Feb. 25, 1945	Feb. 12, 1952	4	June 24, 1952	7	1380	45.5	7.8
47	July 26, 1948	Oct. 18, 1951	1	----------	3½	1030	22.5	3.4

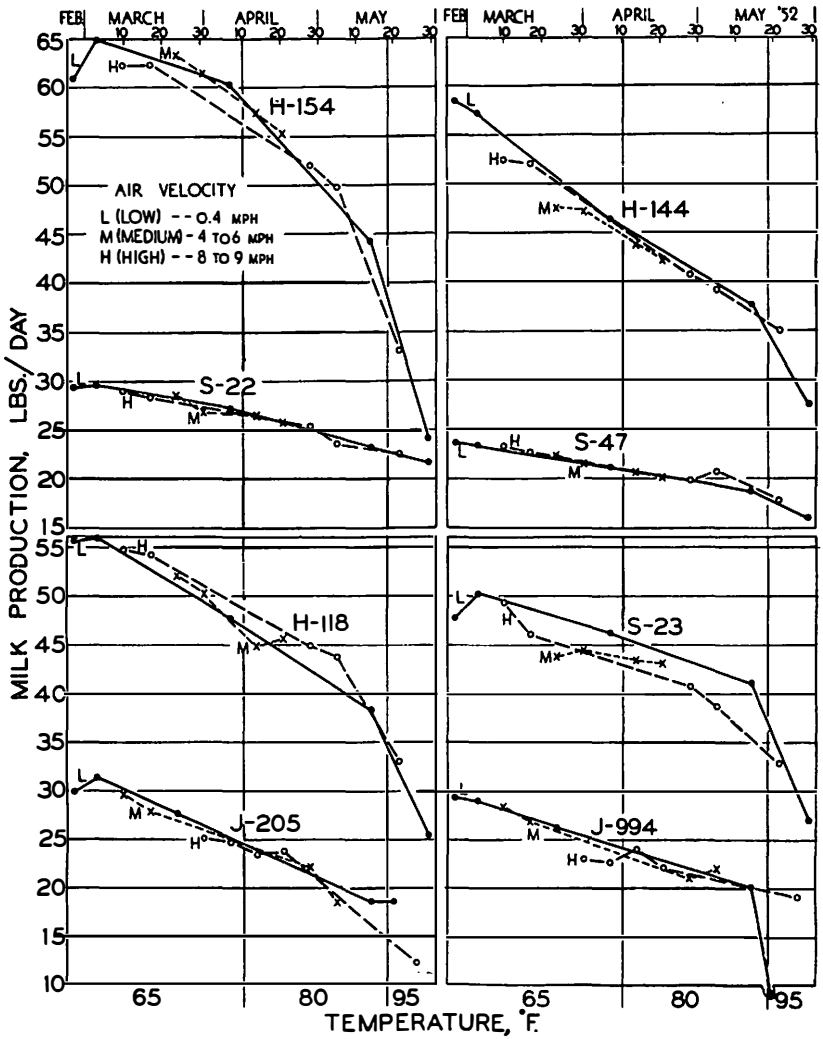

Figure 1 — A comparison of the effects of low, medium, and high air velocity on milk yield at 65°, 80°, and 95°F. The slopes of the curves (due to rising temperature and advancing stage of lactation) were not affected by wind except at 95°F when the milk yield at 0.4 mph was lower than that at 9 mph in the Holsteins (H), in the highest yielding Brown Swiss (S) and in one of the two Jerseys (J).

The method of controlling the rate of air movement will be described in a later publication. In brief, air velocities of 3 mph and above were obtained from fans over alternate stall partitions, discharging down on one-half of each animal. The major portion of this air

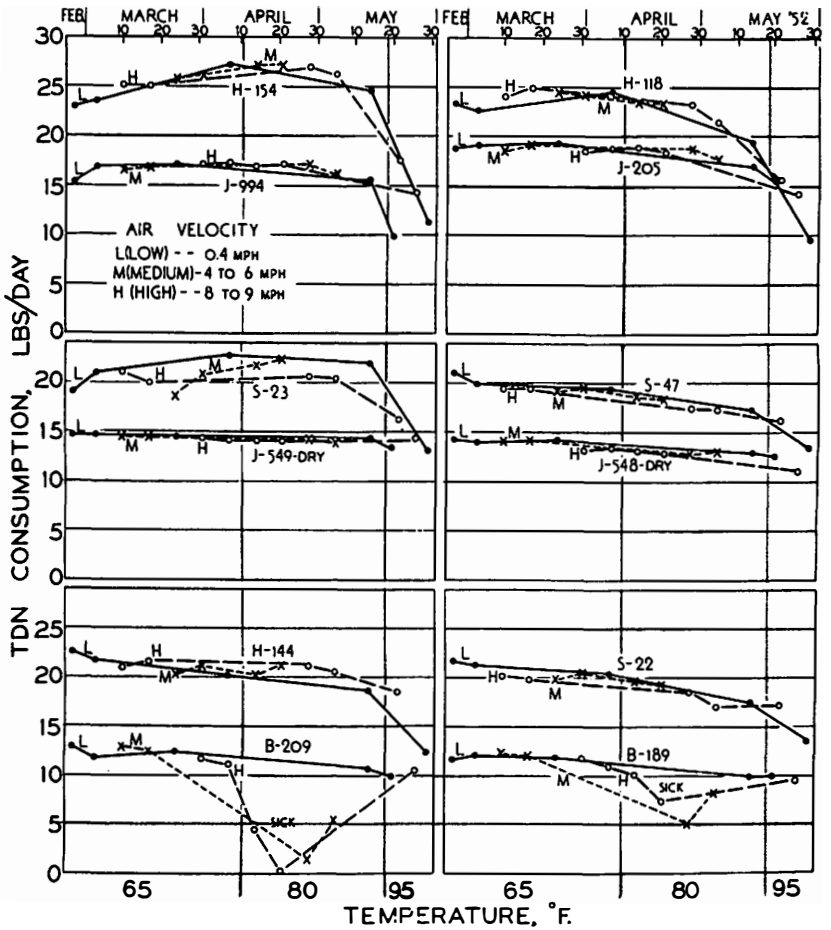

Figure 2 — Same as Figure 1 but for TDN consumption. As in milk yield, no effect of air velocity was found except at 95°F in the Holsteins and in highest yielding Brown Swiss.

then passed under the animals before rising and returning to the fan inlets. Air speeds were adjusted by variable speed fan drives and by the use of one or two fans for each pair of stalls. During feeding periods the fans were turned off to keep feed from being blown out of the mangers. Low air velocity (0.4-0.5 mph) conditions represent normal air movement without fans.

THEORETICAL CONSIDERATIONS

The cooling effect of increasing wind depends on several factors, including available moisture for vaporization on the outer body sur-

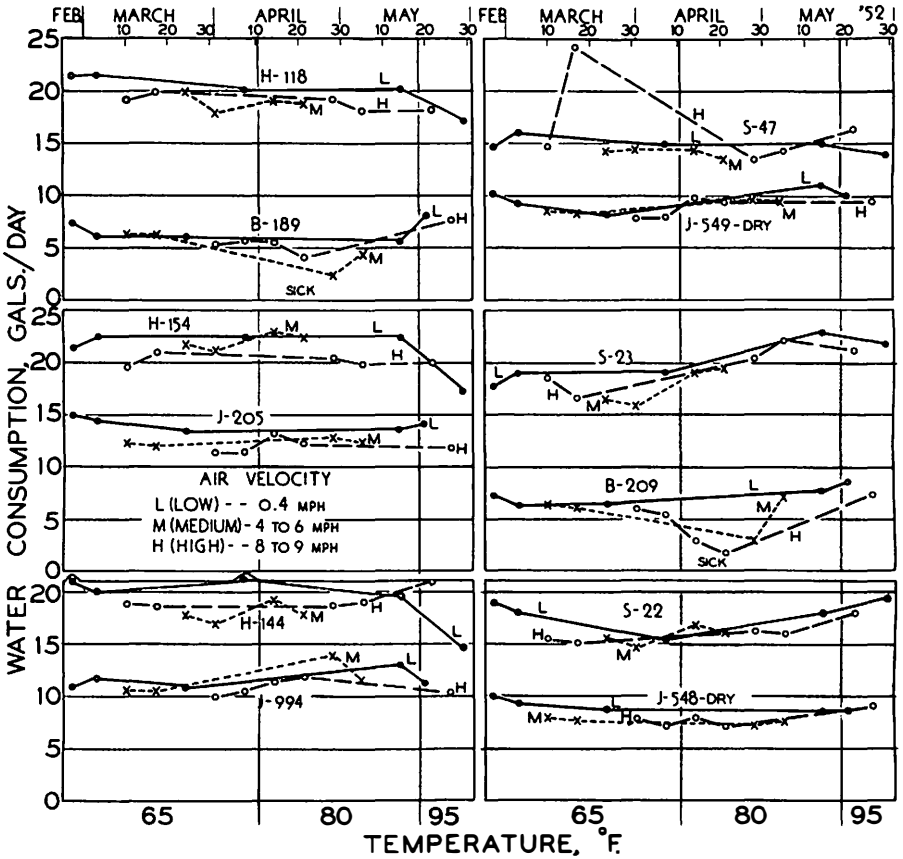

Figure 3 — Water consumption at 65°F and 80°F was slightly depressed by high air velocity.

faces, temperature difference between body surfaces and environment, physiologically-effective outer body surface and its ratio to body weight, amount of insulating covering (hair and subcutaneous fat).

Assuming, for simplicity, that the amounts of insulating covering and radiations are constant, and that the available moisture for vaporization on the outer body surface is relatively insignificant (since cattle sweat very slightly if at all), then cooling by wind is mostly by convection. Since convective cooling tends to vary approximately with the square root of air velocity,[4] the above relations may be represented by the equation

$$C = kA\sqrt{v}\,(t_1 - t_2) \quad - - - - - \quad (1)$$

in which C is the convective cooling rate; A, surface area; v, air velocity; $(t_1 - t_2)$, temperature difference between surface (hair) temperature and environment; and k is the convection constant.

[4]Gagge, A. P., Herrington, L. P., and Winslow, C. E. A., Am. J. Hygiene 26, 97, 1937.

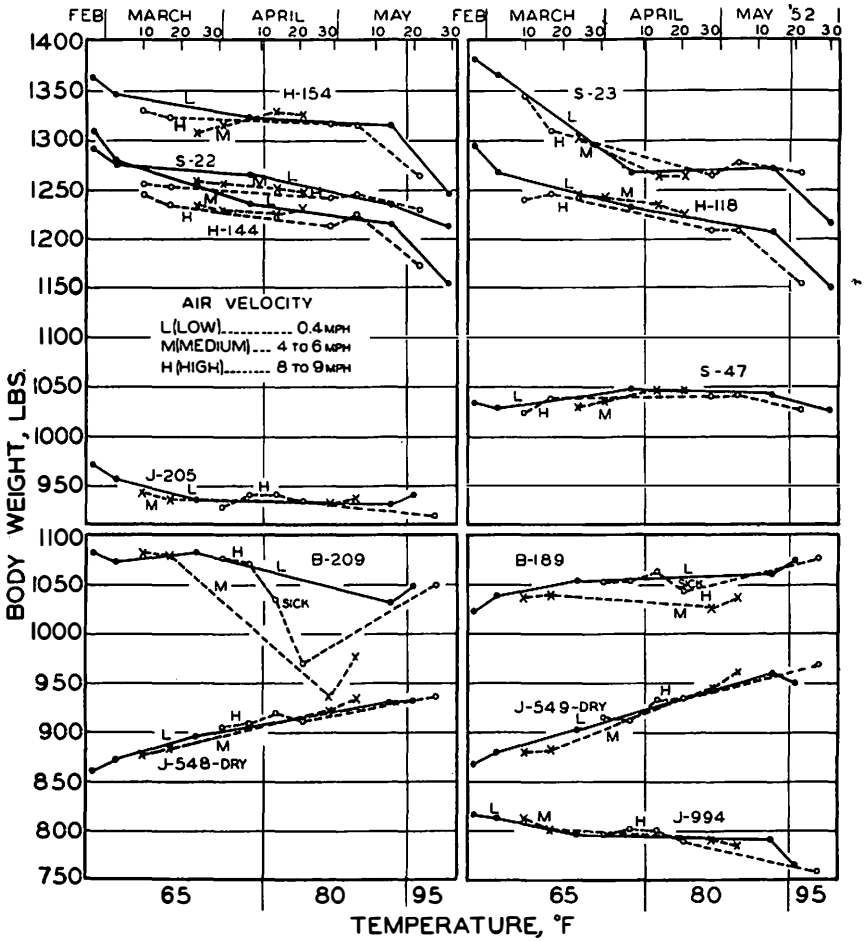

Figure 4 — No effect of changing air velocity was evident on body weight except possibly at 95°F in the Brown Swiss and Holstein.

Accepting the above equation that the convective cooling rate tends to increase with the square root of the air velocity, then increasing the air velocity, v, by 100 percent increases the convective cooling rate, C, by only about 50 percent. In brief, when cattle are kept dry, increasing air velocity at moderate environmental temperatures would not be expected to increase the cooling rate greatly.

Increasing the speed of a fan greatly increases the cooling effect on man at 85° F, but this is because man's skin is moist with sweat and the cooling is mostly by vaporization rather than by convection. The fan would not, however, be expected to cool a cow similarly by

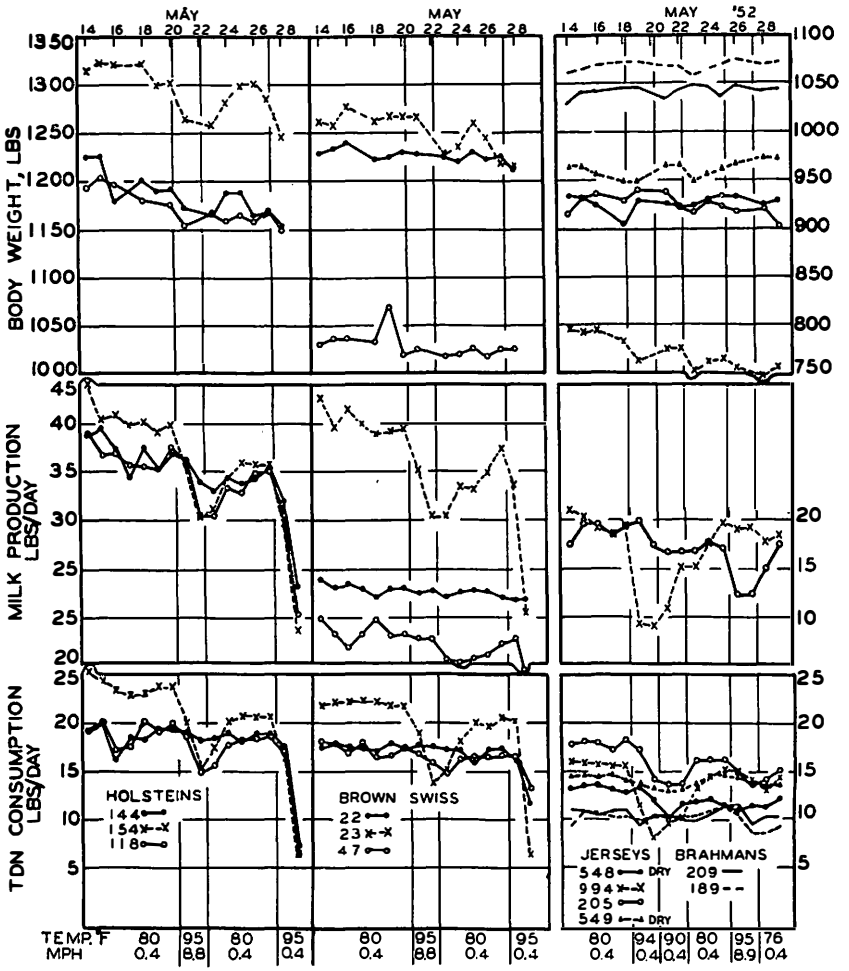

Figure 5 — Milk yield, TDN consumption and body weight plotted against the 80-95°F segment of the temperature curve to show daily, instead of average weekly, values. The 95°F temperature period is seen to have been interrupted for a rest period of 80°F between subperiods at air velocities 9 mph and 0.4 mph. The milk production and feed consumption in the Holsteins and in the highest-producing Brown Swiss was much lower at the 0.4 than at the 9 mph velocity. The curves of the two Jerseys reacted in opposite ways.

vaporization because a cow does not sweat steadily. Moreover, increasing enviromental temperature above 85° F increases the difference beween skin and environmental temperature, $t_1 - t_2$ in equation (1), in man, but decreases it in cows.

With this introductory statement, indicating that increasing air velocity at moderate temperatures is not likely to seriously affect the

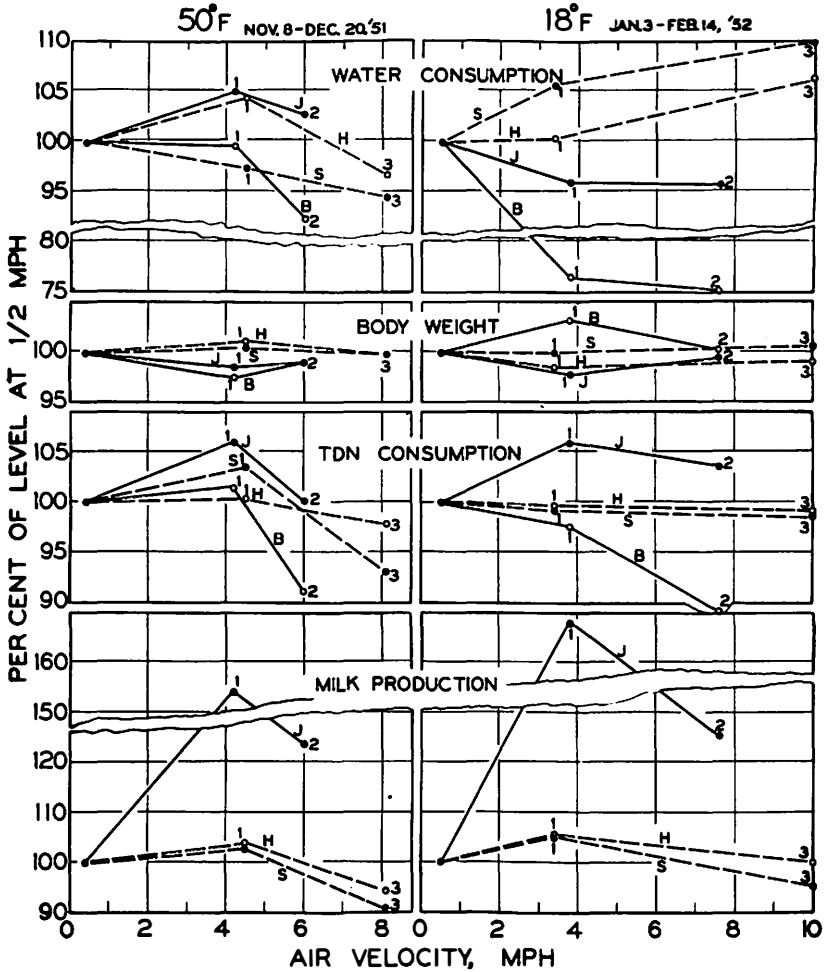

Figure 6 — Milk production, TDN and water consumption. and body weight in terms of percentages of the low (0.5 mph) air velocity for 18° (right sections) and 50°F (left sections) environmental temperature. The curves may be confused because of the time sequence in which the velocities were run. The time sequence is indicated by numerals on the curves. Note that the decline in the curves (especially for milk production) follows this sequence (medium, high, and low for the Jerseys and Brahmans; and medium, low, and high for the Holstein and Swiss) indicating that the changes may be mostly the result of advancing period of lactation rather than of change in air velocity. "J" represents Jersey, "B" Brahman, "S" Brown Swiss, and "H" Holstein.

reactions of cows kept out of the rain or snow, we proceed to discuss the data obtained in this investigation.

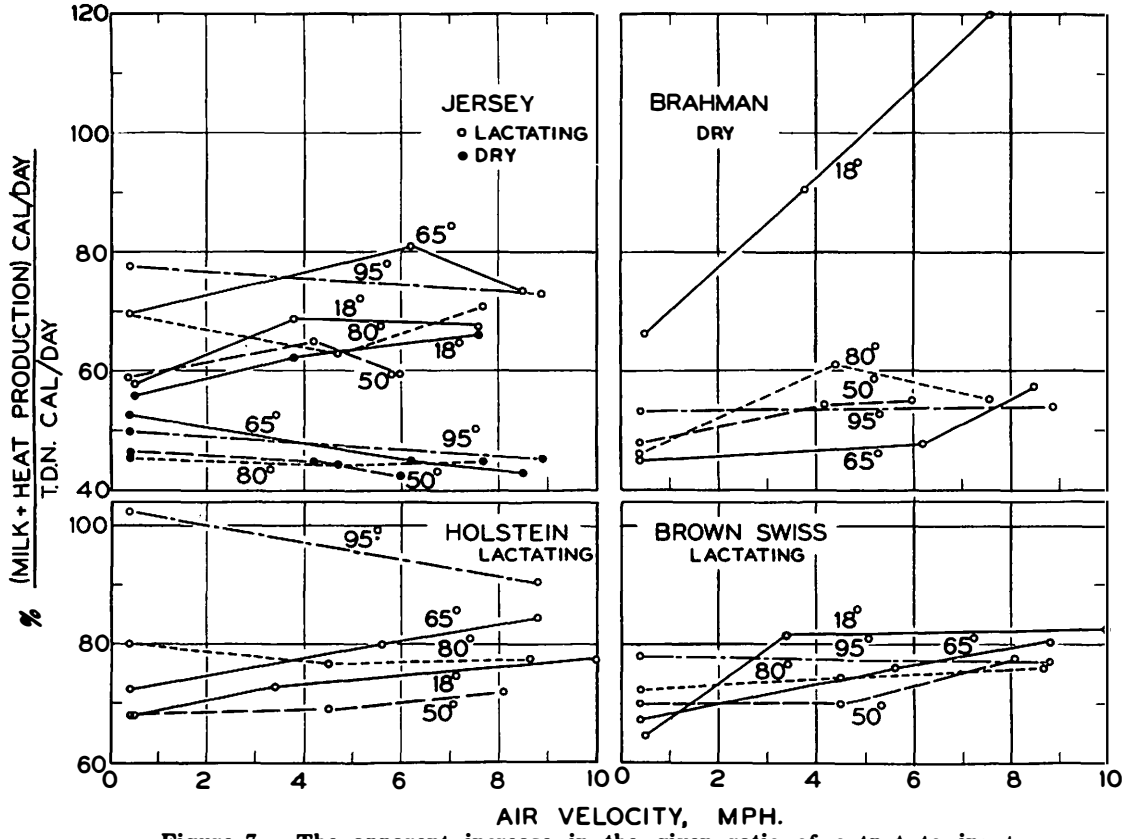

Figure 7 — The apparent increase in the given ratio of output to input calories with increasing air velocity at 18°F while the body weight remained constant, suggests an error in the TDN consumption data, especially in the Brahman (upper right segment). It was assumed that 1 pound FCM was equivalent to 340 Calories and 1 pound TDN to 1,814 Calories. The heat production data will be reported in Univ. Mo. Agric. Exp. Sta. Res. Bul. 552.

INTERPRETATION OF DATA

Tables 3 to 10, and Figures 1 to 6 show that changing air velocity from 0.5 to 8 or 9 mph did not greatly affect the milk yield, feed and water consumption, or body weight of the Brown Swiss, Holstein and Jerseys at temperatures 18°, 50°, 65°, or 80° F. The decline in milk production follows, approximately, the time course associated with advancing lactation rather than the changing air velocity.

The apparently constant feed consumption regardless of air velocity, particularly at 18° F, appears to be in error, as indicated by several considerations. First, as shown in Figure 7, the estimated ratio of output calories (in the milk and heat production[5]) to input calories (in the consumed TDN) increases most dramatically at 18° F with increasing air velocity in the Brahman cattle (upper right segment). This ratio normally should be constant if the body weight remained constant. In this case, however, the body weight remained constant while the output to input caloric ratio increased. This could be explained also by replacement of body fat by protein of lower caloric value; but it is more likely caused by an error in the feed consumption data, due to the scattering of the feed by the wind at the higher velocity, or to some fault in drying the left-over feed.

Furthermore, the feed-consumption data do not seem to fully harmonize with those previously reported.[6] In the earlier report it was found that lowering the temperature from 50° to 15° F (at 0.5 mph air velocity) increased the TDN consumption by about 20 percent in the Jerseys and 35 percent in the Brahmans. While the body weight increased somewhat with declining temperature (and increasing feed consumption), the ratio of output to input calories remained fairly constant.

At 95° F the milk production and feed consumption in the Holstein and Brown Swiss were lower at the low air velocity than at the high velocity. Regarding the Jerseys, one, J-994, produced less milk and consumed less feed; but the other Jersey produced more milk and consumed more feed at high than at low air velocity. The difference in the amout of feed consumed at the high and low air velocities at 95° F by the Brahmans and the non-lactating Jerseys was slight and the changes were not consistent (Figures 2 and 5).

In general, the curves in Figures 2 to 5 indicate that the higher the milk production level and the larger the cow, the greater the effect of change in air velocity at 95° F. This may be because heavy milk production is associated with high heat production and large body size is associated with a smaller surface area per unit weight, with

[5]Univ. Mo. Agric. Res. Bul. 552.
[6]Univ. Mo. Agric. Res. Bul. 460.

consequent greater difficulty in heat dissipation. The resulting greater thermal stress may have rendered the larger and more heavily milking cows more sensitive to the slightly reduced cooling associated with reduced air velocity. The depressed milk yield in the larger animals may be within the limits of experimental errors, as in the case of the two Jerseys that reacted in opposite direction on changing the air velocity from 0.4 mph to 9 mph at 95° F — one increased and the other decreased the milk yield and feed consumption. At any rate, the effect of changing air velocity is also slight at 95° F.

The situation would, of course, radically change if the hair and skin became wet, as occurs when sprinkled or exposed to rain. Increasing air velocity would then greatly increase the heat dissipation by vaporization because of the large surface area of the hair. This may explain the frequent chilling effect of wind and cold rain, which could become dangerous under unfavorable conditions.[7]

Figures 1 to 6, along with their legends explain and clarify these statements in details related to the effect of wind on milk production and feed and water consumption.

[7]Illustrated by a recent serious effect on a windy cold rain in Florida on unacclimatized Indian-evolved cattle in poor nutritional condition.

APPENDIX

TABLE 3 -- MILK PRODUCTION, HAY, TDN, AND WATER CONSUMPTION AND BODY WEIGHT FOR LACTATING HOLSTEIN AND BROWN SWISS COWS AT THREE AIR VELOCITIES FOR TEMPERATURE LEVELS 50° AND 17° F.

	Beginning	50°F at Air Velocities			17°F at Air Velocities		
Cow No.	50°F, .4 mph (Oct. 27-Nov. 8)	Low (Nov. 22-Dec. 6)	Medium (Nov. 8-Nov. 22)	High (Dec. 6-Dec. 20)	Low (Jan. 17-Jan. 31)	Medium (Jan. 3-Jan. 17)	High (Jan. 31-Feb. 14)
			Milk Production, lbs/day				
H-178	45.0	42.9	45.5	40.1	34.7	35.2	35.7
H-132	37.4	35.6	37.0	34.3	30.4	32.8	30.8
H-184	46.6	42.6	43.4	39.8	32.4	35.0	31.2
S-9	31.7	30.2	30.8	27.0	19.8	20.2	18.2
S-41	17.1	18.0	18.4	17.0	13.9	15.2	13.8
S-47	29.1	30.1	29.8	26.8	22.2	23.2	21.1
			Water Consumption, gals/day				
H-178	18.8	18.4	19.3	19.0	18.5	17.8	18.6
H-132	18.0	17.4	18.4	16.5	16.0	16.4	17.4
H-184	19.1	19.2	19.7	17.7	15.8	16.2	17.3
S-9	13.8	16.7	15.8	15.3	12.7	12.8	13.5
S-41	8.5	12.0	11.4	11.2	10.8	11.1	11.7
S-47	13.0	14.6	15.0	14.4	11.0	12.5	12.8
			Total Number of Drinks Per Day				
H-178	11.8	10.2	11.6	9.4	12.6	10.9	10.2
H-132	7.3	7.4	7.6	6.4	6.8	7.2	7.8
H-184	9.0	9.0	9.7	10.0	9.6	7.3	6.2
S-9	10.2	11.7	11.2	15.2	8.9	8.4	7.2
S-41	6.6	7.8	9.6	7.4	7.0	8.0	7.4
S-47	9.8	9.4	10.0	10.0	8.6	6.6	7.0
			Hay Consumption, lbs/day				
H-178	25.0	27.6	27.4	27.8	28.5	28.4	29.0
H-132	27.0	29.6	29.6	29.1	29.7	29.0	28.3
H-184	28.0	28.8	29.2	28.6	28.6	28.5	29.2
S-9	18.6	21.8	23.3	22.5	22.8	23.5	23.2
S-41	16.0	20.0	21.2	17.6	22.6	21.2	22.2
S-47	19.0	24.0	25.3	22.3	23.5	23.1	23.4
			TDN Consumption (Total Digestible Nutrients)*, lbs/day				
H-178	23.7	25.0	24.9	25.1	24.5	24.6	24.2
H-132	24.6	25.2	25.3	24.3	24.0	23.5	23.9
H-184	25.6	26.3	26.6	25.5	24.5	24.7	24.3
S-9	18.2	19.8	20.6	19.4	18.7	19.2	18.3
S-41	16.8	17.4	18.0	15.5	18.0	17.3	17.8
S-47	18.4	20.9	21.6	19.3	19.2	19.0	19.1
			Body Weight, lbs.				
H-178	1184	1184	1202	1208	1204	1179	1192
H-132	1252	1231	1238	1208	1226	1204	1218
H-184	1142	1144	1160	1136	1141	1134	1129
S-9	1122	1138	1144	1129	1101	1104	1112
S-41	1114	1124	1134	1124	1140	1136	1154
S-47	997	1025	1025	1029	1012	1012	1010

*Computed with the aid of F. B. Morrison's "Feeds and Feeding," 21st Ed., 1948.

TABLE 4 -- MILK PRODUCTION, HAY, TDN, AND WATER CONSUMPTION AND BODY WEIGHT FOR LACTATING AND DRY JERSEY AND DRY BRAMAN COWS AT THREE AIR VELOCITIES FOR TEMPERATURE LEVELS 50° AND 17° F.

	Beginning	50°F at Air Velocities			17°F at Air Velocities		
Cow No.	50°F, .4 mph (Oct. 27-Nov. 8)	Low (Dec. 6-Dec. 20)	Medium (Nov. 8-Nov. 22)	High (Nov. 22-Dec. 6)	Low (Jan. 31-Feb. 14)	Medium (Jan. 3-Jan. 17)	High (Jan. 17-Jan. 31)
			Milk Production, lbs/day				
J-548	13.4	9.6	13.0	11.0	3.6	5.8	4.0
J-549	23.8	11.8	20.4	15.7	4.0	7.0	5.6
			Water Consumption, gals/day				
J-999 dry	10.0	9.1	9.2	9.0	8.7	8.6	8.2
J-548	11.2	9.6	9.8	9.9	9.2	8.8	8.8
J-549	12.1	10.0	12.7	11.6	10.2	9.5	10.2
J-264 dry	6.3	7.0	6.3	6.5	6.0	5.8	5.6
B-209	6.0	6.2	6.8	5.8	7.4	5.2	4.9
B-189	4.8	5.8	5.2	5.3	7.0	5.8	5.9
			Total Number of Drinks Per Day				
J-999 dry	9.0	6.0	7.7	9.2	6.8	8.4	9.2
J-548	10.4	9.4	9.7	11.2	9.0	9.2	13.4
J-549	8.0	7.4	6.3	6.4	6.8	5.8	10.4
J-264 dry	9.0	6.0	6.4	6.0	6.2	8.8	6.4
B-209	6.0	6.0	4.7	4.5	3.2	4.6	3.7
B-189	7.8	5.4	8.1	6.6	5.0	4.7	5.4
			Hay Consumption, lbs/day				
J-999 dry	18.3	18.0	19.4	18.4	17.0	19.1	18.0
J-548	18.2	17.1	18.5	17.6	16.8	18.2	18.0
J-549	19.3	18.7	19.4	18.6	19.1	18.8	19.6
J-264 dry	13.9	14.0	14.4	11.9	10.2	13.2	11.2
B-209	13.8	13.3	14.4	13.2	15.0	12.9	11.2
B-189	11.2	12.8	12.2	8.5	13.2	13.0	11.1
			TDN Consumption (Total Digestible Nutrients),* lbs/day				
J-999 dry	15.8	15.7	16.4	15.9	15.1	16.2	15.7
J-548	16.3	15.2	15.9	15.4	15.1	15.8	15.8
J-549	18.1	16.4	18.6	17.4	16.2	16.1	16.5
J-264 dry	13.6	13.7	13.9	12.6	11.8	13.3	12.3
B-209	13.5	13.3	13.9	13.2	14.2	13.1	12.3
B-189	12.3	13.1	12.9	10.9	13.3	13.7	12.2
			Body Weight, lbs.				
J-999 dry	902	942	914	932	1007	992	1001
J-548	858	839	840	838	854	839	854
J-549	833	830	840	828	832	824	832
J-264 dry	787	807	776	788	848	814	840
B-209	1068	1083	1068	1078	1054	1077	1058
B-189	992	1040	1003	1023	1019	1064	----

*Computed with the aid of F. B. Morrison's "Feeds and Feeding," 21st Ed., 1948.

TABLE 5 -- HAY, TDN, AND WATER CONSUMPTION FOR LACTATING HOLSTEIN AND BROWN SWISS COWS AT TWO OR THREE AIR VELOCITIES FOR TEMPERATURE LEVELS 65°, 80°, AND 95°F.

	Beginning	65°F at Air Velocities			80°F at Air Velocities			95°F at Air Velocities	
	65°F .4 mph	Low	Medium	High	Low	Medium	High	Low	High
Cow No.	(Feb. 23-Mar. 6)	(Apr. 3-10)	(Mar. 20-Apr. 3)	(Mar. 6-20)	(May 8-18)	(Apr. 10-24)	(Apr. 24-May 8)	(May 27-29)	(May 20-22)
				Hay Consumption, lbs/day					
H-144	20.8	18.4	16.3	16.6	16.8	17.8	18.7	8.8	17.1
H-154	23.8	27.6	25.2	24.0	25.4	27.6	27.2	6.7	13.7
H-118	22.6	22.2	22.2	22.9	16.3	20.4	19.0	7.5	12.4
S-22	25.4	23.1	22.8	22.2	20.2	21.6	18.8	15.0	20.1
S-23	19.8	24.7	18.3	16.6	23.4	23.4	20.4	10.4	12.5
S-47	25.6	24.2	24.4	24.2	20.0	22.6	20.0	15.4	18.4
				TDN Consumption (Total Digestible Nutrients),* lbs/day					
H-144	22.2	20.2	20.7	21.4	18.8	20.8	20.9	12.4	18.6
H-154	23.4	27.2	26.0	25.2	23.7	27.2	26.7	11.3	17.6
H-118	23.1	24.5	24.5	24.4	19.6	23.6	22.4	11.7	16.6
S-22	21.6	20.5	20.4	20.0	17.5	19.7	18.0	13.8	17.5
S-23	20.0	22.8	19.9	20.5	21.6	22.2	20.6	13.2	16.3
S-47	20.6	19.5	19.6	19.5	17.4	18.7	17.4	13.5	16.3
				Water Consumption, gals/day					
H-144	20.5	21.2	17.4	18.7	19.7	18.6	18.8	14.6	21.0
H-154	21.9	22.5	21.5	20.2	22.4	22.7	20.1	17.2	20.0
H-118	21.4	20.1	18.9	19.5	20.2	19.0	18.7	17.2	18.2
S-22	17.4	15.4	15.2	15.2	18.0	16.4	16.0	19.4	18.0
S-23	18.4	19.1	16.3	17.6	22.9	19.4	21.3	21.9	21.2
S-47	15.4	15.0	14.4	19.4	15.0	14.0	13.9	14.0	16.4
				Total N mber of Drinks Per Day					
H-144	11.0	8.3	9.8	11.4	12.9	8.4	12.2	12.0	15.5
H-154	8.8	6.8	8.0	7.6	10.1	7.6	7.4	15.5	15.5
H-118	9.0	8.3	6.8	7.8	10.7	8.4	8.4	14.5	15.0
S-22	10.8	9.8	10.0	9.8	10.8	9.0	10.4	12.0	13.5
S-23	15.7	14.3	14.0	15.1	15.7	14.7	14.4	22.0	22.0
S-47	12.4	10.3	10.5	10.6	12.1	11.8	12.2	10.5	19.0

*Computed with the aid of F. B. Morrison's, "Feeds and Feeding," 21st Ed., 1948

TABLE 6 -- HAY, TDN, AND WATER CONSUMPTION FOR LACTATING AND DRY JERSEY AND DRY BRAHMAN COWS AT TWO OR THREE AIR VELOCITIES FOR TEMPERATURES LEVELS 65°, 80°, AND 95° F.

	Beginning	65°F at Air Velocities			80°F at Air Velocities			95°F at Air Velocities	
	65°F, .4 mph	Low	Medium	High	Low	Medium	High	Low	High
Cow No.	(Feb. 23-Mar. 6)	(Mar. 20-27)	(Mar. 6-20)	(Mar. 27-Apr. 10)	(May 8-18)	(Apr. 24-May 8)	(Apr. 10-24)	(May 18-20)	(May 25-27)
				Hay Consumption, lbs/day					
J-548 dry	15.3	15.2	15.1	13.4	12.8	12.7	12.8	12.0	9.0
J-994	13.8	15.1	14.5	15.2	15.4	14.9	14.8	3.4	12.6
J-205	19.3	19.5	18.6	18.0	17.9	18.1	18.0	14.8	12.2
J-549 dry	16.0	15.9	15.8	15.2	15.6	15.1	14.8	13.6	15.4
B-209	12.4	12.9	13.6	11.0	9.9	4.1*	.6*	8.1	10.7
B-189	11.7	12.2	13.0	11.2	9.4	5.5*	7.8	8.3	9.6
				TDN Consumption (Total Digestible Nutrients),** lbs/day					
J-548 dry	14.2	14.3	14.2	13.4	13.1	13.0	13.1	12.7	11.2
J-994	16.2	17.2	16.9	17.2	15.9	16.8	17.1	9.8	14.5
J-205	19.0	19.4	19.0	18.7	17.1	18.4	18.7	15.6	14.3
J-549 dry	14.7	14.6	14.5	14.3	14.5	14.2	14.1	13.5	14.4
B-209	12.5	12.4	12.7	11.2	10.9	3.5*	2.4*	10.0	10.5
B-189	12.1	12.0	12.4	11.5	10.1	6.9*	8.9	10.0	9.6
				Water Consumption, gals/day					
J-548 dry	9.5	8.6	7.8	7.4	8.5	7.4	7.4	8.6	9.0
J-994	11.3	10.9	10.5	10.4	12.8	12.8	11.6	11.2	10.2
J-205	14.6	13.4	12.2	11.4	13.8	12.6	12.7	14.1	11.8
J-549 dry	9.8	8.1	8.4	7.9	11.0	9.6	9.6	10.1	9.5
B-209	6.8	6.4	6.2	5.6	7.7	5.2*	2.2*	8.6	7.4
B-189	6.6	6.0	6.2	5.5	5.6	3.4*	4.8	8.0	7.6
				Total Number of Drinks Per Day					
J-548 dry	6.8	5.8	4.8	7.2	7.1	5.5	6.8	6.5	13.5
J-994	5.3	6.6	4.6	5.2	8.6	7.2	7.2	8.5	11.0
J-205	9.4	8.0	5.9	7.6	11.6	8.8	10.4	16.5	15.5
J-549 dry	6.0	4.0	4.2	5.0	8.6	6.4	6.8	10.0	9.5
B-209	5.8	4.3	3.6	4.4	9.7	5.9*	2.6*	9.0	7.5
B-189	6.4	5.4	4.4	5.9	8.4	4.0*	5.3	12.5	12.5

*Sick during this period.

**Computed with the aid of F. B. Morrison's "Feeds and Feeding," 21st Ed., 1948.

TABLE 7 -- BODY WEIGHT AND MILK AND BUTTERFAT PRODUCTION FOR LACTATING HOLSTEIN AND BROWN SWISS COWS AT TWO OR THREE AIR VELOCITIES FOR TEMPERATURE LEVELS 65°, 80°, AND 95°F.

	Beginning	65° at Air Velocities			80°F at Air Velocities			95° at Air Velocities	
	65°F, .4 mph	Low	Medium	High	Low	Medium	High	Low	High
Cow No.	(Feb. 23-Mar. 6)	(Apr. 3-10)	(Mar. 20-Apr. 3)	(Mar. 6-20)	(May 8-18)	(Apr. 10-24)	(Apr. 24-May 8)	(May 27-29)	(May 20-22)
				Body Weight, lbs.					
H-144	1295	1237	1233	1240	1216	1229	1219	1155	1173
H-154	1356	1325	1313	1327	1316	1328	1318	1246	1265
H-118	1282	1234	1245	1244	1208	1231	1210	1151	1155
S-22	1284	1266	1258	1256	1235	1250	1245	1213	1230
S-23	1375	1268	1303	1328	1273	1266	1272	1217	1268
S-47	1031	1048	1033	1026	1042	1047	1042	1027	1027
				Milk Production, lbs/day					
H-144	57.9	46.4	47.5	52.3	37.7	43.0	39.9	27.6	35.0
H-154	63.0	60.4	62.4	62.3	45.3	56.4	50.9	24.2	33.2
H-118	55.8	47.7	51.2	54.5	38.3	45.3	44.3	25.4	33.1
S-22	29.5	27.2	27.7	28.7	23.3	26.2	24.5	21.7	22.6
S-23	49.0	46.2	44.1	47.6	41.1	43.2	39.6	27.0	33.0
S-47	23.5	21.2	22.0	23.0	18.8	20.4	20.2	16.0	17.7
				Butterfat, %					
H-144		3.0	2.8	3.3	3.6	3.2	3.1	3.3	3.6
H-154		2.3	3.2	3.6	3.3	3.2	2.9	3.5	3.0
H-118		2.4	3.2	3.2	3.6	3.3	3.4	3.7	3.5
S-22		4.1	4.0	4.1	4.0	4.1	4.4	4.2	4.3
S-23		3.9	4.6	5.1	3.8	3.8	3.8	3.1	3.6
S-47		3.8	3.5	3.4	3.6	3.8	3.8	3.7	4.0

TABLE 8 -- BODY WEIGHT AND MILK AND BUTTERFAT PRODUCTION FOR LACTATING AND DRY JERSEY AND DRY BRAHMAN COWS AT TWO OR THREE AIR VELOCITIES FOR TEMPERATURE LEVELS 60°, 80°, AND 95°F.

	Beginning	65°F at Air Velocities			80°F at Air Velocities			95°F at Air Velocities	
	65°F, .4 mph	Low	Medium	High	Low	Medium	High	Low	High
Cow No.	(Feb. 23-Mar. 6)	(Mar. 20-27)	(Mar. 6-20)	(Mar. 27-Apr. 10)	(May 8-18)	(Apr. 24-May 8)	(Apr. 10-24)	(May 18-20)	(May 25-27)
				Body Weight, lbs.					
J-548 dry	865	894	879	906	928	927	914	930	935
J-994	814	796	805	798	790	788	794	765	758
J-205	964	935	939	934	930	936	938	941	919
J-549 dry	872	901	881	912	961	954	933	950	968
B-209	1077	1082	1080	1073	1031	956*	1002*	1047	1049
B-189	1029	1052	1037	1052	1060	1032*	1052	1074	1076
				Milk Production, lbs/day					
J-994	29.2	26.2	27.6	22.8	20.2	21.6	23.0	9.2	19.1
J-205	30.6	27.6	28.7	25.4	18.6	20.3	23.6	18.6	12.3
				Butterfat, %					
J-994		5.9	6.1	6.1	6.6	4.0	6.1		
J-205		4.4	5.2	4.8	5.0	4.8	4.8		

*Sick during this period.