BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE

No. 147

Contribution from the Bureau of Animal Industry, A. D. Melvin, Chief.
January 16, 1915.

THE EFFECT OF THE CATTLE TICK UPON THE MILK PRODUCTION OF DAIRY COWS.

By T. E. Woodward and W. F. Turner, *Dairy Division*, and Cooper Curtice, *Zoological Division.*

INTRODUCTION.

The common cattle tick, *Margaropus annulatus,* infests the cattle throughout the greater part of Florida, Georgia, Alabama, Louisiana, and Arkansas, large portions of Texas, Oklahoma, Mississippi, South and North Carolina, and small areas in Virginia and California. On account of the enormous losses occasioned by the parasite, it has been necessary to quarantine the area infested, so that cattle outside of this area may be protected. Ever since 1906 tick eradication in the infested area has been actively pushed by Federal and State governments, cooperating with citizens of tick-infested regions, to destroy the pest. While the majority of farmers admit some loss, few are aware of its extent, hence the experiments reported in this bulletin were undertaken to bring out the facts, particularly in relation to the effect of the tick on dairy cows..

The cattle tick is an almost exclusive parasite of cattle. While the ticks may mature on horses, mules, and possibly deer and sheep, their control on these animals has proved to be comparatively easy. All ticks come from eggs laid by the adult female ticks. An engorged female tick dropping from a cow completes oviposition in from five days to a week; the eggs hatch as a rule in about 21 days in ordinary summer weather; the issuing seed ticks crawl upon the grass and await the coming of cattle upon which they crawl when opportunity offers; they then reach maturity in from 21 to 25 days.

While maturing each tick abstracts a definite amount of blood from an animal, and to that degree injures it. The quantity of blood abstracted is many times the weight of the ticks when grown, for these represent only that part of the solids and fluids of the blood which may be converted into the tissues of the tick, the remaining solids and fluids being rejected. The amount of blood taken

by a single tick may be relatively small, but the total amount drawn by thousands of ticks on one cow can not fail to be injurious. If each tick represents but a dram, or a teaspoonful, of blood, a few over 1,000 would represent 8 pounds of blood. It is possible that each tick absorbs more than a dram of blood.

But the greatest disturbance created by the tick seems to be, not in the amount of blood abstracted, but in the fact that it is the carrier of the germ of Texas fever which it transmits to cattle.[1] When cattle that have never become accustomed to ticks are infested they become very sick and usually die. This may occur anywhere, either within or without the tick-infested region. Cattle that survive the ticks usually remain immune to their worst effects afterward. However, as time passes the important fact that no cattle in the quarantined area of the South are ever safe from the effects of Texas fever, either in its acute or chronic form, becomes more and more impressed on those who have to study the affected cattle.

PLAN OF THE EXPERIMENTAL WORK.

As the dairy industry is becoming an important branch of southern agriculture it was thought desirable to ascertain the effect of the tick on the milk production and body weights of dairy cows. Twenty grade Jersey cows[2] of about average dairy quality were selected in the early part of their lactation periods. They were in fair condition of flesh at the beginning, and all had been tick infested at some time. The animals being immune to ordinary attacks of tick fever, the results should be applicable to the average dairy herd in the tick-infested areas. These cows were divided into two groups of 10 animals each, the two groups being balanced as nearly as possible in regard to milk and butter-fat production, condition of flesh, and size. One group was freed from ticks by spraying with "tick dip B," an arsenical solution used by the Bureau of Animal Industry in the tick-eradication work. Data were taken on only nine cows of this group, as one cow received an injury to her udder which stopped her milk flow early in the test. The other group was kept tick-infested by applying seed ticks at regular intervals. The degree of infestation varied with different animals and with the entire group at different times during the course of the experiment.

The experiment began May 21, 1913, and lasted during a period of 140 days. The milk of each cow was weighed and a sample taken at every milking for a composite fat test at the end of each 10-day

[1] Further details concerning the life history of the cattle tick and the protozoan causing the fever can be found in Farmers' Bulletin 258.

[2] The cows and the feed lots used in these experiments were provided by the Anthony Farms Co., Anthony, Fla., of which Mr. E. C. Beuchler is manager and vice president.

period. The body weights were taken for 10 consecutive days at the beginning of the work; thence once every 10 days until the last period, when they were taken for 10 consecutive days as at the beginning of the work. The weights were taken at about the same hour and under the same conditions each time, so that the extent of fill, both as regards feed and water, would be similar. The treatment of the two groups in all respects other than ticks was as nearly alike as possible.

FEEDING.

The tick-free group of cattle were fed as much alfalfa hay as they would eat readily, and enough corn chop, wheat bran, and cottonseed meal, mixed in the proportions 4 : 2 : 1, to maintain the body weights. The aim was to give the infested group the same kind and amount of feed, but toward the close of the experimental period these cows failed to consume as much hay as the tick-free cows. In order to make the digestible nutrients consumed practically equal for each group, the grain ration of the infested cows was raised 1 pound for each $2\frac{1}{2}$ pounds of hay refused. Both groups of cows had access to salt and water in unlimited quantities.

THE TICKS.

The seed ticks used to obtain the various degrees of infestation in the cattle were the progeny of mature ticks obtained from several sources. The supply of ticks was secured through the cooperation of Dr. Charles F. Dawson, of the Florida State Board of Health, as the local supply was insufficient. Dr. Dawson's first material was collected from Tallahassee, Kissimee, Dade City, and other places in Florida. A few small lots were received subsequently. The earlier adult ticks were collected between April 13 and April 28. The seed ticks or larvæ from eggs laid by these emerged between May 22 and June 2, following. On June 12 and 14 two other consignments were received. The resulting broods seemed sufficient to insure thorough infestation of the cattle during the first weeks of the experiment.

A second source of seed ticks was the Anthony Farm cattle not under test. This supply, together with that already mentioned, was sufficient to last until the middle of July by applying them but once a week. These two sources of supply proved to be insufficient, and a third lot was obtained from the Zoological Division of the Bureau of Animal Industry. These were mainly a portion of the original collection by Dr. Dawson, which had been sent by him to Washington and intended for another purpose. One flask of specimens labeled as originating in Texas accompanied these. This Washington consignment was applied during July. As fast as the ticks matured on the

experimental cattle they were picked off, and the seed ticks derived from them became available about August 1. From that time on there was an abundance of material.

The time of application of the ticks may be roughly divided into two periods, viz, from June 4 to July 28, in which ticks were applied at intervals of seven or eight days, and from August 1 to September 25, in which they were applied on each alternate day with but two exceptions. The effect of weekly applications was to cause the ticks to ripen in groups covering about five days; the alternate day applications caused a more continuous and intense infestation. The exact fluctuations of this were not determined on account of cessation of gathering ticks when sufficient had been obtained to complete the experiment.

Collections of ticks from the experimental cattle were made twice daily during milking time from June 26 to September 4. This was necessary in order to obtain seed ticks for a continuation of the experiment into the fall months. The deleterious effects of the ticks were less than if they had been allowed to mature on the cattle; but in such case future seed ticks would not have been available. Additional effort to acquire material from other sources demonstrated the futility of depending upon outside sources for seed ticks. As the experiment proceeded it became too late to employ other cows for raising ticks, a plan which would be better if the experiment were to be repeated.

The count of the ticks made and given in an appended table does not include all that became attached to the cattle, for some dropped off, some were picked off by chickens, and others were licked off by the cattle themselves. Also many incompletely mature ticks were collected which might have added their share of damage to that already produced. Table 1 contains the number of ticks picked from each cow daily, the dates when they were applied, and their source. The infestation during the earlier period, June 4 to August 5, was practically like a fall infestation in intensity, excepting that the ticks were not maturing equally throughout the week, thus causing milder effects during the time that the ticks matured less rapidly. Infestation on different cows was from slight to gross during the whole experiment. Under farm conditions pasture infestations may occur daily, thus making continuous appearances, such as occurred during only a part of the week in the experiment, and producing consequently more severe injuries. The collecting of ticks was continued until within 30 days of the close of the experiment, when the supply was sufficient to maintain infestation until the completion of the work.

TABLE 1.—*Source of seed ticks placed on cows and number of ticks picked from each cow at stated periods.*

Period.	Source of seed ticks placed on the cows.	Number of ticks picked from—										
		Cow 11.	Cow 12.	Cow 13.	Cow 14.	Cow 15.	Cow 16.	Cow 17.	Cow 18.	Cow 19.	Cow 20.	Total.
1913.												
June 26 to July 1	Florida, except Anthony	1	14	16	3	44	15	6	1	2	5	107
July 2 to July 9	Anthony (few) and other places.	2	181	63	6	256	49	35	3	54	170	819
July 10 to July 19	Anthony and other Florida	0	728	187	40	707	217	104	7	146	370	2,506
July 20 to July 29	Anthony (most) and other places.	2	1,106	414	53	1,475	252	129	3	231	670	4,335
July 30 to Aug. 8	Anthony (few) and other places.	0	355	451	16	1,843	223	85	0	54	699	3,726
Aug. 9 to Aug. 18	Florida (except Anthony) and Washington, D. C.	6	93	119	16	825	158	84	3	68	300	1,672
Aug. 19 to Aug. 28	Anthony, Fla	7	906	872	66	1,184	392	615	6	139	980	5,167
Aug. 29 to Sept. 5	do	8	3,892	2,603	45	8,116	1,594	2,430	8	230	6,467	25,393
Total		26	7,275	4,725	245	14,450	2,900	3,488	31	924	9,661	43,725

NOTE.—No ticks were picked after Sept. 5, as there was then a sufficient supply of mature ticks on hand from which to procure seed ticks for the remainder of the experimental period.

The infestation from August 20 to October 7 was unusually large in those animals which were susceptible to the ticks; in others the infestation was only slight, as throughout the experiment. It may be said, however, concerning the infestation generally that the table does not present a complete picture to the eye, nor do photographs taken on various dates. In the weekly infestation there were three or four broods on the cows at the same time, viz, newly attached seed ticks, week-old, two-weeks old, and, depending on the exact date, maturing ticks. In alternate-day infestation there were 11 broods on at once. On cows which favored their development one could feel by touch the young ticks that were covered by hair. From the beginning difficulty was experienced in gaging the number of young ticks that should have been put on the cows. In the weekly infestation all the available ticks were used. The effects would not have been different had the same numbers been applied at intervals throughout the week. The infestation would have been less visible, however.

Effort was made to apply about the same number each time, but later application gave better results than earlier ones. While the number placed on the animals was purely a matter of judgment, it is probable that the numbers applied from day to day did not vary so much as did the vigor with which the ticks attached themselves to the cattle. After the seed ticks were applied no changes could be made and results alone proved the numbers that remained on the cattle.

The seed ticks were applied by permitting them to crawl on to the cow's hair in various places from the edge of pint fruit jars used in hatching them. Sufficient time was allowed after hatching to permit the seed ticks to harden and become brown. They had been confined in the jars by cotton cloth. This cloth was used later to wipe up the ticks and scatter them over the cattle. In the first period of the experiment the ticks were mainly placed on the backs, bellies, and escutcheons of the cows, but in the second period they were placed more generally over the entire body.

Some of the tick masses became too moist during oviposition and incubation in the wet season, and this caused the masses to adhere and resulted in the death of the larvæ, especially when too many of the adult ticks were put together. Previously many egg masses had been kept too dry, presumably on account of atmospheric conditions and the small number of adults placed in a jar. Later on better conditions were secured by collecting the ticks in paper bags in lots of 200 or 300 and transferring them to the cloth-covered jars when they were nearly hatched.

These methods caused the numbers of seed ticks occurring on the cattle to be purely guesswork. Failure resulted in spite of special efforts to infest those cattle that presented the fewest adult ticks. Such were nearly immune to ticks.

RESULTS OF EXPERIMENTS.

The damage done to the infested cows by the ticks seems to have arisen from two distinct causes; first, a fever incited in some of the cattle at various periods, and, second, loss of blood abstracted by the growing tick.

FEVER CAUSED BY THE TICKS.

The presence of fever on various dates is shown in Table 2, where temperatures of both tick-infested and tick-free cows are shown. No attempt was made to take daily temperatures, as the matter of taking any temperatures at all was an afterthought rather than part of the plan. One set of temperatures was taken at 9 a. m.; all others at 4 p. m. The temperatures of the tick-infested cattle were higher than the checks and nearly always above normal. The temperatures of the tick-free cattle were also often above normal. This may have been due to moist, hot conditions of the atmosphere, since only in exceptional cases were the temperatures abnormal on cool days.

TABLE 2.—*Temperature records of the experimental cows at various periods and average of all readings.*

Cow No.	Degree of tick infestation.	July 27, p. m.	Aug. 2, p. m.	Aug. 6, p. m.	Aug. 14, p. m.	Aug. 19, p. m.	Aug. 27.		Sept. 1, p. m.
							A. M.	P. M.	
1	Free	102.2	102.2	101.8	103.2	101.8	101.8	101.6	102.6
2	do	102.2	102.8	101.8	103.6	101.8	101.8	102.3	104.0
3	do	103.2	102.4	103.6	105.6	102.8	102.6	102.2	104.4
5	do	102.0	102.4	103.0	103.8	101.8	101.8	101.6	103.0
6	do	103.2	102.2	102.4	104.8	102.5	101.6	102.2	105.4
7	do	102.8	102.2	103.4	105.9	103.2	102.2	101.2	105.2
8	do	102.6	103.0	103.2	104.4	102.2	101.2	102.2	104.6
9	do	104.4	103.2	102.4	104.7	103.0	101.8	102.6	105.0
10	do	101.1	103.0	102.6	104.5	102.8	101.2	101.6	103.0
11	Light	103.2	102.8	101.8	103.8	103.2	101.8	102.4	103.6
14	do	102.8	102.4	101.8	103.0	102.2	101.6	102.8	102.8
18	do	104.0	102.2	102.4	104.4	103.4	102.4	103.2	104.2
19	do	103.6	103.0	102.0	104.4	103.0	102.0	102.2	103.8
16	Medium	103.6	103.8	102.4	105.0	103.8	102.2	103.0	104.8
17	do	102.8	103.0	102.8	103.8	103.6	103.2	105.0	104.2
12	Heavy	104.0	104.0	102.4	104.4	104.0	102.2	103.0	104.2
13	do	106.8	104.6	103.6	106.8	106.2	104.4	102.8	106.2
15	do	104.0	103.0	103.2	104.2	103.6	102.2	102.6	105.2
20	do	103.8	103.4	102.2	104.2	103.6	102.2	102.8	103.8

Cow No.	Degree of tick infestation.	Sept. 2, p. m.	Sept. 3, p. m.	Sept. 4, p. m.	Sept. 5, p. m.	Oct. 1, p. m.	Oct. 2, p. m.	Oct. 3, p. m.	Average.
1	Free	102.4	102.0	102.2	101.8	100.2	104.2	102.4	102.16
2	do	103.5	103.4	102.0	100.6	102.2	103.2	102.8	102.53
3	do	104.2	105.2	104.2	101.0	103.0	104.8	103.6	103.52
5	do	103.0	103.8	102.6	102.4	104.0	104.0	104.0	102.88
6	do	104.6	104.5	103.6	101.0	103.2	104.2	103.4	103.25
7	do	104.8	105.8	103.2	101.4	102.6	103.0	103.4	103.35
8	do	103.6	102.8	103.4	101.0	104.4	104.0	103.6	103.08
9	do	104.6	104.2	101.8	102.2	103.2	105.2	104.6	103.52
10	do	103.4	102.6	102.6	102.0	103.2	103.6	102.6	102.65
11	Light	103.6	103.8	104.0	102.2	103.2	103.4	102.2	103.00
14	do	102.2	102.4	102.8	102.2	102.2	102.2	102.2	102.37
18	do	102.8	102.8	104.2	102.2	103.8	103.2	103.4	103.24
19	do	105.4	104.4	104.6	102.6	104.4	104.0	102.7	103.47
16	Medium	105.2	104.6	105.6	102.8	104.8	103.8	103.6	103.93
17	do	104.2	104.6	104.6	102.8	104.6	103.8	103.2	103.74
12	Heavy	104.2	104.0	104.0	102.6	104.4	104.2	102.4	103.60
13	do	106.0	105.8	104.0	103.4	105.0	105.2	103.6	104.96
15	do	104.2	104.5	104.4	102.8	106.2	105.8	105.2	104.07
20	do	103.8	104.2	104.2	103.2	105.4	104.4	103.2	103.65

Blood taken from cows 12 and 13 and observed to run from the tick wounds of cows 15, 17, and 20 in particular was abnormal in being too thin. The red blood clots formed but a small part of the mass. All these animals, also cow 16, were noticed to be visibly distressed as to feelings and respiration on various occasions. Cow 15 alone showed a slight pendulous swelling under the lower jaw. Cows 11, 14, 18, and 19 were infested with but few large ticks and not many visible small ones. Neither were they apparently ill at any time. To what quality these cattle owed their immunity from ticks is not known. They looked more like Jersey cattle than the other ones infested. In color cow 14 was lemon fawn and cow 19 was light fawn, and the latter's coat was very short and thin. Cow 15, the cow that became most heavily infested, was a large red brindle cow that resembled the Shorthorn or beef type. (Fig. 1.) This

cow seemed to resist the effects of the ticks until toward the end of the experiment, but finally failed rapidly in giving milk and died within a week after the close of the experiment.

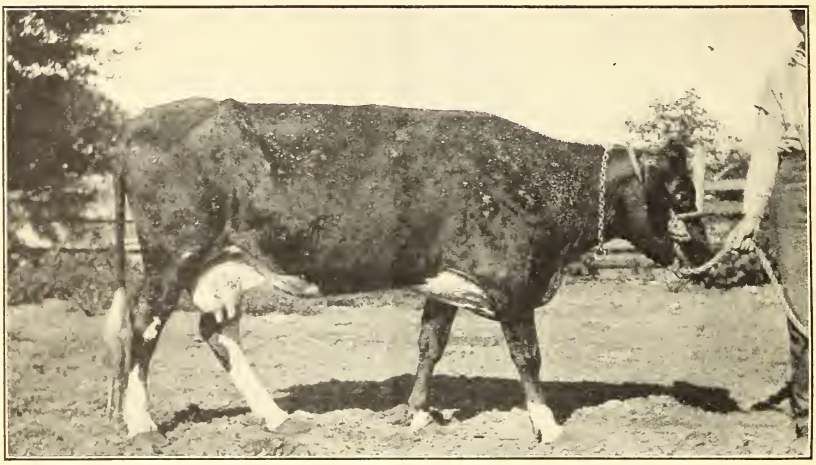

FIG. 1.—Cow No. 15, heavily infested with ticks over the entire body. This was one of the best cows in the group, but she died of tick fever shortly after the close of the experiment. Photo taken Sept. 25, 1913.

Cow 20 was infested almost as heavily as cow 15. She was a large Jersey-like cow of lemon-yellow color. (Fig. 2.) Her milk failed quite early in the experiment. She presented a dejected appearance

FIG. 2.—Cow No. 20, heavily infested on neck and shoulders. Photo taken Sept. 24, 1913.

for some time but later recuperated and gained or held her weight to the end. Externally there seemed to be no reason why ticks developed so much more on her than on cow 14.

Cow 12, a mongrel Jersey with black predominating and white under parts, was the next most infested. (Fig. 3.) She became ill but acquired the habit of licking herself as clean of ticks as she could and of being assisted by other cows. She seemed to recover from her fever and improved somewhat in condition.

Cows 13, 16, and 17 were infested about alike, but Nos. 13 and 17 suffered more from fever than No. 16. There seemed to be no particular difference in the coats of Nos. 13 and 16 sufficient to explain why No. 16 should be less infested. They were red cows of mixed origin and doubtful ancestry. Cow 17 (fig. 4) was a very dark cow with white under parts, having a rather fine Jersey-like head. The sickness reduced her milk flow much more than was the case with No. 13. As a whole, the light fawn-colored cows seemed to resist ticks better than the dark-colored ones.

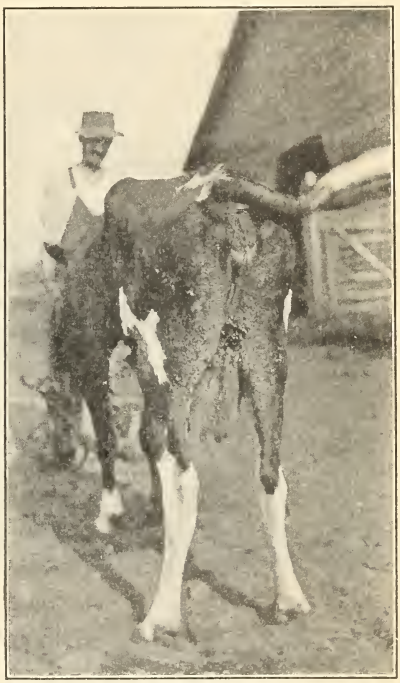

FIG. 3.—Cow No. 12, heavily infested on rear parts. Photo taken July 19, 1913.

The sickness in the cattle was not entirely due to the number of ticks, for cows that had fewer ticks by far than cow 15 were sick much earlier. It has previously been stated that one of the sources of ticks was the Anthony farm. This farm sustains a large dairy, and frequently the herd is replenished with fresh milkers brought from Georgia and the surrounding country. According to the superintendent, many go through acclimatization or Texas fever. It is quite probable that ticks from some of the acclimatized animals furnished the first protozoa (piroplasma) to produce disease in the experimental animals; it may be that afterwards ticks from sick cows in the experiment transferred the disease to other cows. While all these cattle were used to ticks, it is quite evident that they were not thoroughly immune to fresh attacks of disease, whether due to blood-letting or piroplasma parasitism. That immunity is a variable quantity is accepted by many southern cattlemen who have studied and had experience with traded cattle.

The 10 check cattle remained free from ticks through keeping them in a separate pen and stalls; otherwise they were under similar conditions as the infested cattle. Although they were separated from the

tick-infested group in the stable by the mangers only, and later turned out into a small field on account of the muddy condition of the barn lot, there was insufficient manifestation of small ticks to show pen and yard infestation. However, it was thought necessary to spray these cattle on occasions because of a few scattered ticks which were presumably carried to them on the rag with which the udders were washed. Spraying was followed for a day or two by a diminished quantity of milk, after which the normal flow reestablished itself. The spray used was arsenical tick dip B, a concentrated solution which when used in prescribed dilution produced a subsequent slight exfoliation of the epidermis.

The deleterious effects of the ticks were not so apparent in the experiment as they would have been had more ticks been developed

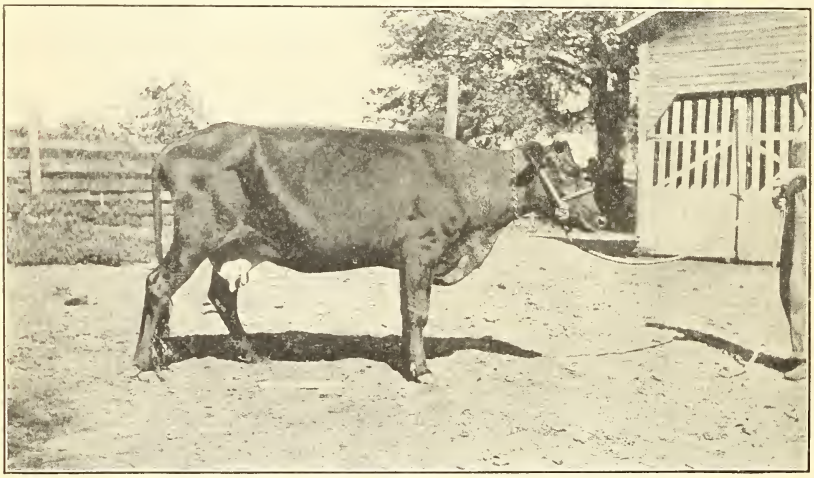

FIG. 4.—Cow No. 17, showing moderate infestation with ticks.

early in the experiment. In that case early losses would have been reflected throughout. It is probable that excessive invasions of ticks on freshening cows in spring reduces their milk flow by fully one-half before the lactation period is ended.

An attempt was made to put on about the same number of seed ticks at each application, so that the number applied from day to day was probably fairly uniform. Seed ticks secured from adult ticks from outside sources seemed to be less vigorous and to have more difficulty in attaching themselves to the cows than those more recently obtained from ticks that had matured on the Anthony cattle, so that fewer of them matured and consequently less damage resulted than when the Anthony ticks were used. This apparently low vitality of the seed ticks obtained from outside sources, together with the light infestation obtained at the early part of the work, delayed any

definite results until toward the latter part of the experimental period.

The cows used were so-called immune, yet all the tick-infested group except the four lightly infested ones suffered from attacks of fever at different times during the experimental period. This was not due entirely to the number of ticks maturing upon these animals, for cow 15, which showed the heaviest infestation throughout the entire period, was one of the last to suffer from an attack of fever.

EFFECT OF TICKS ON MILK PRODUCTION AND BODY WEIGHT.

Although each of the cows used in this work had been tick infested at some time, the individual variation in the degree of infestation that could be obtained was so wide that two subgroups were made of four animals each, one of which will be called the lightly infested and the other the heavily infested group. These subgroups show the effect of varying degrees of infestation upon the body weights and milk production of the cows in a manner more marked than when the two entire groups are compared. In the discussion which follows only the summaries of groups are given. Complete data for each cow will be found in the appendix. The average results are shown in Table 3 following, and graphically in the chart, figure 5.

TABLE 3.—*Effect of tick infestation on milk production and body weight of cows.*

Group.	Number of cows.	Milk production.			Body weight.			Feed.	
		Average for first 10-day period.	Average for last 10-day period.	Average decrease.	Average for first 10-day period.	Average for last 10-day period.	Average gain (+) or loss (−).	Average consumption per cow for entire period.	
								Hay.	Grain.
		Pounds.	*Pounds.*	*Per ct.*	*Pounds.*	*Pounds.*	*Per ct.*	*Pounds.*	*Pounds.*
Tick free	Nos. 1 to 10	176.2	92.1	47.7	719.2	763.4	+6.1	2,500	638
Tick infested	Nos. 11 to 20	177.9	60.6	65.9	707.2	732.9	+3.6	2,437	658
Lightly infested	Nos. 11, 14, 18, 19.	157.5	68.6	56.4	694.4	736.0	+6.0	2,385	585
Moderately infested	Nos. 16, 17	149.4	56.8	61.9	746.1	809.4	+8.5	2,563	569
Heavily infested	Nos. 12, 13, 15, 20.	212.6	54.5	74.3	700.7	691.4	−1.3	2,424	786

COMPARISON OF TICK-FREE AND TICK-INFESTED COWS (ENTIRE GROUPS).

At the beginning of the experimental period the two groups produced practically the same amount of milk—the cows of the tick-free group producing an average of 176.2 pounds during the first 10-day period and those of the tick-infested group an average of 177.9 pounds. During the final 10-day period the cows of the tick-free group produced an average of 92.1 pounds of milk, a decrease of 47.7 per cent from their production during the initial period, while the

cows of the tick-infested group produced an average of 60.6 pounds per cow, a decrease of 65.9 per cent when compared with their first 10-day period. It should be noted especially that while the tick-infested cows produced 1 per cent more milk than the tick-free cows in the beginning, they produced only 65.8 per cent as much during the final period. The two groups consumed practically the same

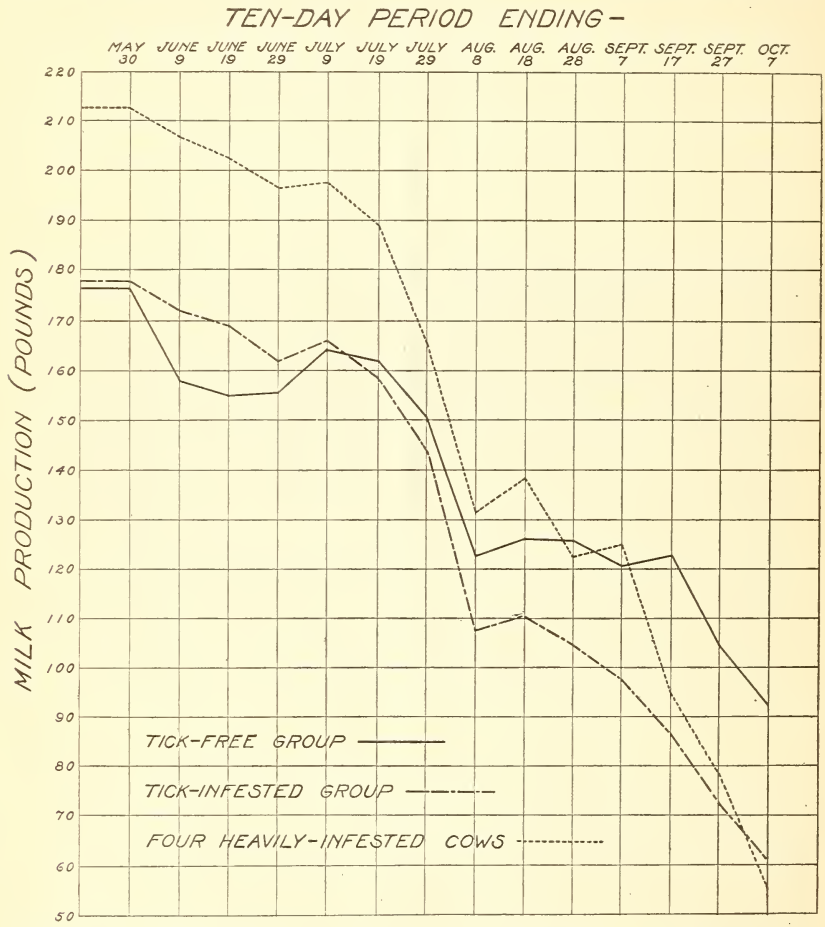

FIG. 5.—Average milk production by 10-day periods of the tick-free and tick-infested groups and of four heavily infested cows.

amount of feed during the entire period. The percentage of fat in the milk of each group increased toward the close of the experiment, that of the infested group showing a slightly greater increase.

At the beginning of the test the tick-free cows weighed on the average 719.2 pounds and the tick-infested 707.2 pounds. During the experimental period each group increased in body weight, but the increase of the tick-free group was greater than that of the tick-

infested. During the final 10-day period the cows of the tick-free group averaged 763.4 pounds in weight, an increase of 6.1 per cent, and those of the tick-infested 732.9 pounds, an increase of 3.6 per cent from the initial weight.

In making this comparison it should be remembered that during the entire experimental period the two groups consumed practically an equal amount of nutrients, and that toward the latter part of the experimental period the milk production of the tick-infested group was considerably decreased, so that this group was fed an amount in excess of that required for milk production. Presumably this excess of food would tend to make flesh and thus offset any detrimental effect that the ticks would have upon the body weights.

COMPARISON OF TICK-FREE AND HEAVILY INFESTED GROUPS.

Four cows in the tick-infested group were soon found to be more easily infested than the remaining six. A gross infestation of these four cows was obtained early in the experimental period and was maintained throughout the test. At different times all four suffered from attacks of fever, with an almost total loss of appetite and a falling off in milk flow. One, which suffered from an attack of fever at the end of the experimental period, died shortly after the close of the work.

By referring to Table 3 it will be noticed that there is a much more pronounced decrease in milk production between this group and the tick-free group than when the two entire groups are compared, showing that the heavier degree of infestation results in a proportionately increased injury. This is likewise proved to be true when the body weights of the two groups are compared.

COMPARISON OF TICK-FREE AND LIGHTLY INFESTED GROUPS.

While four cows of the tick-infested group proved to be easily infested, another four of the same group proved to be very resistant. The immature ticks were applied to these four cows with the same care and in as large numbers as they were to the heavily infested animals; in fact, extra efforts were made to obtain a heavy infestation upon these resistant animals. However, at no time during the experimental period were any of the four so heavily infested that the degree of infestation could be classed as gross, and for the greater part of the period none of them was carrying mature ticks. The decrease in milk production was more than in the tick-free cows, but considerably less than in the heavily infested animals.

COMPARISON OF LIGHTLY INFESTED AND HEAVILY INFESTED GROUPS.

While the heavily infested cows produced more milk during the initial period and through the greater part of the experiment, they also consumed more feed than those of the lightly infested group

(see Table 3). At the beginning of the experimental period the four heavily infested cows produced an average of 212.6 pounds of milk, while the four lightly infested cows produced an average of 157.5 pounds during the same 10-day period. During the final 10-day period the heavily infested cows produced an average of but 54.5 pounds of milk, a decrease of 74.3 per cent from their production during the initial period. During the same period the lightly infested cows produced an average of 68.6 pounds of milk, a decrease of 56.4 per cent from their production during the first period. While the heavily infested cows produced 35 per cent more milk than the lightly infested during the initial period, they produced only 79.4 per cent as much during the final period. When the two groups are compared with the tick-free groups, it is seen that the lightly infested group produced during the final period of the experiment 81.4 per cent as much milk as the tick-free, while the heavily infested group produced but 57.6 per cent as much. A comparison of the body weights of the two groups shows the heavily infested with an average weight per cow of 700.7 pounds during the initial 10-day period, which decreased to 691.4 pounds per cow, or 1.3 per cent, while the lightly infested cows, with an average weight of 694.4 pounds, increased to 736 pounds per cow, or 6 per cent.

No figures are given on cost of milk production, as the aim was merely to measure the effect of tick infestation on yield of milk and body weight. As the cows were kept in comparatively small inclosures, the cost of milk production was higher than under ordinary conditions when cows are on pasture.

EFFECT OF SPRAYING OR DIPPING IN AN ARSENICAL SOLUTION UPON THE YIELD OF MILK.

At four different times during the experimental period the cows of the tick-free group were sprayed with tick dip B, an arsenical solution. This was done to keep the tick-free cows absolutely free from ticks. Each spraying caused a temporary reduction in the milk yield, as shown by the curves in figure 6. The average yield for the first day after each spraying, when compared with the average of three days preceding spraying, showed percentage reductions in each case as follows: 8.7, 27, 8.3, and 5.7 per cent. It will be noted that the reduction was much the highest for the second spraying. On the day prior to this spraying and for two days thereafter timothy hay was fed, owing to a shortage of alfalfa. This, no doubt, had its influence on the milk yield, as indicated in the excessive shrinkage at that time. From three to five days were required for the cows to return to their normal production. The average of five days after each spraying compared with the average of three days preceding

spraying showed reductions, respectively, of 6.2, 21.7, 4.5, and 7.6 per cent. Disregarding the second spraying, the average reduction for five days was 6.1 per cent.

These results with spraying are similar to those obtained with dipping during the 165-day test conducted by J. H. McClain, of the Dairy Division, Bureau of Animal Industry, at Summerville, S. C., in 1912. In this experiment 10 cows were dipped seven times with a solution of tick dip B, the dippings coming at intervals of about 21 days, with an average decline in milk production, for two days, of 10.6 per cent after each of the seven dippings. But apparently the cows became accustomed to the dipping process, for there was no appreciable decrease in the milk flow after the first four dippings except the natural decrease due to the advance in the lactation period. The average decline in production was approximately as follows: After each of the first four dippings, milk 14.8 per cent; fat 8.9 per cent; after each of the last three dippings, milk 1.9 per cent, but an increase of 10.6 per cent in yield of fat.

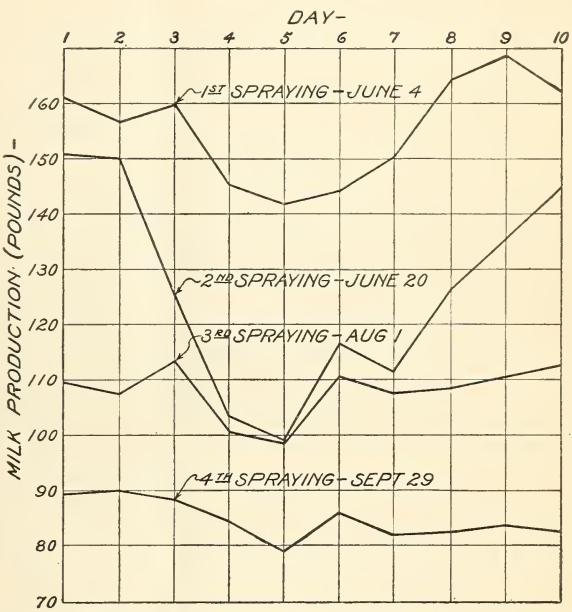

FIG. 6.—Effect of spraying on milk production, showing the average amount of milk produced by the tick-free group for three days before and seven days after each of four sprayings. The unusual decline at the second spraying was probably due to a change in feed.

That the heavily infested cattle in our experiments yielded fully 40 per cent less milk than the check animals at the close of the experiments, and that even those lightly infested gave less by 25 per cent, has been heretofore recorded. Conversely, we may infer that the check cows in this experiment and those regularly dipped in the Summerville experiment gave this additional quantity of milk on account of being kept free from ticks. Had this freedom been obtained without the use of arsenical dips, it is quite certain that an amount of milk equal to 10.6 per cent during one-tenth of the time in the Summerville experiment, and to 6.1 per cent during one-seventh of the time in our experiments, would also have been saved

from loss on account of the ticks. These differences emphasize the good results of the use of arsenical dips, and above all, of the necessity for the complete eradication of ticks so that the remedy, which of itself temporarily reduces the flow of milk, will be unnecessary.

SUMMARY AND CONCLUSIONS.

The cattle tick has a decidedly injurious effect upon supposedly immune dairy cattle, the extent of the injury being largely dependent upon the degree of infestation. The effect is more pronounced upon the milk production than upon the body weights when a sufficient supply of food is given.

At the beginning of the test the tick-free and tick-infested groups gave practically the same amounts of milk; at the close the tick-infested gave only 65.8 per cent as much as the tick-free.

The tick-free group gained 6.1 per cent in body weight; the tick-infested gained 3.6 per cent.

Spraying or dipping tick-free cattle in an arsenical solution causes a marked though temporary decrease in milk flow. In this experiment there was an average reduction of 6.1 per cent from the normal milk flow for a period of five days following each of the four applications of the arsenical solution.

Resistance of cattle to infestation by the tick is a variable quality. Of the 10 animals in the tick-infested group, 4 became grossly infested; 2 more so than the average, and the remaining 4 but lightly infested.

The death of cow 15, due to excessive tick infestation, and various recurrences of fever in the other animals, emphasizes the extreme hazard of cattle being continuously subjected to these losses by the tick. Cow 15 was one of the best of the tick-infested group and represented at least a 10 per cent loss from the capital invested in tick-infested cows. Furthermore, the losses observed in this experiment were sustained on rations sufficient to maintain body weights. It is thought that had there been but a scant supply of food, as sometimes occurs when cows are on pasture, the tick-infested cattle would have suffered earlier and probably to a greater degree than they did. The losses in this case were in spite of a good maintenance ration. It is probable that much of the spring losses in cattle now laid to starvation, due to lack of pasturage, is materially aided by blood depletion due to ticks, and that repeated dippings would save many cattle otherwise lost.

These experiments are not extensive enough to furnish an exact measure of the amount of decrease in milk flow due to infestation, but they show that the losses are considerable and vary in immune cows largely in proportion to the extent of infestation, since in all cases

the milk flow decreased faster in the heavily infested than in the lightly infested cows. This is additional evidence that the tick is a great hindrance to profitable dairying in the South. Even in so-called immune cattle, ticks cause irritation of the skin and withdraw blood that otherwise would produce milk or meat.

Fever-producing parasites are present in the blood of cattle once infested by ticks, though they may be so few in number that no symptoms of the disease are apparent. The danger from them lurks there, nevertheless, for under certain conditions the parasites may multiply so rapidly as to cause marked disease or death, or they may be transferred by ticks to uninfected animals. Thus the tick constitutes a source of danger, and should be exterminated. Furthermore, eradication must be by cooperative, concerted action. One farmer may free his premises of ticks, but reinfestation is liable to occur at any time from neighboring farms or strange cattle, unless the entire community is free from the tick.

The only means of preventing losses by ticks is through disinfection and clean pastures. While dipping may temporarily diminish the quantity of milk given, in the long run it largely conserves the flow of milk. The arsenical solution should be used to frustrate the great dissemination of ticks during their most favorable season. In infected areas where there is no concerted effort to eradicate ticks it may not be wise to use the solution on slightly infested milch cows.

Methods of exterminating the ticks on the farm are described in Farmers' Bulletin 498, a copy of which will be mailed to anyone on application.

APPENDIX.

RECORDS OF THE EXPERIMENTAL COWS.

The following tables show the records of the experimental cows for the whole test by 10-day periods. Table I gives the results by groups, and Table II the individual records of each of the cows. Originally there were 20 cows in the experiment, 10 in each group, but, as before stated, an injury to one of the tick-free cows necessitated her removal from the test. Therefore, in Table I the tick-free group consists of 9 cows, and in Table II no data are given for cow 4, the cow in question.

TABLE I.—*Group records of experimental cows by 10-day periods.*

TICK-FREE COWS.

Ten-day period ended—	Milk production.			Body weight.	Amount of feed consumed per cow.		Ten-day period ended—	Milk production.			Body weight.	Amount of feed consumed per cow.	
	Average amount of milk.	Average amount of milk fat.	Percentage of milk fat.		Hay.	Grain.		Average amount of milk.	Average amount of milk fat.	Percentage of milk fat.		Hay.	Grain.
1913.	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Lbs.*	1913.	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Lbs.*
May 30.....	176.2	6.58	3.73	719.2	168.9	48.8	Aug. 28.....	125.5	5.37	4.28	727.6	185.3	45.6
June 9.....	157.3	5.87	3.73	724.4	173.9	44.0	Sept. 7.....	120.6	5.00	4.13	738.9	179.4	45.6
June 19.....	154.4	5.62	3.64	723.4	172.7	46.7	Sept. 17.....	122.9	5.24	4.26	748.6	172.7	44.5
June 29.....	155.2	5.84	3.76	694.7	172.3	45.6	Sept. 27.....	104.2	4.64	4.45	756.8	169.9	44.5
July 9.....	164.0	6.04	3.69	703.1	189.2	45.6	Oct. 17.....	92.1	4.42	4.79	763.4	170.8	44.5
July 19.....	161.7	5.96	3.69	703.1	190.3	45.6							
July 29.....	150.3	5.98	3.97	706.9	196.1	45.6	Total per cow....	1,932.4	76.30	.....	.....	2,500.4	637.8
Aug. 8.....	122.3	4.56	3.72	789.3	182.1	45.6							
Aug. 18.....	125.7	5.18	4.12	718.0	176.8	45.6							

TICK-INFESTED COWS.

May 30.....	177.9	6.38	3.58	707.2	163.9	47.7	Aug. 28.....	104.5	4.15	3.87	715.6	184.5	47.0
June 9.....	171.6	5.85	3.41	712.8	169.7	44.3	Sept. 7.....	97.8	3.65	3.73	707.7	170.6	47.0
June 19.....	168.7	5.93	3.51	726.7	174.8	50.1	Sept. 17.....	86.9	3.68	4.23	717.0	159.3	45.0
June 29.....	161.1	5.61	3.48	691.6	174.2	47.0	Sept. 27.....	72.5	3.43	4.72	721.2	161.6	49.5
July 9.....	165.9	5.86	3.54	705.6	193.8	47.0	Oct. 7.....	60.6	2.86	4.71	732.9	145.4	44.6
July 19.....	158.1	5.55	3.51	702.7	191.1	47.0							
July 29.....	143.6	5.12	3.56	706.1	190.5	47.7	Total per cow....	1,783.3	66.00	.....	.....	2,436.8	657.9
Aug. 8.....	107.6	3.73	3.46	782.3	176.7	47.0							
Aug. 18.....	110.5	4.20	3.80	728.0	180.7	47.0							

TABLE II.—*Individual records of experimental cows by 10-day periods.*

COW 1, TICK-FREE.

Ten-day period ended—	Milk production.			Body weight.	Feed consumed.		Ten-day period ended—	Milk production.			Body weight.	Feed consumed.	
	Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.		Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.
1913.	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Lbs.*	1913.	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Lbs.*
May 30	178.3	7.67	4.30	863.4	172.5	50.0	Aug. 18	106.9	4.65	4.35	870.0	189.5	50.0
June 9	154.8	6.50	4.20	822.0	179.5	45.0	Aug. 28	112.7	4.73	4.20	877.0	200.0	50.0
June 19	150.8	6.33	4.20	822.0	180.0	50.0	Sept. 7	106.6	4.69	4.40	888.0	199.5	50.0
June 29	144.0	5.98	4.15	805.0	180.0	50.0	Sept. 17	106.4	5.00	4.70	902.5	200.0	50.0
July 9	165.5	6.45	3.90	827.0	200.0	50.0	Sept. 27	85.6	4.54	5.30	916.0	198.5	50.0
July 19	159.4	6.06	3.80	813.0	200.0	50.0	Oct. 7	63.2	3.73	5.90	919.7	196.0	50.0
July 29	149.1	6.81	3.90	833.0	220.0	50.0							
Aug. 8	103.3	4.13	4.00	939.0	208.0	50.0	Total	1,786.6	77.27			2,723.5	695.0

COW 2, TICK-FREE.

May 30	146.5	5.27	3.60	664.4	157.5	43.2	Aug. 18	102.0	4.34	4.25	670.0	173.0	40.0
June 9	115.6	4.62	4.00	678.0	159.5	37.0	Aug. 28	99.3	4.37	4.40	671.0	171.5	40.0
June 19	140.1	5.39	3.85	694.0	158.5	40.0	Sept. 7	97.6	4.11	4.20	688.0	165.0	40.0
June 29	130.7	5.23	4.00	656.0	177.5	40.0	Sept. 17	109.1	5.02	4.60	702.3	171.5	40.0
July 9	143.9	5.61	3.90	664.0	178.5	40.0	Sept. 27	91.9	4.14	4.50	718.6	176.0	40.0
July 19	138.6	5.41	3.90	658.0	178.0	40.0	Oct. 7	81.6	4.37	5.35	728.2	174.0	40.0
July 29	132.5	5.17	3.90	657.0	178.5	40.0							
Aug. 8	88.6	3.54	4.00	734.0	162.5	40.0	Total	1,617.9	66.59			2,381.5	560.2

COW 3, TICK-FREE.

May 30	157.2	6.45	4.10	707.5	170.0	50.0	Aug. 18	140.5	5.62	4.00	673.0	180.5	40.0
June 9	149.5	5.38	3.60	682.0	177.5	40.0	Aug. 28	146.2	5.85	4.00	704.0	197.5	40.0
June 19	157.9	5.68	3.60	681.0	177.5	40.0	Sept. 7	139.3	5.36	3.85	702.0	173.5	40.0
June 29	155.2	5.74	3.70	657.0	173.0	40.0	Sept. 17	139.0	5.70	4.10	708.2	159.5	40.0
July 9	160.6	5.94	3.70	677.0	197.5	40.0	Sept. 27	115.6	4.68	4.05	707.9	133.0	40.0
July 19	162.6	5.85	3.60	676.0	200.0	40.0	Oct. 7	111.4	5.24	4.70	695.5	149.0	40.0
July 29	153.8	5.54	3.60	693.0	199.5	40.0							
Aug. 8	131.0	4.72	3.60	745.0	183.5	40.0	Total	2,019.8	77.75			2,471.5	570.0

COW 5, TICK-FREE.

May 30	221.8	7.98	3.60	746.4	171.5	60.0	Aug. 18	118.2	4.92	4.15	758.0	155.0	40.0
June 9	203.4	7.32	3.60	754.0	173.5	53.0	Aug. 28	105.2	4.73	4.50	783.0	154.0	40.0
June 19	192.5	6.74	3.50	762.0	167.5	50.0	Sept. 7	98.5	4.43	4.50	805.0	158.5	40.0
June 29	179.2	6.63	3.70	752.0	155.0	40.0	Sept. 17	95.4	4.29	4.50	810.4	149.5	40.0
July 9	170.4	5.79	3.40	740.0	158.0	40.0	Sept. 27	69.8	3.49	5.00	817.2	153.5	40.0
July 19	156.2	5.62	3.60	723.0	158.5	40.0	Oct. 7	49.2	2.66	5.40	806.8	144.0	40.0
July 29	137.2	4.94	3.60	736.0	158.0	40.0							
Aug. 8	113.9	4.21	3.70	841.0	133.0	40.0	Total	1,910.9	73.75			2,189.5	603.0

COW 6, TICK-FREE.

May 30	268.6	9.13	3.40	729.2	172.5	68.0	Aug. 18	176.0	7.04	4.00	742.0	185.0	70.0
June 9	261.5	8.37	3.20	723.0	179.5	67.0	Aug. 28	189.0	7.56	4.00	733.0	199.5	70.0
June 19	247.7	8.05	3.25	739.0	177.5	70.0	Sept. 7	179.3	7.35	4.10	734.0	190.0	70.0
June 29	233.0	7.46	3.20	719.0	173.5	70.0	Sept. 17	179.9	6.84	3.80	743.0	177.5	60.0
July 9	242.8	8.26	3.40	717.0	199.5	70.0	Sept. 27	150.6	6.02	4.00	754.2	175.5	60.0
July 19	238.7	8.35	3.50	736.0	200.0	70.0	Oct. 7	135.5	5.83	4.30	772.1	175.5	60.0
July 29	218.3	8.51	3.90	729.0	198.5	70.0							
Aug. 8	183.6	6.43	3.50	810.0	180.5	70.0	Total	2,904.5	105.20			2,584.5	945.0

TABLE II.—*Individual records of experimental cows by 10-day periods*—Continued.

COW 7, TICK-FREE.

Ten-day period ended—	Milk production.			Body weight.	Feed consumed.		Ten-day period ended—	Milk production.			Body weight.	Feed consumed.	
	Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.		Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.
1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*	1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*
May 30	138.7	5.13	3.70	660.9	171.0	40.0	Aug. 18	121.4	5.04	4.15	659.0	186.0	40.0
June 9	127.4	5.67	4.45	738.0	176.5	35.0	Aug. 28	121.6	5.84	4.80	647.0	198.0	40.0
June 19	128.2	4.87	3.80	652.0	179.5	40.0	Sept. 7	115.7	4.98	4.30	651.0	198.5	40.0
June 29	133.0	5.19	3.90	642.0	179.5	40.0	Sept. 17	121.5	5.29	4.35	661.5	181.5	40.0
July 9	147.5	5.97	4.05	644.0	198.0	40.0	Sept. 27	108.9	4.90	4.50	678.9	178.5	40.0
July 19	146.8	5.87	4.00	633.0	197.0	40.0	Oct. 7	105.1	5.04	4.80	685.9	180.0	40.0
July 29	138.8	5.69	4.10	646.0	210.0	40.0							
Aug. 8	120.6	4.82	4.00	704.0	187.5	40.0	Total	1,775.2	74.30			2,621.5	555.0

COW 8, TICK-FREE.

May 30	174.1	6.27	3.60	839.9	175.0	48.0	Aug. 18	137.7	4.99	4.35	818.0	192.5	50.0
June 9	153.4	5.83	3.80	840.0	180.0	44.0	Aug. 28	134.1	6.30	4.70	864.0	200.0	50.0
June 19	151.3	5.67	3.75	842.0	179.5	50.0	Sept. 7	121.2	5.33	4.40	872.0	200.0	50.0
June 29	154.0	6.01	3.90	785.0	180.0	50.0	Sept. 17	118.0	5.78	4.90	882.5	197.0	50.0
July 9	160.2	6.09	3.80	807.0	200.0	50.0	Sept. 27	105.5	5.28	5.00	893.2	200.0	50.0
July 19	157.7	5.99	3.80	813.0	200.0	50.0	Oct. 7	90.8	4.77	5.25	922.6	200.0	50.0
July 29	155.1	6.36	4.10	816.0	220.0	50.0							
Aug. 8	123.4	5.06	4.10	914.0	216.5	50.0	Total	1,936.5	79.73			2,740.5	692.0

COW 9, TICK-FREE.

May 30	133.7	5.21	3.90	500.5	157.5	31.6	Aug. 18	132.9	5.71	4.30	523.0	169.5	40.0
June 9	115.8	4.40	3.80	505.0	160.0	33.0	Aug. 28	125.6	5.02	4.00	541.0	168.0	40.0
June 19	118.1	4.25	3.60	540.0	160.0	40.0	Sept. 7	124.5	4.73	3.80	541.0	152.5	40.0
June 29	132.8	5.05	3.80	508.0	156.0	40.0	Sept. 17	126.2	5.17	4.10	544.5	139.0	40.0
July 9	144.1	5.55	3.85	502.0	172.0	40.0	Sept. 27	112.4	4.83	4.30	547.4	134.0	40.0
July 19	145.0	4.93	3.40	523.0	179.5	40.0	Oct. 7	103.2	4.44	4.30	552.7	139.0	40.0
July 29	140.4	5.34	3.80	519.0	180.0	40.0							
Aug. 8	119.6	3.95	3.30	596.0	162.0	40.0	Total	1,774.3	68.58			2,229.0	554.6

COW 10, TICK-FREE.

May 30	167.3	6.11	3.65	760.8	173.0	48.0	Aug. 18	95.5	4.30	4.50	749.0	160.0	40.0
June 9	134.3	4.78	3.55	778.0	179.5	42.0	Aug. 28	95.8	3.93	4.10	729.0	179.0	40.0
June 19	103.1	3.61	3.50	779.0	174.5	40.0	Sept. 7	102.4	4.05	3.95	769.0	177.0	40.0
June 29	135.2	5.27	3.90	727.0	176.0	40.0	Sept. 17	110.4	4.04	3.65	772.6	178.5	40.0
July 9	140.8	4.79	3.40	750.0	199.0	40.0	Sept. 27	97.3	3.89	4.00	778.9	180.0	40.0
July 19	149.9	5.55	3.70	753.0	200.0	40.0	Oct. 7	89.2	3.66	4.10	787.2	180.0	40.0
July 29	144.7	5.50	3.80	733.0	200.0	40.0							
Aug. 8	117.1	4.22	3.60	822.0	181.0	40.0	Total	1,683.0	63.70			2,537.5	570.0

COW 11, TICK-INFESTED.

May 30	208.2	8.74	4.20	813.9	175.5	54.8	Aug. 18	108.7	4.29	3.95	816.0	189.5	40.0
June 9	180.4	7.04	3.90	818.0	179.0	52.0	Aug. 28	109.0	5.01	4.60	829.0	200.0	40.0
June 19	169.3	6.77	4.00	842.0	180.0	52.0	Sept. 7	113.7	4.89	4.30	829.0	196.0	40.0
June 29	152.1	6.24	4.10	800.0	180.5	40.0	Sept. 17	109.1	5.02	4.60	836.1	198.5	40.0
July 9	172.5	6.90	4.00	818.0	200.0	40.0	Sept. 27	98.9	4.75	4.80	857.9	197.5	49.0
July 19	145.4	5.39	3.70	813.0	198.0	40.0	Oct. 7	103.2	4.95	4.80	862.4	198.5	50.0
July 29	141.9	5.53	3.90	807.0	200.0	40.5							
Aug. 8	101.0	3.64	3.60	909.0	183.0	40.0	Total	1,913.4	79.16			2,676.0	618.3

TABLE II.—*Individual records of experimental cows by 10-day periods*—Continued.

COW 12, TICK-INFESTED.

Ten-day period ended—	Milk production.			Body weight.	Feed consumed.		Ten-day period ended—	Milk production.			Body weight.	Feed consumed.	
	Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.		Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.
1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*	1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*
May 30.....	221.0	7.62	3.45	640.2	154.5	58.0	Aug. 18.....	135.5	5.01	3.70	620.0	172.0	60.0
June 9.....	213.6	6.73	3.15	643.0	171.5	55.0	Aug. 28.....	122.2	4.77	3.90	622.0	166.0	60.0
June 19.....	209.7	7.34	3.50	675.0	179.0	62.0	Sept. 7.....	130.1	4.55	3.50	622.0	161.0	60.0
June 29.....	200.3	6.01	3.00	648.0	181.5	60.0	Sept. 17.....	118.0	4.90	4.15	622.0	154.5	60.0
July 9.....	199.0	6.57	3.30	623.0	192.5	60.0	Sept. 27.....	112.4	5.17	4.60	626.7	164.5	60.0
July 19.....	192.9	6.75	3.50	623.0	191.0	60.0	Oct. 7.....	110.2	5.07	4.60	655.3	174.5	60.0
July 29.....	161.0	6.08	3.80	628.0	173.0	61.5							
Aug. 8.....	143.0	5.15	3.60	715.0	169.0	60.0	Total...	2,268.9	81.72	.....	.....	2,404.5	836.5

COW 13, TICK-INFESTED.

May 30.....	224.6	8.53	3.80	587.7	152.5	58.0	Aug. 18.....	153.5	6.14	4.00	591.0	189.0	60.0
June 9.....	224.9	8.55	3.80	576.0	156.0	56.0	Aug. 28.....	146.2	6.14	4.20	594.0	184.5	60.0
June 19.....	219.6	8.23	3.75	590.0	178.0	62.0	Sept. 7.....	134.5	5.65	4.20	564.0	158.5	60.0
June 29.....	213.9	7.91	3.70	567.0	179.0	60.0	Sept. 17.....	116.0	5.63	4.85	565.7	136.5	50.0
July 9.....	213.7	8.65	4.05	582.0	195.5	60.0	Sept. 27.....	110.6	5.64	5.10	566.5	139.5	50.0
July 19.....	211.2	8.03	3.80	578.0	200.0	60.0	Oct. 7.....	103.0	5.67	5.50	573.9	139.5	50.0
July 29.....	190.8	7.63	4.00	590.0	197.5	61.5							
Aug. 8.....	148.9	5.81	3.90	649.0	191.5	60.0	Total...	2,411.4	98.21	.....	.....	2,397.5	807.5

COW 14, TICK-INFESTED.

May 30.....	128.7	4.50	3.50	664.1	166.5	32.0	Aug. 18.....	95.0	3.74	3.95	665.0	178.0	40.0
June 9.....	125.2	4.07	3.25	655.0	168.0	32.0	Aug. 28.....	101.5	3.86	3.80	651.0	182.0	40.0
June 19.....	119.6	4.19	3.50	676.0	177.5	42.0	Sept. 7.....	102.6	3.28	3.20	669.0	173.0	40.0
June 29.....	116.7	4.08	3.50	648.0	160.0	40.0	Sept. 17.....	112.1	4.09	3.65	684.6	179.5	40.0
July 9.....	120.0	4.20	3.50	655.0	189.5	40.0	Sept. 27.....	99.1	4.16	4.20	696.0	176.5	49.0
July 19.....	120.5	4.10	3.40	665.0	180.0	40.0	Oct. 7.....	101.9	4.08	4.00	707.0	172.5	50.0
July 29.....	112.9	3.84	3.40	640.0	180.0	40.5							
Aug. 8.....	85.2	2.90	3.40	730.0	168.5	40.0	Total...	1,541.0	55.09	.....	.....	2,451.5	565.5

COW 15, TICK-INFESTED.

May 30.....	250.4	8.01	3.20	865.6	176.0	68.0	Aug. 18.....	163.9	5.41	3.30	853.0	188.5	70.0
June 9.....	247.5	7.18	2.90	863.0	180.0	62.0	Aug. 28.....	168.3	6.06	3.60	881.0	196.0	70.0
June 19.....	241.9	7.47	3.05	886.0	180.0	72.0	Sept. 7.....	151.1	4.53	3.00	818.0	183.5	70.0
June 29.....	235.9	7.55	3.20	816.0	181.5	70.0	Sept. 17.....	120.2	4.21	3.50	832.2	174.5	60.0
July 9.....	240.6	6.98	2.90	864.0	199.0	70.0	Sept. 27.....	79.7	3.75	4.70	825.9	156.0	60.0
July 19.....	235.1	7.52	3.20	868.0	200.0	70.0	Oct. 7.....	5.0	0.24	4.70	801.8	14.0	6.0
July 29.....	207.9	6.65	3.20	846.0	217.0	70.5							
Aug. 8.....	170.7	5.29	3.10	925.0	194.5	70.0	Total...	2,521.2	80.85	.....	.....	2,440.5	888.5

COW 16, TICK-INFESTED.

May 30.....	154.3	5.39	3.50	763.0	170.0	40.0	Aug. 18.....	107.7	4.20	3.90	783.0	188.5	40.0
June 9.....	162.8	5.70	3.50	757.0	176.5	38.0	Aug. 28.....	97.6	3.90	4.00	776.0	197.0	40.0
June 19.....	154.5	4.94	3.20	768.0	179.5	42.5	Sept. 7.....	89.3	3.75	4.20	749.0	182.5	40.0
June 29.....	145.9	4.96	3.40	741.0	182.0	40.0	Sept. 17.....	84.2	3.37	4.00	772.5	172.0	40.0
July 9.....	153.6	4.99	3.25	752.0	195.5	40.0	Sept. 27.....	74.1	3.45	4.65	788.0	177.0	40.0
July 19.....	156.8	4.70	3.00	735.0	200.0	40.0	Oct. 7.....	64.0	3.20	5.00	811.7	176.0	40.0
July 29.....	140.9	4.65	3.30	764.0	200.0	40.5							
Aug. 8.....	117.3	3.75	3.20	831.0	183.5	40.0	Total...	1,703.0	60.95	.....	.....	2,580.0	561.0

TABLE II.—*Individual records of experimental cows by 10-day periods*—Continued.

COW 17, TICK-INFESTED.

Ten-day period ended—	Milk production.			Body weight.	Feed consumed.		Ten-day period ended—	Milk production.			Body weight.	Feed consumed.	
	Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.		Amount of milk.	Amount of milk fat.	Percentage of milk fat.		Hay.	Grain.
1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*	1913.	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Lbs.*
May 30	144.4	5.05	3.50	729.2	176.0	40.0	Aug. 18	98.8	3.89	3.95	778.0	186.5	40.0
June 9	134.3	4.53	3.35	813.0	179.5	36.0	Aug. 28	78.8	2.99	3.80	763.0	184.0	40.0
June 19	142.1	5.04	3.55	762.0	178.5	42.5	Sept. 7	67.9	2.82	4.15	760.0	170.0	40.0
June 29	137.4	4.67	3.40	717.0	180.5	40.0	Sept. 17	71.4	3.21	4.50	764.8	169.5	40.0
July 9	144.2	5.48	3.80	744.0	200.0	40.0	Sept. 27	59.0	2.92	4.95	775.8	172.0	49.0
July 19	136.2	4.53	3.40	726.0	200.0	40.0	Oct. 7	49.5	2.40	4.85	807.2	170.0	50.0
July 29	126.1	4.16	3.30	746.0	199.0	40.5							
Aug. 8	92.1	3.13	3.40	833.0	181.0	40.0	Total	1,482.2	54.82			2,546.5	578.0

COW 18, TICK-INFESTED.

May 30	145.7	5.25	3.60	624.3	155.0	43.2	Aug. 18	79.6	2.99	3.75	657.0	173.0	40.0
June 6	152.5	5.49	3.60	623.0	149.5	36.0	Aug. 28	67.1	2.55	3.80	658.0	182.0	40.0
June 19	157.5	5.75	3.65	650.0	155.0	42.0	Sept. 7	50.7	1.93	3.80	663.0	159.5	40.0
June 29	151.1	5.59	3.70	618.0	157.5	40.0	Sept. 17	30.7	1.20	3.90	668.9	137.5	40.0
July 9	147.8	5.32	3.60	640.0	185.5	40.0	Sept. 27	5.0	0.18	3.65	680.9	144.5	49.0
July 19	137.8	5.24	3.80	640.0	180.0	40.0	Oct. 7	Dry.	Dry.	Dry.	692.9	137.5	50.0
July 29	128.4	4.88	3.80	653.0	178.5	40.5							
Aug. 8	75.0	2.78	3.70	715.0	159.0	40.0	Total	1,328.9	49.15			2,254.0	580.7

COW 19, TICK-INFESTED.

May 30	147.4	4.86	3.30	675.3	157.0	40.0	Aug. 18	101.3	3.85	3.80	763.0	160.5	40.0
June 9	134.8	4.31	3.20	649.0	157.5	37.0	Aug. 28	100.1	4.00	4.00	633.0	161.5	40.0
June 19	132.5	4.57	3.45	678.0	160.0	42.0	Sept. 7	93.5	3.74	4.00	654.0	154.0	40.0
June 29	122.1	4.40	3.60	653.0	159.0	40.0	Sept. 17	82.1	3.53	4.30	654.4	134.5	40.0
July 9	130.1	4.68	3.60	640.0	180.0	40.0	Sept. 27	74.3	3.45	4.65	666.3	144.0	49.0
July 19	127.5	4.97	3.90	631.0	162.0	40.0	Oct. 7	69.2	3.18	4.60	681.8	133.5	50.0
July 29	123.1	4.31	3.50	643.0	160.0	40.5							
Aug. 8	79.9	2.50	4.00	703.0	138.0	40.0	Total	1,517.9	56.35			2,161.5	578.5

COW 20, TICK-INFESTED.

May 30	154.4	5.87	3.80	709.1	176.0	43.2	Aug. 18	61.0	2.47	4.05	754.0	181.5	40.0
June 9	140.0	4.90	3.50	731.0	179.0	39.0	Aug. 28	53.7	2.26	4.20	752.0	192.0	40.0
June 19	137.0	4.93	3.60	740.0	180.0	42.0	Sept. 7	44.8	2.37	5.30	749.0	168.0	40.0
June 29	135.2	4.73	3.50	708.0	180.5	40.0	Sept. 17	25.1	1.63	6.50	748.8	135.5	40.0
July 9	137.3	4.81	3.50	738.0	200.0	40.0	Sept. 27	11.4	0.79	6.90	727.6	145.5	40.0
July 19	117.8	4.24	3.60	748.0	200.0	40.0	Oct. 7	Dry.	Dry.	Dry.	734.6	137.5	40.0
July 29	102.9	3.50	3.40	744.0	200.0	40.5							
Aug. 8	62.9	2.20	3.50	813.0	178.5	40.0	Total	1,183.5	44.70			2,454.0	564.7

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1915