THE RELATIONSHIP BETWEEN THE BODY TEMPERATURE OF DAIRY COWS, AT TIME OF MILKING AND THE PERCENTAGE OF BUTTER-FAT

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THESIS

Respectfully submitted to the faculty of the Michigan Agricultural College in partial fulfillment of the requirements for the degree of Master of Science.

by

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INTRODUCTION

Previous to the introduction of the Babcock test, and to the establishment of Advanced Registry Classes by the various Breed Associations, little attention was paid to the quality of the milk produced by the dairy cow.

With the introduction of the Babcock test and the subsequent payment for milk on the quality basis, the attention of breeders, investigators and others was turned to the fat content of the milk.

Investigators and breeders then found that the fat content of the milk of the individual cow varied considerably. This led to further studies and revealed a number of factors that apparently influenced the fat content of the milk.

One of the factors that may influence the fat content of milk is the body temperature of the cow at the time of milking.

As there was no experimental data covering this factor, and as it was the common belief of Breed Associations and others that the body temperature had a direct influence upon the percentage of fat in the milk, this investigation was undertaken in an effort to determine the relationship of the body temperature of dairy cows at the time of milking to the percentage of butterfat.

GENERAL DISCUSSION AND REVIEW OF LITERATURE

Factors Influencing the Butter-fat Content of Milk

Milk production is essentially a physiological characteristic, not fully understood; and its secretion from the mammary glands is supposed to be caused partially by hormones or the internal secretions of ductless glands.

Since butter-fat is the basis upon which the price of milk is determined, the factors influencing its percentage in milk have demanded the attention of scientists and husbandmen for years. Many of these factors are now known; and only with extreme difficulty has the influence of some of them been measured.

Breed

The most readily measured influence and the one that plays the largest part in determining the fat content of milk is that exerted by the different breeds; and they are classified by Eckles (2) according to test as follows:

Breed	Official A. R. Averages	Experiment Station Averages
Holstein-Friesian	3.42%	3.45%
Guernsey	5.00%	4.98%
Jersey	5.35%	5.14%
Ayrshire	3.97%	3.85%
Brown Swiss	3.97%	
Short Horn		3.30%
Red Poll		4.03%

Size

Woll (2) has shown that without exception the cows that have made the largest milk and fat records, have been large animals for their breed. There is, however, no established relationship within the breed, between the size of the animal and the richness of the milk.

Completeness of Milking

Eckles (2) states that it is an established fact that the first milk drawn from the udder contains a very low percentage of fat, while that of the strippings tests very high.

Wylie (34) found that when leaving about one-fourth of the normal amount of milk as strippings in the udder of a cow, it apparently caused an increase in the percentage of the fat for the following milkings of some cows, and also, that the effect seemed to last over several days.

Individuality

Wing (38) shows in the following table that there is a great variation in the percentage of fat in the milk of individual cows within the breed.

Breed	Number of Milkings	Fat Content in Per Cent Highest	Fat Content in Per Cent Lowest
Jersey	28	6.31	4.56
Shorthorn	27	5.29	3.46
Ayrshire	27	4.36	3.49
Holstein	95	4.15	1.67

Rhodes (40) found that variations in test were rather common in mixed herds of Jerseys and Holsteins, and cites this table as a typical example of individualism.

Cow Number	Per Cent of Butter-fat of an Average Monthly Test
1	3.1%
2	2.9%
3	4.4%
5	4.1%
6	4.1%
7	3.7%
8	3.7%

Cows number 1 and 2 were Jerseys; number 3 was a grade, and the remaining cows were Holsteins.

Fraser (43) found that cows, for no apparent reason, yielded milk that fluctuated in butter-fat content as much as four per cent in two days.

The official testing records (41) of the various breed associations show that the cows which excel in total butter-fat production exceed the average of the breed in the per cent of butter-fat in the milk; and are usually the high testers of the breed.

<u>Frequency of Milking</u>

At Beltsville, Maryland the Dairy Division of the United States Department of Agriculture (35) in measuring the rate of change, and the average increase of milk and fat due to a change from two to three times a day milk, found that the milk increased 11.9% and the fat increased 12.2%.

The average increase when the change was made from three to four times a day milking was, 6.6% for milk and 5.8% for fat.

Time of Milking

Gowen (4) states that the evening milk of a cow is, in general, higher in butter-fat than the morning milk. Eckles (2) states that when cows are milked twice a day at twelve hour intervals the milk usually varies but little, although there is a tendency for the milk from the morning milking to be a little higher in fat content. If the intervals are not equally divided in the day, the yield of milk following the longer period will be higher, but that of the shorter period will be richer; often increasing in per cent of fat from 0.5% to 1%. Ingles (5) conducted tests on a mixed herd of 23 animals for a period of 18 weeks, and found the average percentage of fat in the morning milk to be 2.97% and that of the evening milk 4.31%. The author does not, however, state as to the length of time between milkings.

Excitement

Babcock (42) reports that kind treatment and pleasant surroundings have a greater influence upon the quality of milk than the kind of food, provided the ration given contains sufficient nutrients for the production of milk and for the maintenance of the animal. He further states that as a general rule the percentage of fat in the milk is more sensitive than the yield of milk to changes, such as: increasing of decreasing the intervals between milkings; the rate of milking; change of milkers and manner of milking, especially if the manipulation of the teats and udder be different.

If the cow has become quiet before milking, excitement between milkings does not seem to have much influence upon the yield of milk nor upon the percentage of fat in the milk. There is, however, a great difference in cows in this respect. As a rule cows that have been milking for a long time are less sensitive than fresh cows giving a large quantity of milk.

Exercise

Woodward (6) found that exercise, walking three miles a day, increased the test slightly but unmistakably.

Water

In the published results of the experiments conducted by the Dairy Division of the United States Department of Agriculture (7) it is stated that the water drunk has no apparent influence upon the composition of the milk produced. Also that rations of varying water content have no effect upon the composition of milk. Woodward (6) substantiated the above when he proved that the quantity of water consumed does not affect the test, unless the total yield of milk is materially reduced. Henderson (9) reports that withholding water caused the milk flow to fall slightly, and the percentage of fat to increase. He found, however, some cases where the percentage of fat decreased.

Feeding

Much attention both in this country and in Europe has been paid to the influence of feed upon the richness of milk because many dairymen and others believe that the per cent of fat in the milk varies with the quality of the feed; but Eckles (2) states that conclusive evidence now shows that the fat percentage of milk cannot be permanently increased by any method of feeding.

Woodward (6) found that the test of milk decreased directly with the increase in feeding of prickly pear. He also found that the feeding of seven to eleven pounds to each cow per day of either cottonseed or linseed meal caused an increase in the fat content of milk, but though this experiment continued for forty days, the percentage of fat in the milk had returned to normal after the first ten days.

Woodward (6) further concludes, after receiving negative results in the feeding of gluten meal, and positive results in the feeding of linseed oil, that the increase in percentage of fat is due to the oil rather than to the protein in the feed.

Eckles (2) states that a sudden change in the ration, such as greatly increasing the protein or oil content thereof, may increase the fat for a few days with some individuals, but with only temporary results.

Kellner (8) showed that coccanut meal has a specific effect in increasing the butter-fat content of milk.

Henderson (9) fed cows three times a day and found that they were enabled to consume a larger amount of feed, and that they produced a correspondingly larger amount of milk, without a measurable increase or decrease in the percentage of butter-fat. Also, that a sudden change in the grain ration had no noticeable effect on the percentage of fat in the milk produced.

McCandlish (10) showed that when feeds of a high protein content are compared with general mixtures, the chances are about even for an increase or no change in the percentage of fat. But when these high protein feeds, as coccanut meal, gluten meal, and germ oil meal are compared with each other the chances are about even that an increase or decrease in percentage of fat will result. Also, that the readministration of cottonseed meal, before the cows have had time to recover from the effects produced during a previous administration, tends to decrease rather than increase the fat content of milk.

At the Iowa Agricultural Experiment Station (11) the feeding of soy beans to dairy cows caused a decrease in the milk yield, but an increase in the percentage and total yield of fat.

Ragsdale and Turner (12) increased the percentage of fat by decreasing the total ration 50%. The peak of the increase was reached about the third day, and the percentage of fat remained abnormally high as long as the reduced ration was continued, though the yield of milk was reduced and the total fat was materially increased. This trial was of ten days' duration.

Eckles and Palmer (15) found that with underfeeding the protein and ash content of the milk declined and the fat showed a marked rise, especially when the animal was in good condition.

Condition

White and Judkins (13) show that condition at the time of feeding, with reference to flesh and adipose tissue will especially influence the percentage of fat. They also found that cows losing flesh slowly would yield milk testing somewhat higher in fat for a period of three to six months than when freshening in thin condition. Eckles (14) found that thin cows did not test as high immediately following parturition as the average shown by those cows for the entire lactation period.

Drugs

McCandlish (18) states that the ways in which drugs may influence the mammary glands are many and varied, and cites as follows:

1. The drug may either stimulate or inhibit the action of the cells by acting directly on the protoplasm of the secretory cells.

2. The stimulation or depression of the secretory nerve terminations in the mammary gland, may result in an increased or decreased secretion of milk.

3. The heart action may be increased or decreased thus altering the amount of blood which would pass through the udder.

4. The vasomotor influence of drugs is important in that it may increase or decrease the amount of blood passing through

the udder by the vasoconstriction of arterioles in other parts of the body or by dilation of the arterioles in the mammary glands.

5. Drugs acting upon the digestive system may influence the activity of digestion and absorption and thus affect the amount of nutrients available for milk and fat production.

6. The drug may, by acting on organs indirectly associated with the mammary gland, influence milk and fat production.

7. Individual cows vary in degree of susceptibility to drugs; and this with the many possible combinations of action increases the complexity of the problem.

Hays and Thomas (17) report experiments in using various drugs and tonics as follows:

1. Air slacked lime mixed with the feed caused an increase in the total milk but no noticeable change in the percentage of fat.

2. Fowlers' solution of arsenic, sulphide of autimony, sodium bicarbonate, ginger, and a tonic compound of oilmeal, saltpeter, epsom salts, gentiam, fennugreek, powdered charcoal and sulphur did not increase the test, but in some cases had a depressing effect upon the milk secretion.

Henderson (9) found that:

1. Gentian fed at the rate of one ounce twice a day in the feed, had no noticeable influence upon the production of milk or upon the percentage of fat.

2. Malt extract given at the rate of six ounces in the feed twice daily did not cause an increase in milk or fat.

3. Ginger fed at the rate of two ounces per day in the feed, caused the cows to refuse some grain because they did not like it, but the percentage of fat and total fat increased. It had no apparent effect on the total milk.

4. Nux vomica was fed daily in two dram doses and though the cows ate it readily there was no apparent effect on milk or test.

5. Pilocarpine Hydrochlor, injected hypodermically twice daily in one-fourth grain doses, had no apparent effect on the percentage of fat, but it caused an increase in total milk and fat per day.

6. Alcohol, 95% pure, applied externally to the udder (ad lib.) immediately before milking, seemed to have no effect on the percentage of fat or upon the total milk produced.

7. Sodium carbonate fed in one ounce doses caused, with low testing cows, a slight gain in milk, but a loss in test, with no apparent change in the total fat produced. There was no increase in the milk of high testing cows but there was an increase of .275 to .338% in percentage of fat.

Hays and Thomas (17) state that their results obtained with the use of drugs, do not indicate that the difference in character of the milk of Holstein and Guernsey cows has any relation to their manner of reaction to drugs.

McCandlish and Olson (18) obtained results as indicated below with the following drugs, when only four cows were used:

1. Castor oil was administered as a drench. One-half pint was given in the morning and one pint was given in the evening for two days. All the cows were thrown off feed and refused to eat grain for two feeds. There was a decrease of 11 per cent and 10 per cent in the percentage of fat and total fat yield respectively, and an increase of one per cent in the milk yield.

2. Aloes and Rhubarb were given as boli. One ounce of aloes and one and three-eighths ounces of Rhubarb were given in the evening, and one and three-eighths ounces of Rhubarb were given in the morning, for two days. There was an average increase of 8 per cent in the percentage of fat and 5 per cent in the total fat yield, with a slight decrease in the milk yield.

3. Potassium iodide was administered at the rate of three to four drams in one quart of water, evening and morning for two days. There was an average increase of 4 per cent in milk yield, 1 per cent in percentage of fat, and 5 per cent in total fat yield.

4. Strychnine was injected hypodermically, one-half grain in the evening and one-fourth grain in the morning, for two days, resulting in an average increase of 4 per cent in milk production, 6 per cent in total fat yield and 1 per cent in the percentage of fat.

5. Sodium cacodylate was administered by dissolving 24 grains in 20 cc of distilled water and injecting hypodermically twice a day for two days. This resulted in an average decrease of 2% in milk and an increase of 4% in percentage of fat, and a one per cent increasein total fat yield.

6. Urotropin and benzoic acid were administered orally, two drams of urotropin and two drams of benzoic acid were mixed in one quart of water and given twice daily for two days. The range of variations in the percentage of fat and total fat yielded were very wide. One cow showed an increase in milk, percentage of fat and total fat yield, but the average for the three cows showed a slight decrease throughout.

The authors state that the aloes-rhubarb mixture was the only one in which all cows showed a marked increase in percentage of fat.

Lanzoni (19) found that daily feeding of:

1. 1000 grains of sodium sulphate increased the total pounds of fat, and also increased the percentage of fat slightly.

2. 500 grains of magnesium sulphate slightly increased the percentage of fat.

3. 150 grains of Rhubarb decreased the percentage of fat.

4. 25 grains of aloes decreased the percentage of fat.

5. .8 to 1.0 grains of arsenic administered hypodermically decreased the percentage of fat.

Oestrum

Reed, Burnett and Huffman (31) state that the percentage of fat in milk may increase or decrease during a period of oestrum. Also that this increase or decrease is likely to be preceded or followed by a corresponding decrease or increase in the percentage of fat. This, however, varies with the individaul cow.

Age

Eckles (2) shows that cows of a high testing breed, averaging 5 per cent of fat, will decline to about 4.5 per cent of fat if they continue to produce to 14 years of age, and that the total amount of milk produced per unit of time increases with the age of the cow until the maximum of production is reached. The production per unit of time then decreases at a continually increasing rate.

Pearl and Minor (1) found that the fat percentage of Ayrshire cows declined with advancing age until the tenth year of the cow's life is reached; then the fat percentage remained about constant through the rest of the milking life of the cow.

Eckles (2) states that the fat content of milk is a matter of inheritance and a low testing two year old will not materially increase her test in later lactation periods.

Gowan (20) found that with a known two year old's milk record, the next five years of production can be predicted with some accuracy. He also (4) found that there is a slight significant fall in the percentage of butter-fat contained in the milk as age advances. But this slight fall may be accounted for by the rise in milk production which occurs coincident with this increase in age. He also found the coefficient of correlation to be $-.0546 \pm .0131$. Gowan (4) also found by mathematical deduction that there is no significant correlation, if the milk production is held constant. The coefficient of correlation was found to be $.0105 \pm .0131$.

Stage of Lactation

Cook (21) found that milk is lower in fat just after calving than when the cow is going dry.

Farrington (22) found that the percentage of fat is higher in the end of the lactation period than at its beginning.

Gowen (4) found that as the period of lactation advanced, the yield of milk decreased and he computed the coefficient of correlation between yield of milk and percentage of butter-fat to be $-.0979 \pm .0156$; or odds of 100,000 to 1 that as the yield of milk decreased the percentage of fat increased.

Gowen (4) also found that as the amount of milk given by cows increased the percentage composition of the butter-fat in the milk decreases. The amount of decrease is statistically significant, but the fall in the butter-fat content could not be easily detected in the small samples usually handled.

Eckles (2) states that under good farm conditions there is little if any increase in the fat content, until the point of rapid decline in milk production is reached.

Eckles and Shaw (23) found that fat represents on the average 31.3% of the total solids of cow's milk. The relation between the fat and total solids shows a small variation during the lactation period. The per cent of fat in the total solids increases about 2 per cent toward the end of the lactation period.

Van Slyke (36) presents the following table to show the variations in percentage of fat in milk with advance of lactation. This table is composed of the monthly averages of nearly 100 different lactation periods.

Month of Lactation	Per cent of fat in Milk	Index Number Using First Month as the Base
1	4.30	100.0
2	4.11	95.6
3	4.21	97.9
4	4.25	98.8
5	4.38	101.9
6	4.53	105.3
7	4.57	106.3
8	4.59	106.8
9	4.67	108.6
10	4.90	114.0
11	5.07	118.0

Hooper (25) found that the percentage is lower while the cow is fresh (regardless of the time of year she freshens) and that the milk becomes richer as the lactation proceeds, unless some other factor upsets this routine.

<u>Seasonal Variation</u>

Eckles (24) found that regardless of where the lactation period began the percentage of fat in the milk showed a general curve for the year. The percentage was less in June and July and gradually rose to its highest point in December or January and then declined again to mid-summer.

McDowell (26) states that the records of 10,870 cows in 64 cow testing associations show that fall and winter fresh cows exceed spring and summer fresh cows by 10 per cent in milk and fat production in the course of the year.

Ragsdale and Turner (28) show that the percentage of fat in milk is lowest during the summer months, then rises gradually during the winter months and again declines during spring and summer.

<u>Temperature</u>

Ragsdale and Turner (28) state that when the seasons of the year are accompanied by varying temperatures, the influence upon the per cent of fat in cow's milk is greater than that of the advance of lactation.

Cooke (21) shows that the quality of milk varies with the temperature, being richer in cold weather and poorer in warm weather.

Woodward (6) states that hot weather lowers the test, and that the decrease is greater with those breeds yielding naturally a milk high in fat.

Ragsdale and Turner (12) show that there is a causative relation between temperature and the percentage of fat in milk, this showing roughly an increase of about .15 per cent of fat for a decrease in temperature of 10° F.

White and Judkins (13) state that though the percentage of fat for the herd was very uniform during the cold and warm months, the average for the warm months is .317% lower than for the cold months.

Newton (29) states that the amount of milk as well as the percentage of butter-fat may be reduced as the result of very cold or very hot weather and that variations may have a range of over one per cent. In actual experience, however, it has been found that the fat percentage in milk rises and falls at times without apparent reason.

Body Temperature of Dairy Cattle.

Lusk (30) found that in warm blooded animals the tendency is to maintain the body temperature at a constant level independent of climatic conditions. The nervous mechanism through which this is accomplished is twofold:- first, there is an increased production of heat in the presence of external cold (the chemical regulation of temperature); and second, variations in the quantity of blood supplied to the skin modify loss of heat by radiation and conduction, and variations in the amount of sweat modify the loss of heat by evaporation of water(these are the factors of the physical regulation of temperature). Loss of heat by an organism at rest follows the paths of conduction and radiation by:

1. Evaporation of water from lungs and skin.
2. Warming the food ingested.
3. Warming the inspired air.

Lavoisier (30) noticed that cold increases the metabolism.

Lusk (30) found that the physical regulation of body temperature increased by certain voluntary acts, such as are observed when a dog exposed to cold lies down in such a way as to expose as small a surface as possible. The contrast to this is offered when on a hot day the dog extends his limbs and stretching himself as much as possible tends to promote the loss of heat.

Krias (32) observed that the normal temperature of the animal body is never a constant figure. He also states that little attention has been given to the study of the variations in the body temperature of farm animals, under conditions which are known to affect the temperature of man. He further adds that a fall in temperature invariably follows the drinking of water and varies directly with the quantity of water drunk. The eating of food caused the body temperature to rise slightly for about one-half hour, though the cows were receiving only a maintenance ration.

Hewitt (37) found the range of variation of the temperature of normal cattle to be greater than the range of variations of human temperatures. He also found the average normal temperature to be around 101.0 degrees F., with a range of 4.4 degrees in extreme cases, but also that there are differences in individuals in these daily variations. Hewitt further found that when water was given to cattle at accustomed times and in regular quantities there was little, if any, variation in the body temperature.

Wooldridge (45) after making 520 observations on 63 apparently healthy dairy cattle, found the average temperature of these cows to be 101.4 degrees F. The lowest temperature was 100.4 degrees F. and the highest was 102.8 degrees F. He further stated that these extremes are seldom met with in practice.

Colin and Thanhoffer (46) give as the range of normal temperatures of dairy cows 100.4 to 101.3 degrees F.

Friedberger and Frohner (47) consider 101.8 degrees F. as the average temperature of dairy cattle.

Hadschopulo (48) from 50,000 observations gives 101.1 degress F. to 101.8 degrees F. as the range of temperatures of normal dairy cows.

Smith, Meade (49) states that the range of temperature of normal dairy cows is from 100.4 to 101.3 degrees F. and further remarks that a variation of one degree or more indicates some failure in the organism or some departure from the natural process of metabolism.

The United States Department of Agriculture (50) gives the range of temperatures in the normal bovine as 101.0 degrees to 102.0 degrees F.

Larson and Putney (51) state that the range of the temperatures of normal dairy cows is from 101.0 degrees to 103.0 degrees F.

Reed and Burnett (33) found after taking 22,515 observations on an average of over 60 head of dairy cows daily for one year, that the average temperature of the group was 101.12 degrees F., with a range from 99.0 to 106.0 degrees F.

GENERAL SUMMARY AND DISCUSSION OF THE REVIEW OF LITERATURE.

It is very evident from the review of literature that the percentage of butter-fat in the milk of dairy cows, varies considerably. This variation may be caused by any one factor or by a combination of two or more factors.

The chief factors that may influence the percentage of fat in milk are:

1. Breed.

    There is a variation according to breed.

2. Size.

    There is no direct relationship between the percentage of fat and the size of the animal.

3. Individuality.

    Individuality is one of the most important factors that affect the percentage of fat in cows milk. The percentage of butter-fat in the milk of individual cows at times fluctuates very widely, the causes for which are not always known. The percentage of the fat of the milk of a cow within the breed is an inheritant characteristic of the individual.

Completeness of Milking

The strippings or last milk drawn from the udder test relatively higher than the preceding milk drawn. When some of this last milk is left in the udder it is liable to cause an increase in the test of the milk of subsequent milkings and the effect may be of several days' duration.

Frequency of Milking

Increasing the number of milkings per day from two to three or four times increases the yield of both fat and milk and may tend to increase the percentage of fat.

Time of Milking

Authorities disagree as to the effect that time of day of milking has upon the percentage of fat in the milk. The author is of the opinion that individual cows, when the periods between milkings are of equal length, have a definite time in the day when their percentage of butter-fat in their milk is higher. The time at which the milk of this cow tests highest may be changed for no apparent reason.

Excitement

Quiet and comfortable surroundings and quarters probably tend to reduce the daily variations of the test of the individual cow. Though a cow has been excited, if she has become quiet before milking, this previous excitement does not seem to affect the percentage of fat in the milk.

Exercise

Exercise tends to increase slightly the percentage of fat in the milk.

Water

The amount of water consumed has no apparent influence upon the percentage of fat in the milk provided that the amount of milk produced remains normal.

Feeding

By judicious feeding one can both increase and decrease the percentage of fat in the milk. The duration of time over which the effect of feed can be extended has not as yet been fully measured.

Condition

Animals in high condition, covered with firm flesh, will continue to yield milk of a higher fat content than when they are in thin condition. The effect of the high condition has been known to extend through six months of the lactation period.

Drugs

Many conflicting results have been obtained on the percentage of fat with the use of drugs and galactogogues. Drugs and galactogogues cannot be relied upon to increase the percentage of butter-fat or the yield of milk.

Oestrum

There has not been sufficient data compiled or published to warrant the drawing of any conclusions regarding the effect of a period of oestrum upon the percentage of fat in the milk.

Age

As cows increase in age the percentage of fat in the milk decresses. This might be due, however, to an increase in the yield of milk.

Stage of Lactation

The fat percentage is lower while the cow is giving a large flow of milk regardless of the time of year she freshens and the milk becomes richer after the first month as the lactation proceeds, unless some other factor upsets this routine.

Seasonal Variation

Regardless of where the lactation period begins, the percentage of fat in the milk is less in the summer and gradually increases toward winter, then again decreases to midsummer.

External Temperature

The quality of the milk varies with the temperature, being richer in cold weather and poorer in warm weather.

Body Temperature

From the review of literature we find that very little work has been done to date in studying the variations in the body temperatures of dairy cows under conditions that are known to affect the temperature of man.

The opinion seems to prevail that a cow can normally fluctuate more in temperature than can a man. The range of temperature in the normal cow is admitted to be from 100.4 to 102.4 degrees F., thus giving a mean temperature of 101.4 degrees F.

EXPERIMENTAL WORK

PLAN OF THE EXPERIMENTAL WORK

OBJECT OF THE EXPERIMENTAL WORK

The object of this experimental work is to study the relationship between the body temperature and the percentage of butter-fat in the milk of dairy cows. The results obtained by this study should tend to aid in measuring the effect that body temperature has upon the percentage of butter-fat in the milk.

General Plan

A number of cows early in their stage of lactation are to be selected from the College herd. The body temperature of each cow is to be taken during each and every milking. The milk is to be tested by the Babcock method. From the data so collected the relationship of the body temperature to the percentage of butter-fat in the milk is to be measured by the aid of accepted mathematical formulae.

Selection of Cows

The essential thing is to get animals that will milk for a long period of time; so several cows, the majority of which have just recently freshened, will be selected for this experiment.

Methods of Collecting Data

Anal temperatures of each cow are to be taken at every milking with the thermometer inserted full length, just as the cow is being milked. The thermometer is to be allowed to remain inserted for at least three minutes. The reading is to be recorded immediately. Accurately calibrated and tested clinical thermometers are to be used exclusively in this work. Samples of the milk of each cow are to be taken at each milking and tested by the Babcock method.

Several experiments are to be conducted in an effort to change the body temperature or the fat content of the milk of dairy cows. by the use of feeds, oils or drugs, and blanketing. The additional data thus obtained might show a definite relation between the body temperature and the percentage of butter-fat in the milk.

EXPERIMENTAL DATA

It was not possible to secure cows that would meet all of our requirements. However, the following purebred cows, which will be designated by their herd numbers, were finally selected.

This table gives a short description of the cows used in the work:

Cow No.	Breed	Age	Estimated Weights at Beginning and End of this Experiment	Date of Last Freshening
6	Holstein	10 yr.	1530# - 1560#	10/17/23
25	Holstein	6 yr.	1522# - 1523#	8/25/23
42	Holstein	4 yr.	1112# - 1162#	9/21/23
95	Guernsey	3 yr.	996# - 1031#	9/23/23
128	Holstein	3 yr.	1150# - 1180#	10/ 7/23
141	Holstein	2 yr.	1275# - 1230#	10/ 3/23
145	Holstein	2 yr.	1000# - 1035#	10/ 1/23

Cows #6 and #141 were milked four times per day through this work.

Cows #25 and #128 were milked four times per day at first, but as their milk flow lessened they were milked three times per day and toward the end of this experiment were milked only twice each day.

Cow #95 was milked three times a day through out this work.

Cows #42 and #145 were milked only twice a day during this entire period.

The following grain mixtures were used throughout the experiment and will be referred to by number when required for reference.

Grain Mixture #1	300#	hominy or ground corn
	300#	gluten feed (Buffalo)
	200#	ground oats
	200#	bran
	150#	oil meal
	100#	cottonseed meal
	12½#	calcium carbonate
	12½#	salt
Grain Mixture #2	300#	hominy or ground corn
	300#	bran
	200#	ground oats
	50#	cottonseed meal
	50#	gluten meal (Buffalo)
	8#	Calcium carbonate
	8#	salt
Grain Mixture #3	40#	ground corn
	40#	ground oats
	25#	cull beans
	10#	oil meal

Grain Mixture #3 was fed to cows #25, 42, 95, 128, and 145 during the months of January and February and a part of March, during which time these cows were used in a feeding experiment.

CORRELATION TABLES, etc.

The following tables contain the collected data arranged to show the correlation between the body temperature of dairy cows and the percentage of butter-fat in their milk.

Tables number I to VII inclusive give the correlated data of the individual cows, collected from November 24 to March 25.

Table number VIII gives the correlated data collected on cow number 141 from October 24 to December 24 inclusive.

Table number IX shows nine hundred correlated observations, the total of those made on all the cows from October 24 to December 24 inclusive.

Table number X contains the data of cow number 39, a pure bred Holstein. This is additional data and is for the thirty day period, beginning five days after freshening.

Tables number XI to XIV inclusive, give the correlated data collected on cow number 141. This is arranged and assembled so that the coefficient of correlation can be computed for the various milking periods in the day.

With the data in tables number XV to XXXIII inclusive, an endeavor is made to find the correlations, if any, between the temperature and the percentage of butter-fat, by correlating separately the data collected at the different milking periods in the day. These data only cover the second thirty day period after freshening.

The data of cow number 25 was not used in these tables because they did not cover this period since she freshened sixty days before this work was started.

Tables number XXXIV to XLI inclusive, contain the data with which the correlation of differences was figured.

The mean temperature of each cow was found as indicated in table number XLII. From this mean the differences are all taken as positive and the coefficient of correlation worked out therefrom.

TABLE NO. I

% Fat	Temperature in degrees											
	99.5	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.5	3.1	
0.5							1					1
0.8												
1.1								1	1			2
1.4					3	4	1	4				12
1.7					3	8	14	17	2			44
2.0		2	1		3	11	12	16	2	1	1	49
2.3		1		2	6	14	31	16				70
2.6	1		1	1	4	19	25	14	2			67
2.9		4	1		5	19	17	18	3			67
3.2		1	3		3	15	13	11	4			50
3.5		2			3	12	9	3	2			31
3.8		2			1	8	8	6	1			26
4.1			1	1	1	5	4	3	3			18
4.4					1	1	3	3				8
4.7					1		5					6
5.0							1	1				2
5.3							1					1
5.6				1								1
5.9						1	1					2
6.2						1						1
458	1	12	7	5	34	118	146	113	20	1	1	458

$r = -.162 \pm .029$

TABLE NO. II

% Fat	Temperatures in degrees										
	99.5	99.8	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.5	
1.4							1				1
1.7			1		1	4	3	1	1		11
2.0			3		3	13	9	5	6		39
2.3			3		2	20	18	2			45
2.6			8	2	11	21	17	3	1		64
2.9	1	2	12	2	3	20	20	1	4		65
3.2			6	3	5	19	18	5	3	1	60
3.5		1	4	1	1	6	8	2	3		26
3.8			2	1	1	5	4	1	4		18
4.1		1	1		1	3	4	1			11
4.4			1				2	1	1		5
4.7						1	2				3
5.0											
5.3											
5.6								1			1
5.9											
6.2											
6.5					1						1
350	1	4	41	9	29	112	106	23	23	1	350

$r = -.019 \pm .036$

TABLE III

% Fat	Temperatures in degrees							
	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	
2.3						1			1
2.6				1	3	3	1		8
2.9				4	16	14	5		39
3.2	1		2	1	30	17	3	2	56
3.5		1	2	5	12	19	5		44
3.8			1	3	5	3	1		13
4.1	1				1	1			3
	2	1	5	14	67	58	15	2	164

r = -.17 ± .051

TABLE NO. IV

% Fat	Temperatures in degrees										
	97.0	98.9	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.8	
2.0								1			1
2.3											
2.6						1					1
2.9											
3.2					1	2	2	1	1		7
3.5			2		1	2	6	1			12
3.8			4	1	3	10	14	8	4		44
4.1	1		7	1	2	19	16	15	3		64
4.4		1	8	3	12	11	23	5	5	1	69
4.7		1	9	3	10	20	22	12	2		79
5.0			5	3	6	14	9	6	3		46
5.3			1	1	1	3	5	5	1		17
5.6							2				2
5.9							3				3
6.2								1			1
	1	2	36	12	36	82	102	55	19	1	346

r = -.222 ± .035

TABLE NO. V

% Fat	Temperatures in degrees									
	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.5	3.1	
1.7				1	1	1					4
2.0			1	1	1	2	2				7
2.3				3	3	1	2	1			10
2.6	2			4	11	6	3				26
2.9	2	1	3	2	11	18	10		1		48
3.2	2	1	3	14	25	30	8	1			84
3.5	4	1		8	31	33	8	1			86
3.8	1		1	10	11	21	10	1			55
4.1	1			3	7	4	4				19
4.4	1			2	3	2	1				9
4.7						3	4				7
5.0				1	1						2
5.3						1	1				2
5.6											
5.9											
6.2					1						1
	13	3	8	49	105	123	53	4	1		360

$r = .021 \pm .034$

TABLE NO. VI

Temperature in degrees

% Fat	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.5	2.8	4.3	4.6	4.9	
1.1						1								1
1.4						1								1
1.7						1								1
2.0				2	4	5	3							14
2.3				2	10	11	6	1	1					31
2.6				4	5	15	20	3						47
2.9	1		2	5	22	35	26	3	4					98
3.2	2		2	1	28	41	38	2	2	1			1	118
3.5				4	13	30	29	5	3		1	1		86
3.8	1			4	12	18	9	1						45
4.1		1		1	2	2	3	2	1					12
4.4					1	4	2	1						8
4.7						1								1
5.0								1						1
	4	1	4	23	97	165	136	19	11	1	1	1	1	464

r = .059 ± .031

TABLE NO VII

% Fat	Temperatures in degrees								
	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.8	
2.0						2				2
2.3						1	1			2
2.6			1		3	3	1			8
2.9	3		1	5	19	26	8	1		63
3.2		1	2	2	22	25	8	1	1	62
3.5		1			5	6	4	1		17
3.8					1	2	2			5
4.1				1	1					2
4.4							1			1
4.7										
5.0										
5.3								1		1
	3	2	4	8	51	65	25	4	1	163

r = .130 ± .077

TABLE NO. VIII

% Fat	Temperatures in degrees											
	0.7	1.0	1.3	1.6	1.9	2.2	2.5	2.8	3.1	3.4	3.7	
1.4				1			1					2
1.7			1									1
2.0			1	2	2							5
2.3			7	5	5	1						18
2.6		1	6	6	15	2	2					32
2.9		4	12	12	16	7	3		1	1		56
3.2	1		8	11	18	3	2					43
3.5			5	9	9	6	1	1	1			32
3.8		2	3	7	7	7	1				1	28
4.1				1	3	1	2	1	1			9
4.4				3	1							4
5.0					1							1
	1	7	43	57	77	27	12	2	3	1	1	231

4 = .184 ± .043

TABLE NO IX

% Fat	Temperatures in degrees .01	.04	.07	1.0	1.3	1.6	1.9	2.2	2.5	2.8	3.1	3.4	3.7	4.0	4.3	4.6	5.2	
1.1					2	1												3
1.4				2	3	2	3		1									11
1.7			2	4	7	7	7		3									30
2.0			2	11	14	15	17	2	3									64
2.3				14	30	39	15	5	2			1				1		107
2.6		1	3	12	42	35	27	8	4	1		1					1	135
2.9	2		2	22	45	55	38	9	5		1	3			1	1		184
3.2		1	4	8	40	40	33	6	6		3	1		1				143
3.5			1	10	27	33	22	7	3	1	1							105
3.8				7	11	12	19	8	1		1	1	1					61
4.1				3	9	9	6	3	3	1	1	1						36
4.4				1	3	6	3											13
4.7						1												1
5.0					2		1											3
5.6						1				1								2
5.9	1									1								2
	3	2	14	94	235	256	191	48	31	5	7	8	1	1	1	2	1	900

$r = .0398 \pm .022$

TABLE NO X

% Fat	Temperatures in degrees							
	1.0	1.3	1.6	1.9	2.2	2.5	2.8	
2.9			1	2		2		5
3.2		3	3	3	1			10
3.5		2	1	4	5	2		14
3.8	1	1	3	8	9	4	1	27
4.1			3	6	5		2	16
4.4			1	3	2			6
4.7		1		3	3		1	8
5.0		1		4	3	1		9
5.3				2	1			3
5.6				1				1
6.2				1				1
	1	8	12	37	29	9	4	100

r = .088 ± .067

TABLE NO. XI

% Fat	Temperature in degrees											
	0.1	1.0	1.3	1.6	1.9	2.2	2.5	2.8	3.1	4.6	4.9	
1.7			1									1
2.0		1	1	1	1							4
2.3		1	4	5	5	1	1					17
2.6			4	8	5							17
2.9		1	9	15	11	1	1		1			39
3.2	1		8	11	7		1				1	29
3.5			3	10	7	1	1	1	1	1		25
3.8			1	6		2						9
4.1					1				1			2
	1	3	31	56	37	5	4	1	3	1	1	143

r = .189 ± .054

TABLE NO. XII

% Fat	Temperatures in degrees									
	0.1	0.7	1.0	1.3	1.6	1.9	2.2	2.5	2.8	
1.4								1		1
1.7					1					1
2.0				2		1				3
2.3				2	2	1				5
2.6				2	2	4	1			9
2.9			1	4	7	6	1			19
3.2	1	1	1	7	8	8	1	1		28
3.5			2	4	17	8	2	1		34
3.8	1		2	3	8	6	2	1		23
4.1					1	3	2	3	1	10
4.4				1	4	2	1			8
4.7					1	1				2
	2	1	6	25	51	40	10	7	1	143

r = .092 ± .056

TABLE NO. XIII

% Fat	Temperatures in degrees							
	1.0	1.3	1.6	1.9	2.2	2.5	2.8	
2.0			2	1				3
2.3		5	2	2				9
2.6			4	2	1	2		9
2.9	2	6	9	9	3	1	1	31
3.2		6	17	16	2	1	1	43
3.5		7	5	6	1	2		21
3.8	2	6	1	5	2			16
4.1		2	2	1				5
4.4			1					1
5.0				1	1			2
	4	32	43	43	10	6	2	140

r = -.017 ± .0569

TABLE XIV

% Fat — Temperatures in degrees

% Fat	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.2	2.5	3.4	3.7	4.3	
1.1						1							1
1.4						1							1
2.0		1		1		3							5
2.3				1	2	2	1	1					7
2.6				5	1	2	12	2					22
2.9	1		2	1	7	8	8	3	3	1			34
3.2			1		6	8	13	1	1				30
3.5				1	2	3	12	7				1	26
3.8					3	4	1	2					10
4.1				1			2				1		4
	1	1	3	10	21	32	49	16	4	1	1	1	140

r = .224 ± .0541

TABLE NO. XV

% Fat — Temperatures in degrees

% Fat	1.3	1.6	1.9	2.2	
1.7	1	1	2		4
2.0			2		2
2.3		3	3		6
2.6	3	5			8
2.9	1	2	2		5
3.2		1	1	1	3
3.8		1	1		2
	5	13	11	1	30

r = .037 ± .123

TABLE NO. XVI

% Fat	Temperatures in degrees				
	1.0	1.3	1.6	1.9	
1.7			1		1
2.0				1	1
2.3		2	5	1	8
2.6	1	3	1		5
2.9	1	1		1	3
3.2	1		1		2
3.5	1	2	3		6
3.8	1	3			4
	5	11	11	3	30

$r = -.415 \pm .102$

TABLE NO. XVII

% Fat	Temperatures in degrees					
	1.0	1.3	1.6	1.9	2.2	
1.1				1		1
1.4	1	1	1			3
2.0			3			3
2.3			3			3
2.6		1	2	3		6
2.9		1	1	1		3
3.2		3	2		1	6
3.5		1				1
4.1		2	1			3
	1	9	13	5	1	29

$r = -.112 \pm .123$

TABLE NO. XVIII

% Fat	Temperatures in degrees					
	0.4	1.0	1.3	1.6	1.9	
1.4		1			1	2
1.7			1	2	2	5
2.0					1	1
2.3		2	1	2		5
2.6		1	4	2		7
2.9			1	1	1	3
3.2	1					1
3.8					1	1
	1	4	7	7	6	25

r = -.182 ± .130

TABLE NO. XIX

% Fat	Temperatures in degrees				
	1.0	1.3	1.6	1.9	
2.0		1			1
2.3			1		1
2.6		2	2		4
2.9	4	5	5	2	16
3.2	1	1	2		4
3.5		1	1		2
4.1			1		1
	5	10	12	2	29

r = -.27 ± .17

TABLE NO. XX

% Fat	Temperatures in degrees					
	1.0	1.3	1.6	1.9	2.2	
2.0			1			1
2.6		1	1			2
2.9			2	2		4
3.2		1	2	2		5
3.5		2	6	3		11
4.1	1	1			1	3
4.4		1				1
	1	6	12	7	1	27

r = -.161 ± .187

TABLE NO. XXI

% Fat	Temperatures in degrees				
	1.0	1.3	1.6	1.9	
2.0	1				1
2.9			1	1	2
3.2		1	2		3
3.5			1	1	2
3.8	1	5	3	1	10
4.1		2	3		5
4.4		1		1	2
4.7			1		1
	2	9	11	4	26

r = .133 ± .19

TABLE NO. XXII

% Fat	Temperatures in degrees					
	0.4	1.0	1.3	1.6	1.9	
2.3				1		1
3.2		1				1
3.5					1	1
3.8		1	1	2	1	5
4.1		2	2			4
4.4	1		2	1	2	6
4.7			4	2	1	7
5.0		1	1			2
5.3			1	1		2
	1	5	11	7	5	29

r = -.066 ± .18

TABLE NO. XXIII

% Fat	Temperatures in degrees					
	0.7	1.0	1.3	1.6	1.9	
3.2			1			1
3.8				1		1
4.1	1	2	2	1		6
4.4	1	2	1	1	1	6
4.7		2	2		1	5
5.0		2	1	1	1	5
5.3				1		1
5.6			1			1
5.9					1	1
6.5		1				1
	2	9	8	5	4	28

r = .21 ± .12

TABLE NO XXIV

% Fat	Temperatures in degrees			
	1.3	1.6	1.9	
2.0	1			1
2.3	1			1
2.6	3	2		5
2.9	1	2	2	5
3.2	3	3	1	7
3.5			3	3
3.8	2		1	3
4.1	1			1
4.7		1		1
	12	8	7	27

r = .207 ± .124

TABLE NO.XXV

% Fat	Temperatures in degrees					
	1.3	1.6	1.9	2.2	3.1	
1.7					1	1
2.0			1			1
2.6		2				2
3.2	1	1	1			3
3.5	1	4	1	1		7
3.8	1	1	1			3
4.1		2				2
4.4	2	1	2			5
4.7			3			3
5.0		1				1
5.3		1				1
5.9		1				1
	5	14	9	1	1	30

r = -.342 ± .108

TABLE NO. XXVI

% Fat	Temperatures in degrees				
	1.0	1.3	1.6	1.9	
2.0			1		1
2.3				2	2
2.6		2	1	1	4
2.9		2	1	2	5
3.2			3		3
3.5		1	3	1	5
3.8			3		3
4.1	1	2			3
4.7			1	1	2
5.3				1	1
6.2		1			1
	1	8	13	8	30

r = -.054 ± .122

TABLE NO. XXVII

% Fat	Temperatures in degrees						
	0.7	1.0	1.3	1.6	1.9	2.2	
1.7		1		1			2
2.0	1	1		2			4
2.3		2	1		1	1	5
2.6	1	1	2		2		6
2.9	1		1		1		3
3.2		2	2				4
3.8		1					1
5.0		1					1
	3	9	6	3	4	1	26

r = .112 ± .131

TABLE NO XXVIII

% Fat	Temperatures in degrees				
	1.0	1.3	1.6	1.9	
1.7		1			1
2.0		1			1
2.3		3	3	1	7
2.6		2	2	1	5
2.9	1	2	3	4	10
3.2		1			1
3.5			1		1
3.8			2		2
	1	10	11	6	28

r = .205 ± .122

TABLE NO. XXIX

% Fat	Temperatures in degrees					
	1.0	1.3	1.6	1.9	2.2	
2.3		2				2
2.6		1		2		3
2.9		1	1	2		4
3.2		1	1	2		4
3.5		2	4	2	1	9
3.8	2	1		1		4
4.1					1	1
4.4			2			2
	2	8	8	9	2	29

r = .047 ± .125

TABLE NO. XXX

% Fat	1.0	1.3	1.6	1.9	2.2	
2.0			1	1		2
2.3		1		1		2
2.6			1	1		2
2.9	1	1	2	1	1	6
3.2		1	4	1		6
3.5		1	1	2		4
3.8		2		3		5
5.0				1		1
	1	6	9	11	1	28

Temperatures in degrees

r = .068 ± .126

TABLE NO. XXXI

% Fat	0.7	1.0	1.3	1.6	1.9	2.2	2.5	
1.4				1				1
2.3				1		1		2
2.6		1	1		5	1		8
2.9		1	3	1	2	1	1	9
3.2	1		1	1	4			7
3.5					1			1
3.8				1				1
	1	2	5	5	12	3	1	29

Temperatures in degrees

r = .135 ± .122

TABLE NO. XXXII

% Fat	Temperatures in degrees 1.0	1.3	1.6	1.9	
2.0		1	2		3
2.3		1	2	1	4
2.6		3	2	1	6
2.9	1	6	3		10
3.2		2	2		4
3.5			3		3
	1	13	14	2	30

r = -.094 ± .18

TABLE NO. XXXIII

% Fat	Temperatures in degrees 1.0	1.3	1.6	1.9	
2.0			1		1
2.6			2	1	3
2.9			4	1	5
3.2		3	3	1	7
3.5		2	4		6
3.8		1	2	2	5
4.1	1		1		2
4.4				1	1
	1	6	17	6	30

r = .063 ± .18

TABLE NO. XXXIV

% Fat	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	26	27	29	34	35	
	Temperature in degrees																									
0.5		1																								1
0.8	1																									1
1.1		1	1		2		1																			5
1.4	1	3	3	7	2	3																				19
1.7	7	10	18	5	9	1	1		2																	53
2.0	6	15	17	8	9	7	3	1	1	1		1				2										71
2.3	17	30	10	14	8	3	3	1	2	2		1	1		1			1					1			95
2.6	12	24	19	15	10	6	1	1	10		1		1	1				1			1				1	104
2.9	10	18	20	13	16	2	8	3					1		1	1	1	3	1			1	1			100
3.2	12	13	20	12	13	4	2	3	2		1	1	2	1	2		1			1				1		91
3.5	5	12	9	5	5	4	3	1	3		1			1	1											50
3.8	5	7	8	7	2	3	4	5						1	1	1	1			1						46
4.1	1	5	3	6	4	2	6		1	1	1				1				1							32
4.4	3	1	5	1	1			1																		12
4.7	4	1	2			1									1											9
5.0		2	1																							3
5.3	1																									1
5.6			1						1																	2
5.9		1			1																					2
6.2			1																							1
	85	143	138	93	82	36	32	16	22	4	4	3	5	4	8	4	3	5	2	2	1	1	2	1	1	698

r = .078 ± .026

TABLE NO. XXXV

% Fat	Temperatures in degrees																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	19	24	
1.4				1			1													2
1.7	1	1	1	2	1	2		3	2	1	1	1	1					1		18
2.0	1	3	2	5	8	6	4	5	5	2	2	4	2	3						52
2.3		3	2	14	12	14	9	6	3	4			1	1	1					70
2.6	2	10	3	15	11	14	11	17	1	3	2	2	1		2	1				95
2.9		5	3	18	13	9	14	20	1	4	2	5	3	1	1		1		1	101
3.2	3	5	5	7	16	11	10	8	4	4	1		1	1	1			1		78
3.5		3	1	9	4	4	6	4	2	1	2		3			1				40
3.8		1		1	5	3	1	3		1		3		1						19
4.1		1	1	1	2	1	2	3	2											13
4.4				1			1	2	1	1		1								7
4.7					1		2													3
5.0								1												1
5.6										1										1
5.9									1											1
6.5		1																		1
	7	33	18	74	73	64	61	72	22	22	10	16	12	7	5	2	1	2	1	502

$r = -.008 \pm .030$

TABLE NO. XXXVI

% Fat	Temperatures in degrees													
	0	1	2	3	4	5	6	7	8	9	10	13	15	
2.0		1	1			1				1				4
2.3	2	2	1		1									6
2.6	2	8	7	3	2		1		1				1	25
2.9	12	28	17	12	10	6	1							86
3.2	15	34	15	14	8	1	1	1	2	1		1	1	94
3.5	12	22	13	13	9	2			1	1	1		2	76
3.8	1	10	3	2	4	1	1	1						23
4.1		2	3	3	1			2					1	12
4.4				1										1
5.0		1												1
	44	108	60	48	35	11	4	4	4	3	1	1	5	328

$r = .065 \pm .037$

TABLE NO. XXXVII

% Fat	0	1	2	3	4	5	6	7	8	9	10	11	12	15	16	22	24	42	
	Temperatures in degrees																		
2.0						1													1
2.6		1																	1
3.2	1		3	1		1	2												8
3.5	2	4	1	2	2			1	1				2						15
3.8	8	12	6	2	5	3	4	3					4						47
4.1	5	19	17	11	10	2	4	2	5		3	1	3					1	83
4.4	9	20	16	6	9	1	10	3	3	1	1	1	7	1		1			89
4.7	10	16	24	14	11	2	9	1	3	1	4	1	3	1			1		101
5.0	3	9	18	5	6	2	8	2	4		3	1	2						63
5.3	2	1	8	4	2	2		2				1	1						23
5.6	2	1	3		1	1									1				9
5.9	1	2						1											4
6.2		1		1															2
	43	86	96	46	46	15	37	15	16	2	11	5	22	2	1	1	1	1	446

$r = .003 \pm .031$

TABLE NO. XXXVII

% Fat	Temperatures in degrees																		
	0	1	2	3	4	5	6	7	8	9	10	11	12	15	16	22	24	42	
2.0						1													1
2.6		1																	1
3.2	1		3	1		1	2												8
3.5	2	4	1	2	2			1	1				2						15
3.8	8	12	6	2	5	3	4	3					4						47
4.1	5	19	17	11	10	2	4	2	5		3	1	3					1	83
4.4	9	20	16	6	9	1	10	3	3	1	1	1	7	1		1			89
4.7	10	16	24	14	11	2	9	1	3	1	4	1	3	1			1		101
5.0	3	9	18	5	6	2	8	2	4		3	1	2						63
5.3	2	1	8	4	2	2		2				1	1						23
5.6	2	1	3		1	1									1				9
5.9	1	2						1											4
6.2		1		1															2
	43	86	96	46	46	15	37	15	16	2	11	5	22	2	1	1	1	1	446

$r = .003 \pm .031$

TABLE NO. XXXVIII

% Fat	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Temperatures in degrees																
1.1				2			1				1	1					5
1.4		1	1	1			1										4
1.7	1	2	4	1	1	1										1	11
2.0	2	3		2	3		1	1	1								13
2.3	3	4	3	6	3	2	2	1									24
2.6	6	10	4	4	9	6	2	1				1				2	45
2.9	8	19	14	9	6	8	2	3	1	2		2		1			75
3.2	7	34	18	20	7	9	5	1	2	2		1			1		107
3.5	9	43	18	17	10	6	4	1		1			1	1	1	2	114
3.8	7	16	14	15	4	9	4			1						1	71
4.1	3	7	3	6	5	2	1								1		28
4.4		1	3	2	1	2									1	1	11
4.7		2	4	2	1	1											10
5.0		1				1											2
5.3		1	1		1		1										4
5.6			1	1													2
5.9			1														1
6.2				1													1
	46	144	89	89	51	47	24	8	4	6	1	5	1	2	4	7	528

r = $-.061 \pm .029$

TABLE NOXXXIX

% Fat	0	1	2	3	4	5	6	7	8	9	10	11	13	14	16	17	19	25	29	33	
	Temperatures in degrees																				
1.1		1																			1
1.4				1					1												2
1.7			1			1															2
2.0	3	5	2	2	2	2	1	1					1								19
2.3	7	11	3	6	4	4	3	1		1											40
2.6	4	19	20	7	4	6	5	1		1											67
2.9	11	31	30	17	14	13	3	9	1	2	1			1	1	1					135
3.2	9	49	39	29	15	7	2	7	1	1	1	2			1	1				1	165
3.5	7	45	33	18	11	7	7	5	2	1	1		1	1				1	1		141
3.8	8	13	18	11	13	6	7	5								1					82
4.1		6	4	4	2	1	1	2		1		1	1				1				24
4.4	1	6	2	1	2																12
4.7		1		1																	2
5.0				1	1																2
5.3				1																	1
	50	187	152	99	68	47	29	31	5	7	3	3	3	2	2	3	1	1	1	1	695

$r = .037 \pm .026$

TABLE NO XXXX

% Fat	Temperatures in degrees														
	0	1	2	3	4	5	6	7	8	9	12	15	16	25	
2.0	2	2	1	1											6
2.3	4	3	4	1	1			1	1						15
2.6	5	6	7	2	4				1						25
2.9	11	29	20	13	11	7	3			1			4		99
3.2	17	26	31	15	8			2	1	1	1	1			103
3.5	11	11	13	9	6	1	2				1			1	55
3.8	1	4	5	3	4		1								18
4.1		1	2	1		1		1							6
4.4			2	1											3
4.7					1										1
5.3						1									1
5.6			1												1
	51	82	86	46	35	10	6	4	3	2	2	1	4	1	333

$r = .054 \pm .031$

TABLE NO. XVXXI

Temperatures in degrees

% Fat	5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	16.5	18.5	20.5	24.5	26.5	28.5	32.5	34.5	42.5	
.5	1																	1
.8	1																	1
1.1	2	3	2	2		2												11
1.4	5	14	5	2	1													27
1.7	22	32	16	4	5	2	1	1		1								84
2.0	43	41	39	17	11	7	6	2										166
2.3	86	64	52	27	13	1	3	2	1					1				250
2.6	109	106	72	40	17	6	3	6	1				1			1		362
2.9	182	186	115	66	12	10	6	4	11	1		1	1	1				596
3.2	225	229	100	44	21	7	7	6	3	2					1	1		646
3.5	186	161	71	34	13	5	10	8				2		1				491
3.8	90	95	62	39	2	3	6	3	2	1								306
4.1	50	65	33	24	10	6	4	3		2							1	198
4.4	41	41	16	17	6	3	7	3			1							135
4.7	34	47	18	12	4	5	3	2				1						126
5.0	16	25	10	11	4	4	2											72
5.3	5	14	6	3		1	1											30
5.6	3	7	2		2				1									15
5.9	4	1	1	1	1													8
6.2	1	3																4
6.5	1																	1
	1110	1134	620	343	122	62	59	40	19	7	1	4	2	3	1	2	1	3530

r = .009 ± .011

TABLE NO. XXXXI

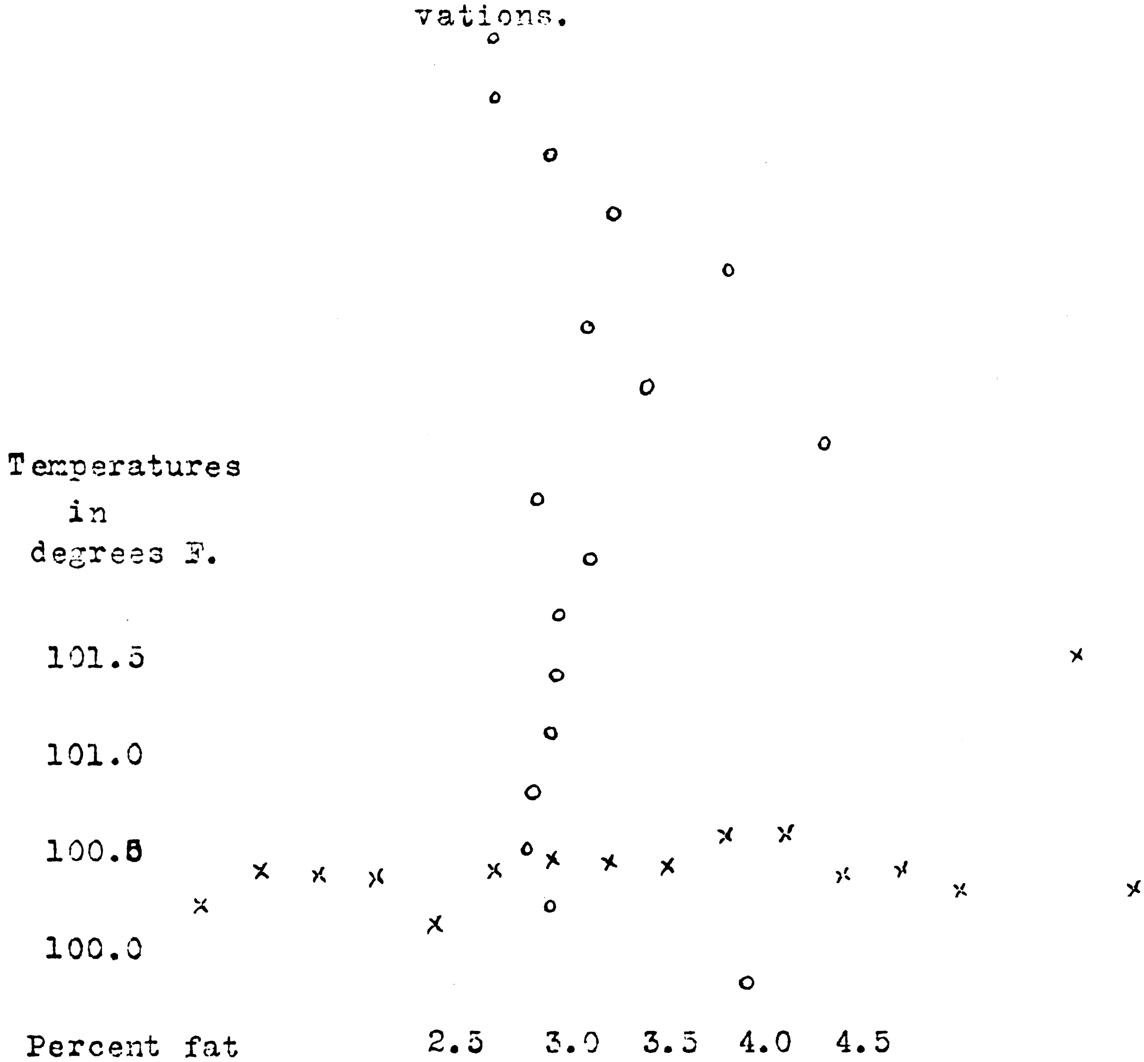
Temperatures in degrees

% Fat	5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	16.5	18.5	20.5	24.5	26.5	28.5	32.5	34.5	42.5	
.5	1																	1
.8	1																	1
1.1	2	3	2	2		2												11
1.4	5	14	5	2	1													27
1.7	22	32	16	4	5	2	1	1		1								84
2.0	43	41	39	17	11	7	6	2										166
2.3	86	64	52	27	13	1	3	2	1					1				250
2.6	109	106	72	40	17	6	3	6	1				1			1		362
2.9	182	186	115	66	12	10	6	4	11	1		1	1	1				596
3.2	225	229	100	44	21	7	7	6	3	2					1	1		646
3.5	186	161	71	34	13	5	10	8				2		1				491
3.8	90	95	62	39	2	3	6	3	2	1								306
4.1	50	65	33	24	10	6	4	3		2							1	198
4.4	41	41	16	17	6	3	7	3			1							135
4.7	34	47	18	12	4	5	3	2				1						126
5.0	16	25	10	11	4	4	2											72
5.3	5	14	6	3		1	1											30
5.6	3	7	2		2				1									15
5.9	4	1	1	1	1													8
6.2	1	3																4
6.5	1																	1
	1110	1134	620	343	122	62	59	40	19	7	1	4	2	3	1	2	1	3530

r = .009 ± .011

Graph No 1 Table No IX

The plotted weighted means of temperatures and percentages of butter-fat of 900 observations.



o= Mean percent of Butter-fat = 2.875

x= Mean degrees of Temperature= 101.77

r = .0898±.022

The following is a summary of the results as given in the tables from I to XLI inclusive.

Table No.	Cow No.	Time of Milking	Average % of Fat	Average Temperature	Correlation Coefficient & Probable Error
1	6		2.76	101.5	-.162 ± .029
2	25		2.38	101.02	-.019 ± .036
3	42		3.24	101.38	-.170 ± .051
4	95		4.42	101.07	-.222 ± .035
5	128		3.35	101.70	.021 ± .034
6	141		3.10	101.64	.059 ± .031
7	145		3.11	101.48	.130 ± .077
8	141		3.296	101.79	.184 ± .043
9	all cows		2.875	101.77	.0898 ± .022
10	39		3.596	101.82	.088 ± .067
11	141	4 A. M.	2.936	101.68	.189 ± .054
12	141	10 A.M.	3.359	101.67	.092 ± .056
13	141	4 P.M.	3.191	101.71	-.017 ± .057
14	141	10 P.M.	3.040	101.72	.224 ± .054
15	6	4 A.M.	2.57	101.66	.037 ± .123
16	6	10 A.M.	2.88	101.42	-.415 ± .102
17	6	4 P.M.	2.67	101.56	-.112 ± .123
18	6	10 P.M.	2.35	101.44	-.182 ± .131
19	42	A.M.	2.93	101.41	-.27 ± .17
20	42	P.M.	3.33	101.61	-.16 ± .19
21	95	A.M.	3.71	101.50	.133 ± .19

The following is a summary of the results as given in the tables from I to XLI inclusive.

Table No.	Cow No.	Time of Milking	Average % of Fat	Average Temperature	Correlation Coefficient & Probable Error
1	6		2.76	101.5	-.162 ± .029
2	25		2.38	101.02	-.019 ± .036
3	42		3.24	101.38	-.170 ± .051
4	95		4.42	101.07	-.222 ± .035
5	128		3.35	101.70	.021 ± .034
6	141		3.10	101.64	.059 ± .031
7	145		3.11	101.48	.130 ± .077
8	141		3.296	101.79	.184 ± .043
9	all cows		2.875	101.77	.0898 ± .022
10	39		3.596	101.82	.088 ± .067
11	141	4 A. M.	2.936	101.68	.189 ± .054
12	141	10 A.M.	3.359	101.67	.092 ± .056
13	141	4 P.M.	3.191	101.71	-.017 ± .057
14	141	10 P.M.	3.040	101.72	.224 ± .054
15	6	4 A.M.	2.57	101.66	.037 ± .123
16	6	10 A.M.	2.88	101.42	-.415 ± .102
17	6	4 P.M.	2.67	101.56	-.112 ± .123
18	6	10 P.M.	2.35	101.44	-.182 ± .131
19	42	A.M.	2.93	101.41	-.27 ± .17
20	42	P.M.	3.33	101.61	-.16 ± .19
21	95	A.M.	3.71	101.50	.133 ± .19

Table No.	Cow No.	Time of Milking	Average % of Fat	Average Temperature	Correlation Coefficient and Probable Error
22	95	Noon	4.29	101.39	-.066 ± .18
23	95	Night	4.64	101.30	.210 ± .120
24	128	4 A.M.	3.14	101.54	.207 ± .124
25	128	10 A.M.	3.83	101.71	-.342 ± .108
26	128	4 P.M.	3.44	101.58	-.054 ± .122
27	128	10 P.M.	2.64	101.29	.112 ± .131
28	141	4 A.M.	2.72	101.54	.205 ± .122
29	141	10 A.M.	3.30	101.61	.047 ± .125
30	141	4 P.M.	3.16	101.65	.068 ± .126
31	141	10 P.M.	2.85	101.69	.135 ± .122
32	145	A.M.	2.77	101.47	-.094 ± .18
33	145	P.M.	3.31	101.40	.063 ± .18
34	6		2.81	101.60	.078 ± .026
35	25		2.83	100.71	-.008 ± .030
36	42		3.20	101.49	.065 ± .037
37	95		4.46	101.16	.003 ± .031
38	128		3.26	101.49	-.061 ± .029
39	141		3.18	101.71	.037 ± .026
40	145		3.13	101.6	.054 ± .031
41	all cows		3.24		.009 ± .011

Table XLII

Cow No.	Number of Observations	Total Temperatures in Degrees	Average Temperatures in Degrees
6	698	70,916.8	101.60
25	548	55,190.5	100.71
42	357	36,230.0	101.49
95	531	53,714.0	101.16
128	555	56,326.4	101.49
141	703	71,499.9	101.71
145	356	36,151.9	101.55
Totals	3748	380,029.5	

Average of all temperatures 101.395[6] F.

Tables Showing Abnormal Changes.

In the tables numbered from XLIII to L inclusive, is given the data obtained in endeavoring to change the body temperature and the percentage of fat in the milk of these cows.

All of the cows received about one pound of grain to three pounds of milk yielded.

The methods used in trying to make these changes are listed as follows:

Table #XLIII contains the data obtained when the grain ration of cow #6 was suddenly changed from 22 pounds of grain mixture #1 and two pounds of cottonseed meal, to

14# grain mixture #1
2# cottonseed meal
8# soybean meal

In table XLIV is shown the effect on cow #25 of suddenly increasing the cottonseed meal in the ration. Four pounds of cottonseed meal replaced an equal amount of grain mixture #2.

In table #XLV isshown the effect of administering hypodermically twice daily to cow #42, three-quarters of a grain of strychnine, twenty-five minutes previous to milking.

In table #XLVI is given the data obtained when sixteen grains of Thyroid Gland Extract (equivalent to ninety grains of fresh Thyroid Gland) was fed three times daily with the grain to cow #95.

In table #XLVII is shown the effect of administering raw linseed oil, as a drench to cow #128. One quart was given twice daily after the cow had been fed. This cow went entirely off feed at the end of the second day and remained off feed for two days.

In table XLVIII is shown the effect on cow #141 of suddenly substituting in the grain ration a combination of ground flax and soybeans. This cow had been receiving 22 pounds of grain mixture #1. Four pounds of flax seed meal and four pounds of soybean meal were substituted for an equal amount of the original grain mixture.

In table XLIX is shown the effect of substituting suddenly in the grain ration of cow #145 three pounds of flax seed meal for an equal amount of grain mixture #2.

TABLE NO. XXXXIII

Date	A.M. % Fat	A.M. Degree	A.M. % Fat	A.M. Degree	P.M. % Fat	P.M. Degree	P.M. % Fat-	P.M. Degree	Daily % Fat	Average Degree	Period % Fat	Average Degree
A April 6	2.4	1.7	2.8	1.5	2.8	1.3	2.8	0.9	2.70	1.3)		
7	2.2	0.8	2.5	1.7	1.7	2.0	3.0	1.4	2.35	1.5)	2.48	101.4
8	2.2	1.4	2.6	1.3	2.6	1.2	2.2	0.8	2.40	1.2)		
9	2.3	1.4	2.5	1.3	1.9	2.1	3.2	1.2	2.48	1.5)		
10	2.5	1.2	3.3	1.3	3.6	0.8	2.3	0.4	2.93	0.9)	2.93	100.9
11	3.3	1.4	3.2	1.5	3.9	1.1	3.3	1.6	3.40	1.4)		
12	2.8	1.4	3.5	1.3	3.5	1.6	3.4	1.0	3.30	1.3)		
13	3.0	1.4	1.5	1.3	4.0	1.5	3.4	1.0	2.98	1.3)	3.30	101.3
14	2.9	1.8	3.4	1.0	2.8	1.8	3.9	1.7	3.25	1.6)		
15	2.9	1.6	3.7	0.0	3.1	1.1	4.0	1.0	3.43	0.9)		
16	2.5	1.2	3.9	1.4	4.6	1.8	2.6	1.5	3.40	1.5)		
17	3.5	1.4	4.7	0.1	2.1	1.6	4.5	1.6	3.65	1.1)	3.53	101.3
18	2.1	1.7	2.8	1.1	4.5	1.6	4.2	1.3	3.40	1.4)		
19	2.3	2.0	1.4	1.8	3.9	1.6	3.1	1.3	2.68	1.7)		
20	2.8	0.0	3.1	1.6	2.8	1.8	2.5	1.2	2.55	1.1)	2.63	101.4
21	1.7	1.4	3.6	1.7	2.0	1.5	3.4	1.5	2.63	1.5)		
22	1.7	1.4	2.9	1.5	2.8	1.4	3.1	1.1	2.62	1.4)		

[illegible]% increase in percentage of fat
.1 degree decrease in temperature

Graph No 2 Table No XLIII

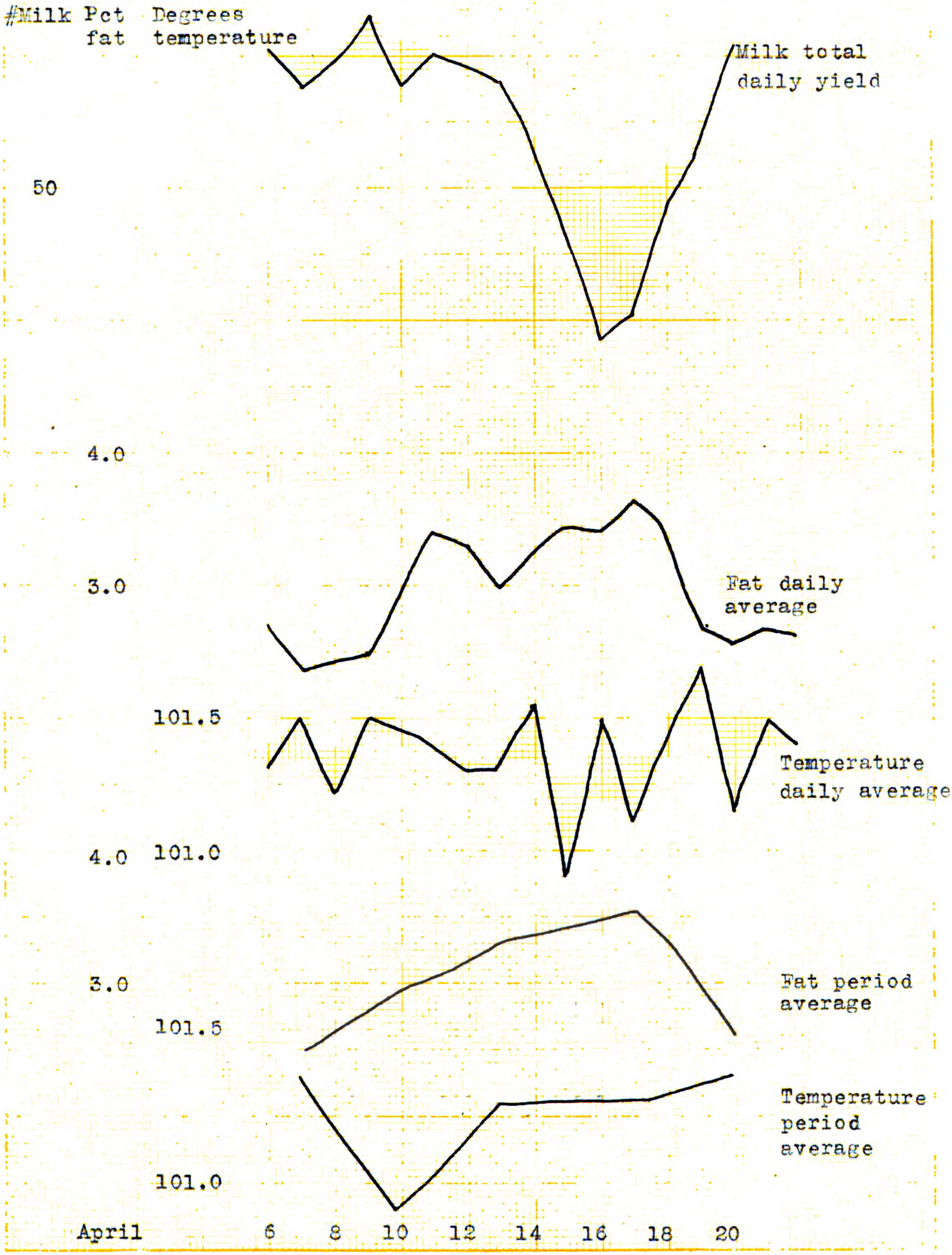


TABLE NO. XXXIV

Date	A.M. % Fat	A.M. Degree	P.M. % Fat	P.M. Degree	Daily Average % Fat	Daily Average Degree	Period Average % Fat	Period Average Degree
April 7	2.4	1.3	2.8	1.8	2.6	1.55		
8	2.6	1.0	2.7	0.2	2.65	0.6	2.65	100.9
9	2.7	0.2	2.7	1.2	2.7	0.7		
10	2.3	0.8	3.0	1.0	2.65	0.9		
11	3.0	0.8	3.9	1.3	3.45	1.05		
12	2.7	0.3	2.3	1.2	2.5	0.75		
13	3.2	0.8	3.2	1.2	3.2	0.85	2.84	101.7
14	2.2	1.1	2.3	1.0	2.25	1.05		
15	2.4	1.6	2.3	1.5	2.35	1.55		
16	3.4	0.8	3.2	1.2	3.3	1.00		
17	3.2	0.8	2.5	1.4	2.85	1.1		
18	2.8	1.4	2.5	1.3	2.65	1.35	2.73	101.2
19	2.9	1.4	2.5	1.3	2.7	1.35		
20	2.9	1.0	2.5	0.6	2.7	0.8		

7% increase in percentage of fat

.8 degrees increase in temperature.

Graph No 3 Table No XLIV

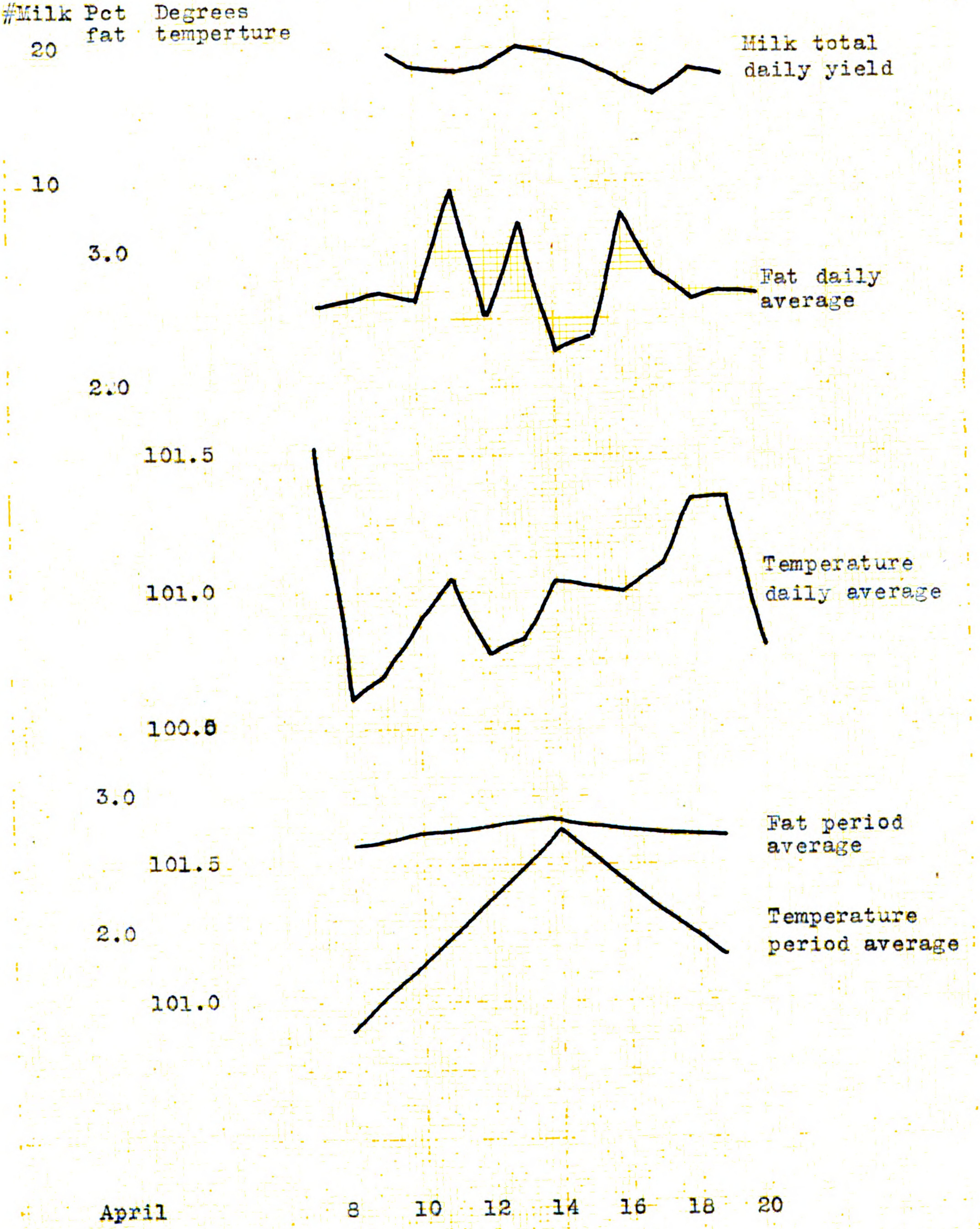


TABLE NO. XXXV

Date	A.M. % Fat	A.M. Degree	P.M. % Fat	P.M. Degree	Daily Average % Fat	Daily Average Degree	Period Average % Fat	Period Average Degree
April 5	3.1	1.5	3.6	1.4	3.35	1.45		
6	2.8	2.1	3.6	1.4	3.2	1.75		
7	3.0	1.5	3.3	1.9	3.15	1.7	3.00	101.5
8	2.7	1.8	3.2	1.2	2.95	1.5		
9	2.0	1.4	2.9	1.9	2.45	1.65		
10	2.8	1.4	3.0	1.0	2.9	1.2		
11	3.2	1.6	3.8	1.9	3.5	1.75	3.75	101.7
12	3.8	1.6	4.2	1.8	4.0	1.7		
13	3.0	1.6	3.1	1.7	3.05	1.65	3.13	101.7
14	3.0	1.8	3.4	1.7	3.2	1.75		
15	3.7	1.8	3.1	1.7	3.4	1.75		
16	3.3	1.8	3.4	1.6	3.35	1.70	3.23	101.5
17	3.0	1.4	3.5	1.7	3.25	1.55		
18	3.0	2.0	3.5	2.0	3.25	2.0		
19	2.7	1.6	3.6	1.8	3.15	1.7		
20	2.6	0.0	3.4	1.4	3.0	0.7		

20.5 percent increase in percentage of fat the first two days
.2 degree increase in temperature
9% is the average increase in percentage of fat for the four days of trial
.2 degrees increase in temperature

Graph No 4   Table No XLV

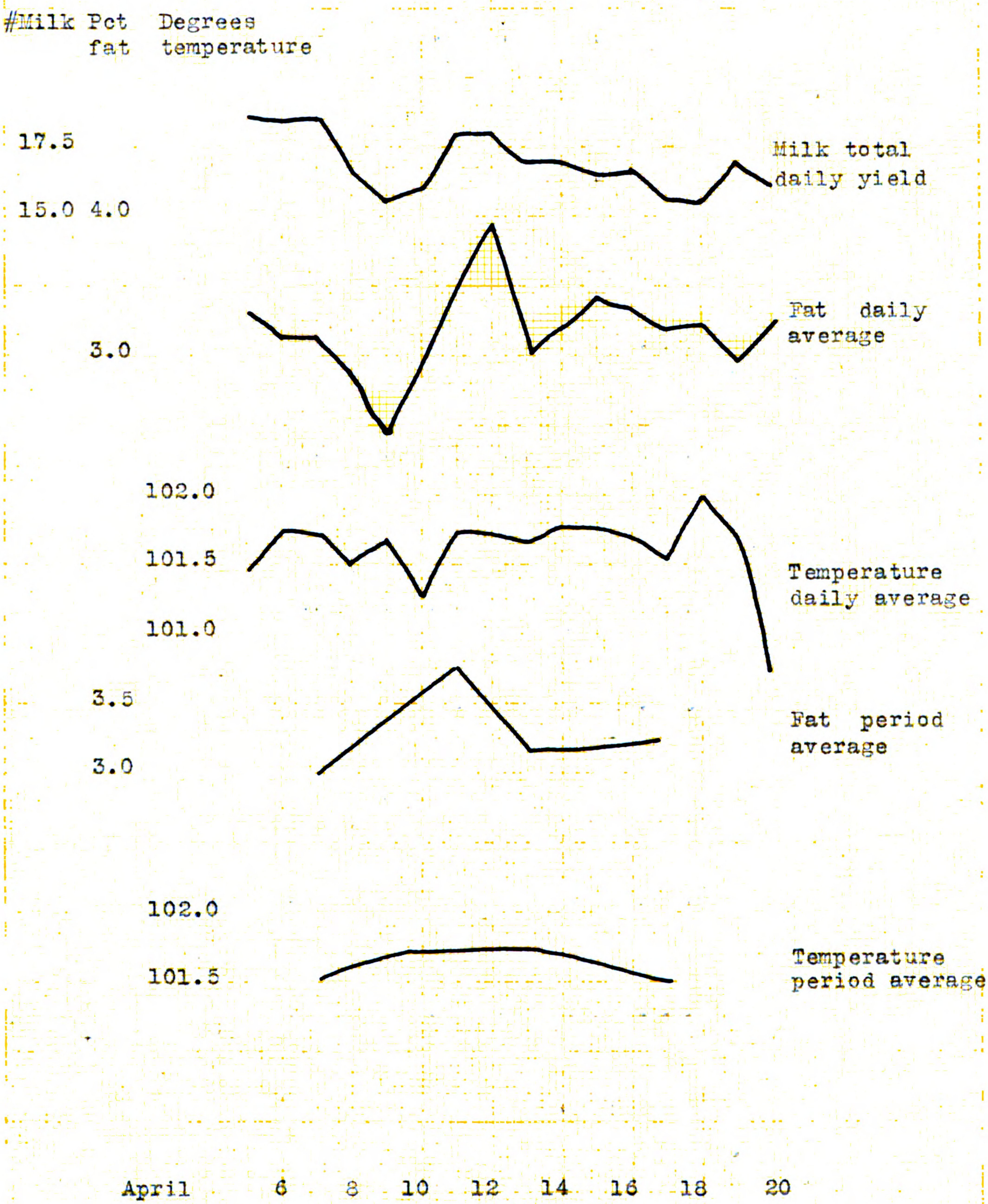


TABLE NO. XXXVI

Date	A.M. % Fat	A.M. Degree	Noon % Fat	Noon Degree	P.M. % Fat	P.M. Degree	Daily % Fat	Average Degree	Period % Fat	Average Degree
April 7	4.3	2.0	5.3	1.4	5.6	0.7	5.07	1.37)		
8	4.6	1.4	4.6	1.3	5.0	0.6	4.73	1.1)		
9	4.0	1.6	4.3	0.0	3.3	0.6	3.86	0.7)	4.44	[illegible]
10	4.1	1.4	3.3	0.7	4.9	0.5	4.1	0.87)		
11	5.5	1.4	4.2	0.5	5.2	1.0	4.96	0.93)		
12	4.6	1.2	5.1	0.6	4.2	0.9	4.63	0.9)	4.80	[illegible]
13	4.7	1.6	4.8	1.4	5.1	1.0	4.86	1.33)		
14	4.2	1.4	5.4	1.9	4.5	1.0	4.7	1.43)		
15	4.4	1.5	5.0	1.0	5.1	1.8	4.83	1.43)	4.80	101.4
16	4.0	1.3	4.1	1.4	5.1	1.4	4.4	1.37)		
17	4.6	[illegible]	4.2	0.4	5.5	0.8	4.76	0.8)	[illegible]	[illegible]
18	4.5	1.6	4.6	1.0	5.0	1.3	[illegible]	1.3)		
19	[illegible]	[illegible]	[illegible]	1.2	[illegible]	[illegible]	[illegible]	[illegible]		

5.7 percent increase in percentage of fat the first two days
.1 degree decrease in temperature the first two days
5.7 percent increase in percentage of fat the next three days
.3 degrees increase in temperature the next three days.

Graph No 5 Table No XLVI

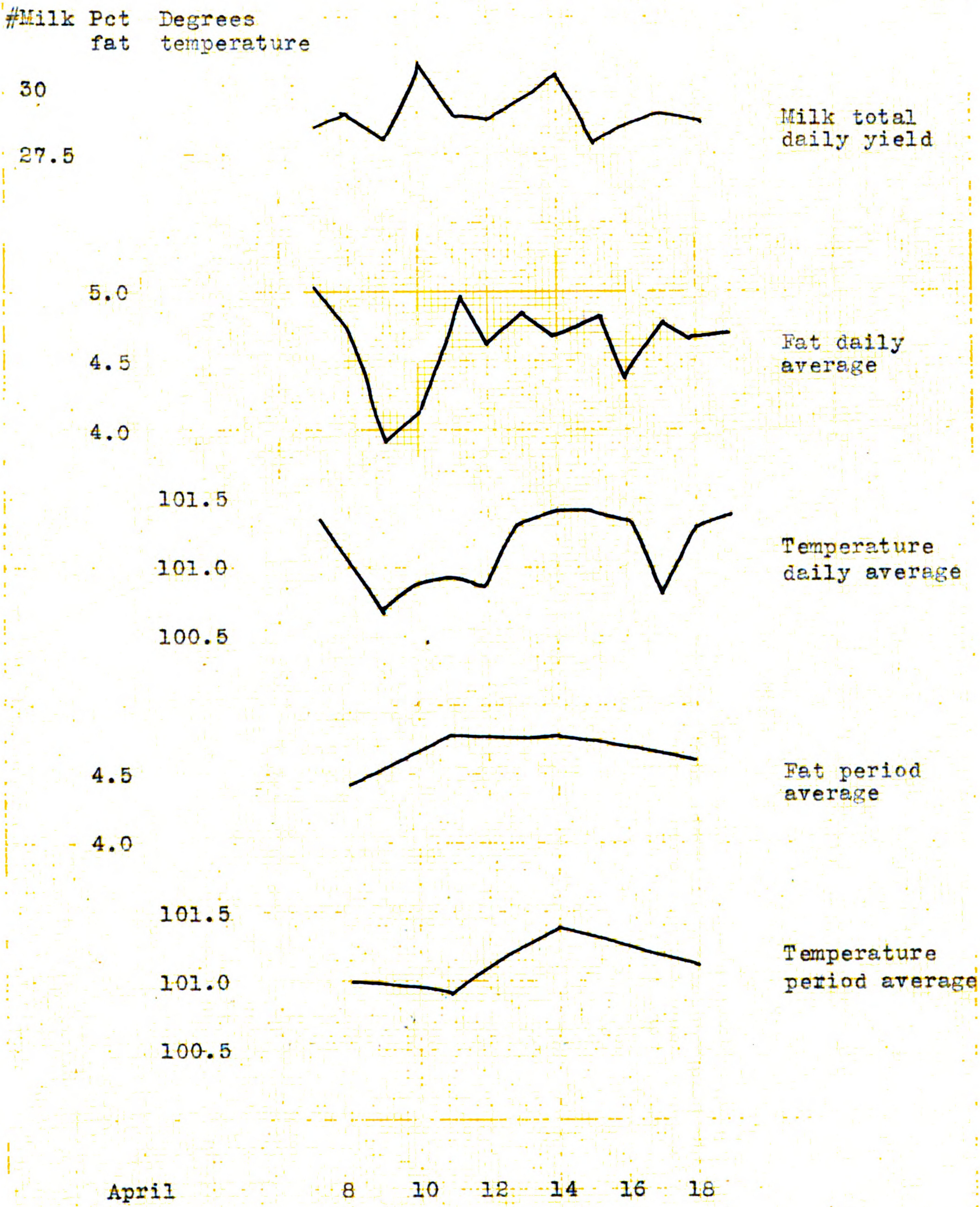


TABLE NO. XXXVII

Date	A.M. % Fat	A.M. Degree	P.M. % Fat	P.M. Degree	Daily Average % Fat	Daily Average Degree	Period Average % Fat	Period Average Degree
April 7	3.2	1.6	3.5	1.6	3.35	1.6		
8	4.1	1.6	2.6	1.0	3.35	1.3	3.24	101.4
9	2.6	1.0	2.9	1.6	2.75	1.3		
10	3.1	1.6	3.9	1.3	3.5	1.45		
11	2.9	1.5	3.0	1.7	2.95	1.6		
12	2.9	0.8	4.7	1.3	3.8	1.05	3.37	101.3
13	5.5	1.8	4.6	1.7	5.05	1.75		
14	3.5	1.8	3.6	2.2	3.55	2.0		
15	3.3	2.0	3.9	1.9	3.6	1.95	4.06	101.9
116	2.9	1.6	2.7	2.0	2.8	1.8		
17	3.2	1.8	3.0	1.8	3.1	1.8	3.07	101.8
18	3.2	1.8	3.0	1.6	3.1	1.7		
19	3.3	1.8	3.3	1.8	3.3	1.8		

4 percent increase in percentage of fat during the time oil was given
.1 degree decrease in temperature
22 percent increase in percentage of fat next three days
.5 degrees increase in temperature

Graph No 6 Table No XLVII

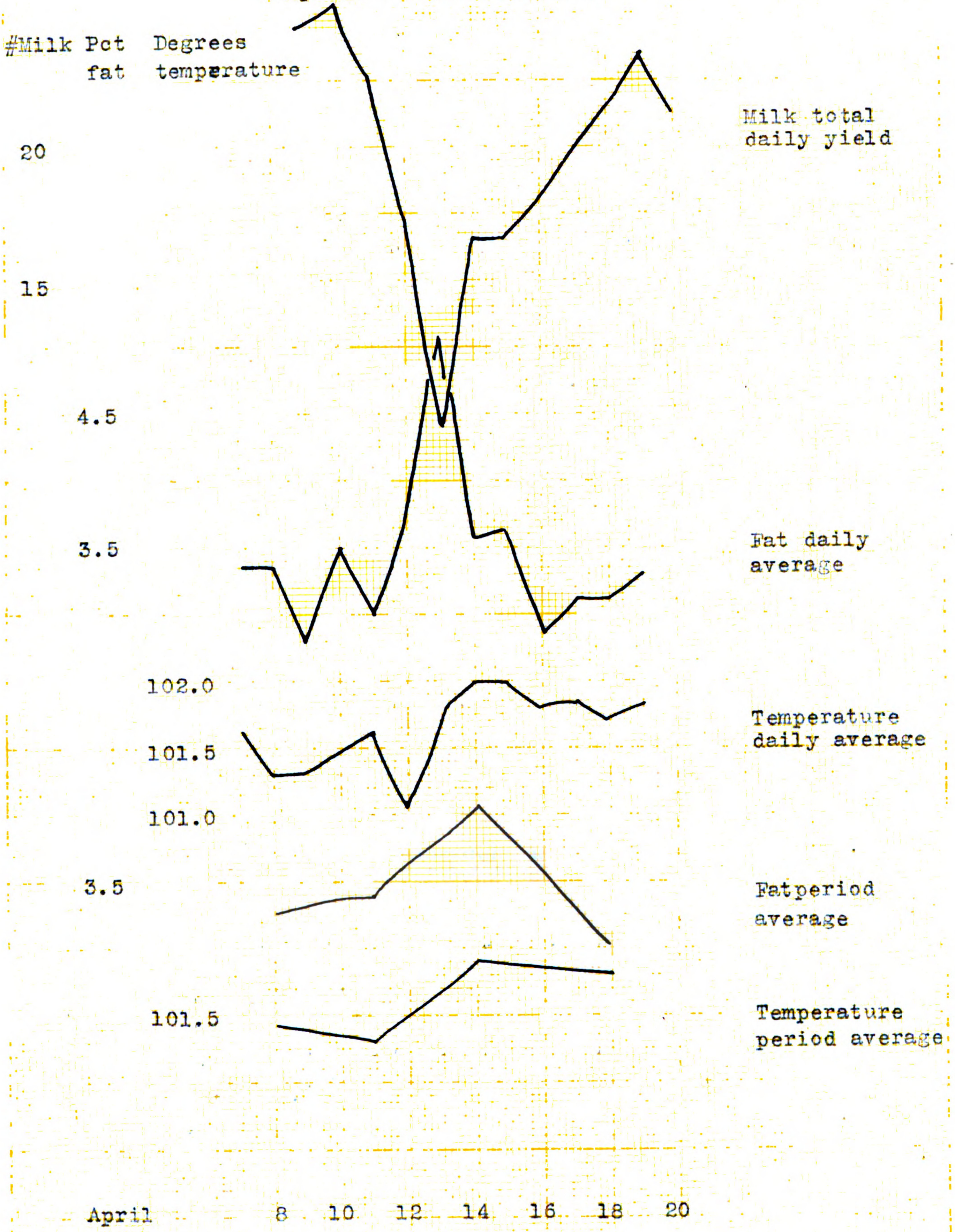


TABLE NO. XXXVIII

Date	A. M. % Fat	A. M. Degree	A.M. % Fat	A.M. Degree	P.M. % Fat	P.M. Degree	P.M. % Fat	P.M. Degree	Daily % Fat	Average Degree	Period % Fat	Average Degree
April 6	3.2	1.3	3.8	1.6	3.0	2.0	3.4	1.7	3.35	1.65)		
7	2.8	1.8	3.3	1.6	3.1	1.8	3.6	1.6	3.2	1.7)	3.2	101.7
8	3.2	1.3	3.8	1.2	2.7	1.6	3.4	1.5	3.28	1.4)		
9	3.5	1.6	3.4	1.7	2.2	2.2	3.2	1.9	3.08	1.85)		
10	3.2	1.5	2.4	1.9	3.3	2.4	3.4	0.4	3.075	1.55)	3.07	101.6
11	3.2	1.8	2.8	1.5	3.5	1.8	3.8	1.9	3.33	1.75)		
12	4.0	1.4	4.1	2.0	5.3	2.0	3.7	1.5	4.28	1.73)		
13	2.9	1.5	3.9	1.6	4.0	1.8	3.7	2.1	3.63	1.75)	3.7	101.7
14	3.8	1.2	4.0	1.8	3.6	2.2	3.5	1.0	3.73	1.55)		
15	3.5	1.6	3.9	1.7	3.7	1.8	3.5	1.6	3.65	1.68)		
16	3.6	1.8	4.4	1.8	3.8	2.0	2.7	1.4	3.63	1.75)		
17	3.4	1.6	3.8	2.0	2.5	2.4	3.7	2.1	3.35	2.03)	3.35	102.0
18	3.2	1.8	3.3	1.6	3.5	2.0	2.1	1.2	3.03	1.65)		
19	3.4	1.8	3.4	1.4	3.1	2.0	2.6	1.6	3.13	1.75)	3.20	101.7
220	2.6	1.6	3.7	1.6	3.2	1.5	2.7	1.9	3.05	1.65)		
21	3.4	1.0	3.9	1.9	3.4	1.6	3.7	1.9	3.6	1.6)		

15.6 percent average increase in percentage of fat for six days
No noticable increase or decrease in temperature.

Graph No 7 Table No XLVIII

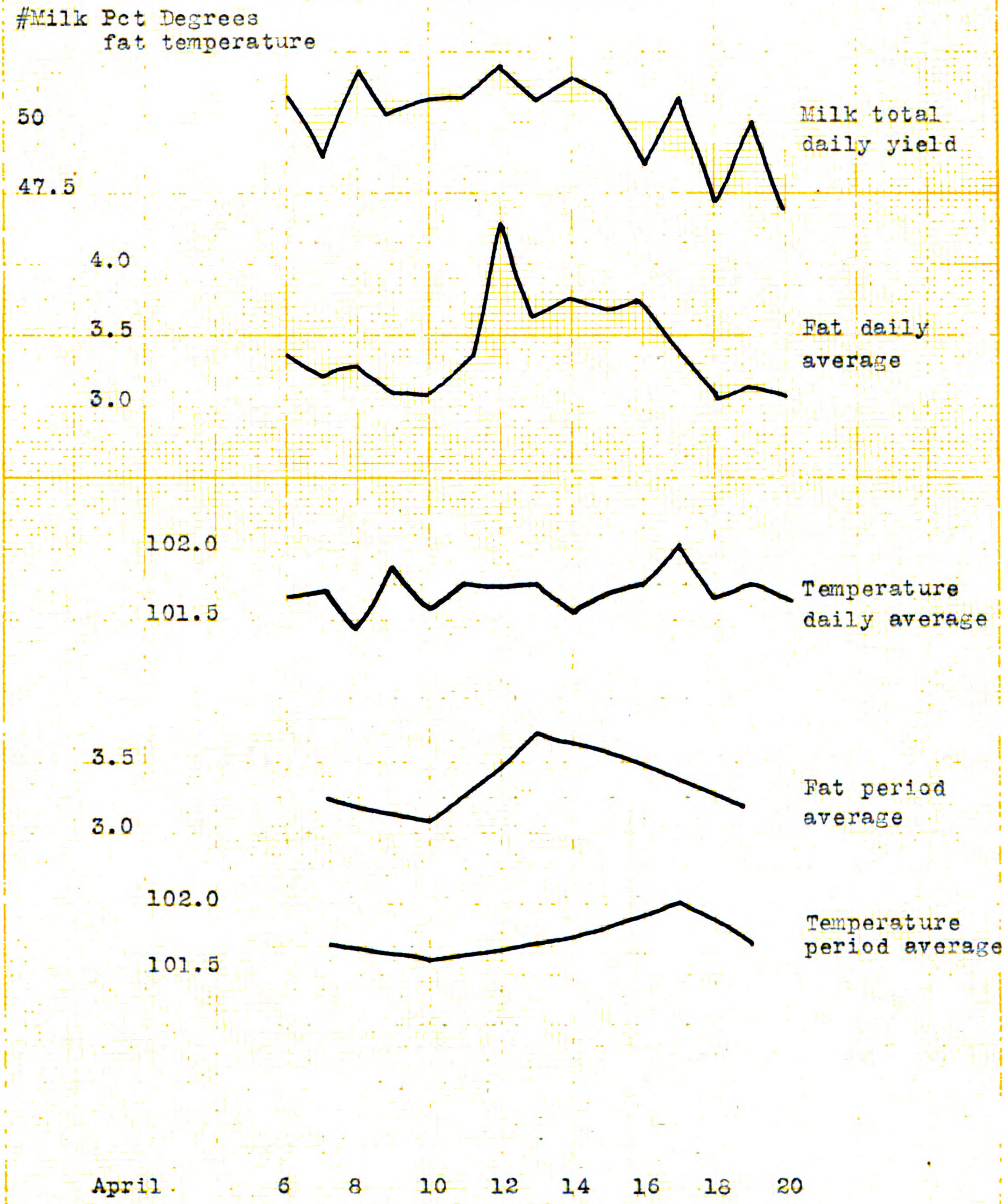
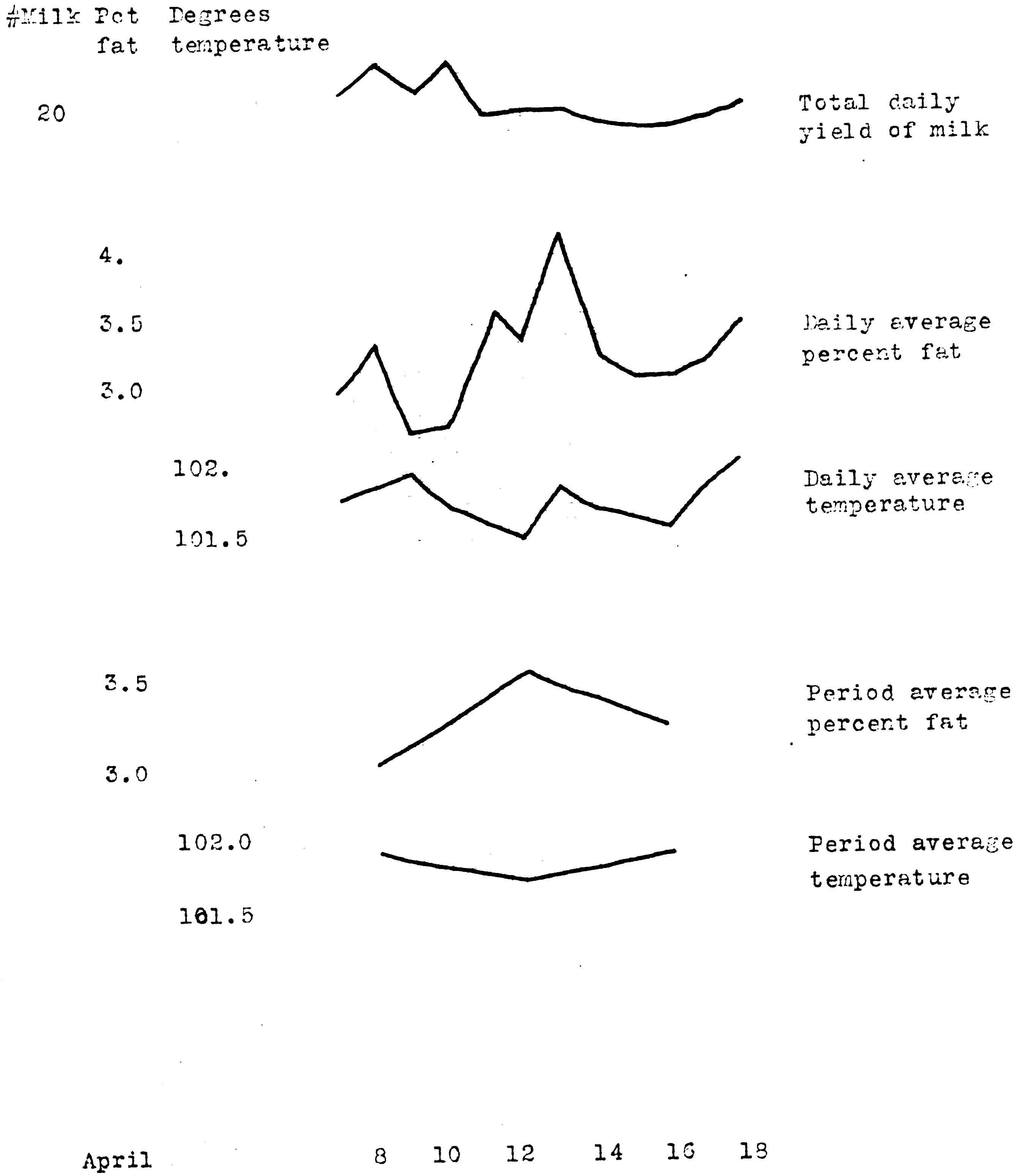


TABLE NO. XXXXIX

Date	A. M. % Fat	A. M. Degree	P. M. % Fat	P. M. Degree	Daily Average % Fat	Daily Average Degree	Period Average % Fat	Period Average Degree
April 7	3.0	1.9	3.1	1.7	3.05	1.8		
8	3.3	1.8	3.5	2.0	3.4	1.9	3.0	101.9
9	2.5	2.0	3.0	2.0	2.75	2.0		
10	3.2	1.5	2.4	2.0	2.8	1.75		
11	3.6	1.6	3.6	1.7	3.6	1.65		
12	3.1	1.6	3.7	1.5	3.4	1.55	3.61	101.7
13	3.6	1.8	4.7	2.0	4.15	1.9		
14	3.2	1.8	3.4	1.7	3.3	1.75		
15	2.9	1.8	3.4	1.6	3.15	1.7		
16	3.0	1.5	3.3	1.8	3.15	1.65	3.27	101.9
17	3.2	1.8	3.3	2.0	3.25	1.9		
18	3.4	2.2	3.7	2.0	3.55	2.1		

20.2 percent increase in percentage of fat
.2 degrees decrease in temperature

Graph No 8 Table No XLIX



The following is a summary of the data given in tables XLIII to XLIX inclusive.

Table No.	Cow No.	Experimental Period Averages: Preliminary, Pct. of Fat	Preliminary, Degrees Temp.	Trial, Pct. of Fat	Trial, Degrees Temp.	Subsequent, Pct. of Fat	Subsequent, Degrees Temp.	Per cent Increase in Fat	Per cent Increase of Fat	Degrees Increase or Decrease in Temperature
43	6	2.48	101.4	3.30	101.3	2.63	101.4	.75	29.	-.1 ± .256
44	25	2.65	100.9	2.84	101.7	2.73	101.2	.19	7.	+.8 ± .435
45	42	3.00	101.5(av)	3.39	101.7	3.23	101.5	.28	9.	+.2 ± .322
		First two days		3.75	101.7			.64	20.5	
		Last two days		3.13	101.7			none	none	
46	95	4.44	101.0	4.80	101.4	4.65	101.2	.26	5.7	+.3 ± .357
47	128	3.24	101.4	3.37	101.3	3.07	101.8	.13	4.	-.1 ± .217
48	141	3.22	101.7	3.70	101.7	3.20	101.7	.5	15.6	.0 ± .181
49	145	3.00	101.9	3.61	101.7	3.27	101.9	.61	20.2	-.2 ± .175

Methods used in computing Probable Error.

The following formulae were used in computing the Probable Error of the average temperature and the probable error of differences of the average temperatures as given in tables XLIII to XLIX inclusive.

1. P. E. $.6745 \frac{\sigma}{\sqrt{N}}$
2. P. E. of differences $\sqrt{(P.E.)_1^2 + (P.E.)_2^2}$

Effect of Blanketing on Temperature and Test.

On April 4, at 4:00 P. M. the body of cow #42 was covered with three blankets, her legs were swathed in cotton, burlap, and derby bandages and her neck was covered with two ply of heavy cotton ducking, in an endeavor to raise her body temperature.

Anal temperatures were taken every half hour for the first sixteen hours then every three hours thereafter with results as shown in the following table.

Date	Time	Temperature in Degrees F.	Date	Time	Temperature in Degrees F
April 4	4:30 P.M.	101.4	Apr. 5	12:30 A.M.	101.3
	5:30 "	102.0		1:00 A.M.	101.4
	6:00 "	102.2		1:30 A.M.	101.3
	6:30 "	102.4		2:00 A.M.	101.3
	7:00 "	102.2		2:30 A.M.	101.3
	7:30 "	102.1		3:00 A.M.	101.3
	8:00 "	101.9		3:30 A.M.	101.2
	8:30 "	101.5		4:00 A.M.	101.5
	9:00 "	101.8		4:30 A. M.	101.6
	9:30 "	101.7		5:00 A. M.	101.5
	10:00 "	101.0		5:30 A. M.	101.6
	10:30 "	101.1		6:00 A.M.	101.5
	11:00 "	101.5		6:30 A.M.	101.7
	11:30 "	101.5		7:00 A. M.	101.6
	12:00 M.	101.3		7:30 A.M.	101.5

Date	Time	Temperature in Degrees F.	Date	Time	Temperature in Degrees F.
Apr.5	10:00 A.M.	101.5	Apr. 7	4:00 A.M.	102.2
	1:00 P.M.	101.4		7:00 A.M.	101.7
	4:00 P.M.	101.4		10:00 A.M.	101.2
	7:00 P.M.	102.2		1:00 P.M.	101.6
	10:00 P.M.	102.2		4:00 P.M.	102.0
	12:30 A.M.	101.9		7:00 P.M.	102.0
Apr.6	1:00 A.M.	102.6		10:00 P.M.	101.6
	4:00 A.M.	102.1	Apr. 8	1:00 A.M.	101.6
	7:00 A.M.	101.5		4:00 A.M.	101.4
	10:00 A.M.	101.4		7:00 A.M.	101.1
	1:00 P.M.	101.4		10;00 A.M.	101.7
	4:00 P.M.	101.9		1:00 P.M.	101.4
	7:00 P.M.	101.5		4:00 P.M.	101.7
	10:00 P.M.	101.5		7:00 P.M.	101.6
Apr.7	1:00 A.M.	101.6		10:00 P.M.	100.9

The daily averages of the percentages of fat are as follows:

April 4	3.31 per cent
5	3.13
6	3.14
7	2.90
8	2.40

Cow #42 weighed 1279 pounds at the beginning of the trial and only 1074 pounds at the end, thus showing a loss in weight of 205 pounds during the five days.

The yield of milk decreased 10 per cent. The percentage of fat increased 6 per cent the first day. The percentage on the fifth day had dropped 14 per cent, thus giving for the last day a total decrease of 8 per cent in the percentage of fat under her before blanketing average.

GENERAL SUMMARY AND DISCUSSION.

The body temperatures of apparently normal dairy cows vary considerably from day to day as does the percentage of butter-fat in their milk.

In endeavoring to find the relationship between the body temperature of dairy cows at the time of milking and the percentage of butter-fat in their milk, certain fundamental discoveries have been made.

The average of all the body temperatures taken on these seven cows is found to be 101.4 degrees F. This average is the same as that established by Wooldridge, but this work shows greater extremes in the variations of temperature than has been noted in the literature. Though the cows appeared to be normal, variations from 99.0 degrees to 106.0 degrees have been noted. There were also daily fluctuations of two degrees for no apparent cause.

These trials show that the percentage of fat in the milk of individual cows varies widely during a lactation period, and that these sudden fluctuations are seemingly natural or caused by factors not easily discernible.

Though this work has not been exhaustive many points might be proven by correlating isolated data or by correlating the data collected on the individual cows. When the data is taken as originally collected and then correlated directly we find for some cows a positive correlation four to five times greater than its probable error, and on other cows negative correlation nearly seven times greater than its probable error. Each of the above if taken as they stand could be used to prove their respective relationships. When all the data collected on the seven cows are correlated together we find a positive correlation coefficient only four times as great as its probable error. The author does not consider that this correlation coefficient though four times greater than its probable error is a sufficient indication of the relationship between the body temperature and the percentage of butter-fat in the milk to justify a statement that the temperature of the cow and the percentage of butter-fat are positively correlated, because when the data of the seven cows is considered individually only three out of the seven show positive correlations. Also, that though the data show a positive correlation coefficient during some milking periods in the day, at any of the other milking periods it might show a negative relationship with either a positive or negative relationship shown when the data of allperiods in the day are correlated together.

This work also shows that there is a certain period in the day at which time the fat percentage in the milk of the individual cow is highest. This period is varied by the individual cow and may be changed to another time in the day without apparent cause.

It is seemingly easier to change the percentage of fat in the milk of dairy cows than to change their temperature. Marked changes in temperatures were caused without upsetting the processes of metabolism or the normal body functions of the cow.

Though the percentage of fat in the milk was increased when soybean meal, flax seed meal, linseed oil, cottonseed meal, Strychnine, and Thyroid Gland Extract were given to the respective cows, the work should not be taken as conclusive, but should tend to show that the average percentage of fat in the milk varied much more than did the average temperature of these cows.

The experiment in blanketing shows that the temperature was only temporarily increased by this means, and that an increase in test is not obtained by continuous blanketing. The percentage of fat was increased only for short periods.

Though the temperature at times fluctuated nearly as much as two degrees in one day, the differences between the average variations of temperatures were usually smaller than their probable errors. The remarkable thing is that though there was an increase in the percentage of fat in all these endeavors made to change tests and temperatures, three cows of the seven showed an average decrease in temperature, one cow showed no change, and three cows showed an average increase in temperature.

The author is of the opinion that there still remain other combinations or correlations that should be worked out before definite conclusions on the relationship between the body temperature of dairy cows and the percentage of butter-fat in the milk are drawn.

CONCLUSIONS

1. The body temperature of apparently normal dairy cows varies as much as two degrees F. in a day.

2. The range of the variations of the percentage of fat in the milk has been found with apparently normal cows under apparently normal conditions to be as much as 2.3 per cent in a day.

3. It was possible to cause fluctuations in the percentage of fat in the milk of cows by the use of feeds, oils and drugs. There also seemed to be fluctuations in the temperatures of the cows, but these fluctuations were not as marked nor was there a uniform increase or decrease of temperature.

4. The relationship between the body temperature of dairy cows at time of milking and the percentage of butter-fat varies with the individual cow, and may vary with the milking periods of the day and with the stage of lactation. The present data does not indicate a uniform relationship between the body temperature and the percentage of butterfat. However, such a relationship may exist. This relationship may easily be upset by factors that tend to affect only the body temperature or the percentage of fat in the milk of dairy cows.

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