PESTS OF DAIRY CATTLE IN PAYNE COUNTY, OKLAHOMA, CONTROL METHODS USED AND INTERRELATED ITEMS OF PUBLIC HEALTH SIGNIFICANCE

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By

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PREFACE

Much has been written concerning the pests of dairy cattle; especially regarding prevalence, life histories, and recommendations for their control. There has also been extensive legislation to protect both man and animals from the diseases spread by these pests, requiring many items of sanitary construction and methods. But little has been written concerning the actual controls used or results obtained by following these rules and recommendations, since the advent of the newer insecticides.

The author has endeavored to show the control practices used and results obtained by Grade A dairymen in Payne County, Oklahoma, as well as inter-related items of public health importance.

Indebtedness is acknowledged to Dr. D. E. Howell, Professor of Entomology, who suggested this problem and gave valuable assistance, suggestions and criticisms; to Dr. F. A. Fenton, Head of the Department of Entomology; to Dr. Charles H. Brett, and to Professor G. A. Bieberdorf, Assistant Professors of Entomology, for their valuable suggestions. The author gratefully acknowledges the assistance given by Dr. V. G. Heller, Head of the Agricultural Chemistry Research Department and to Mr. C. P. Peck, laboratory technician of the City County Health Department, Stillwater, Oklahoma, for their assistance in obtaining certain chemical and bacteriological data. Acknowledgement is also due Dr. C. W. Moore, Director of the City County Health Department, for allowing the author to collect necessary data while serving as a part-time Sanitarian of the City County Health Department.

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INTRODUCTION

Many external parasites of cattle are recorded from Payne County, Oklahoma, but during the period of study, September, 1947 to July, 1948, only five types were present in large enough numbers to be important. These were house flies, stable flies, horn flies, horse flies and heel flies or grubs.

These flies are considered serious pests of dairy animals because of several factors, such as, loss of blood and irritation resulting from their bites, reduction of animals' feeding time due to their presence and the nervous reaction due to their annoyance. Many workers in the fields of Entomology and Dairy Husbandry have endeavored to measure the losses due to these pests by determining the increase in milk production resulting from control of the flies. Carlyle (12) reported as early as 1889, that spraying cows with repellents resulted in no increase in milk production as compared with unsprayed cows. In 1913 Bishopp (4) cited losses of from 40 to 60 per cent in milk flow following an outbreak of stable flies. But as late as 1943, Shaw (39) reported that stable flies did not depress milk production any more than spraying with an acceptable spray properly applied, and that no increase in milk flow was gained by spraying with repellent type sprays (3). So until recently, control of flies being responsible for gains in milk flow, has been subject to considerable discussion and controversy.

Flies have also received considerable attention by legislatures because of their potential danger as transmitters of diseases, as described by Herms (21) and by Hewett (22). An outstanding example of this type of legislation is the Standard Milk Ordinance (41) recommended to the States, Counties, and Cities by the United States Public Health Service. This ordinance has been adopted by hundreds of Cities throughout the United States, as the rules

and regulations to govern their milk supply. The usefullness of many of the provisions of this ordinance is now being questioned by various authorities. One section of the ordinance that includes the items of construction and methods that relate directly or indirectly to fly control is under particular attack.

A date which marks the turning point in the control of flies about dairies and on dairy cattle was January 1, 1944, when the chemical DDT (dichloro-diphenyl-trichloroethane) was placed under allocation of the War Production Board. However as production of DDT was increased, new and more extended uses were found which combined to keep military demands ahead of production. Bishopp (6) reported in April, 1945 that about a dozen chemical firms were producing this insecticide and, that approximately 2,000,000 pounds per month were going for military use. It was not long after the above date that small quantities of DDT were available for purchase by the general public. Experiments since that time have shown that the use of DDT on dairy animals and in milking barns will give satisfactory control of flies with increase in milk production according to Bruce (10). Laake (29) has reported substantial increases in weight gains in beef cattle following such sprayings.

Because of the amazing results of this chemical in the control of flies, it has been accepted as a panacea by the dairyman and others. For this reason experiments as to its toxicity to man and animals, and its relation in fly control to items of sanitary constructions and methods, has lagged somewhat behind its ever increasing use.

Draise (15) has shown that DDT may be absorbed through the skin of animals. Allen (1) has shown that animals fed large doses of DDT, produced milk containing toxic amounts of DDT. Neal (34) has shown the toxicity and potential dangers of DDT to humans and higher animals.

Howell (23) has shown that dairy cattle, when sprayed with recommended formulas for horn fly control, secreted some DDT in the milk. These findings cause considerable interest from a public health standpoint as to; the methods of application, the control results, and the relationship between fly control and sanitary construction and methods, where DDT is used. The quantity of DDT to be found in the milk of a typical local supply also becomes of great interest. The author has endeavored to obtain a better understanding of the interrelationships, of the factors presented above, as they apply to the milk supply of Stillwater, Oklahoma.

MATERIALS, METHODS AND PROCEDURES

The Dairies

The Grade A milk producers, supplying milk to the pasteurization plants in Stillwater, Oklahoma, were selected for this study. These dairies operate under the rules and regulations, as interpreted by the code of the 1939 Standard Grading Ordinance, recommended by the United States Public Health Service (41). Based on an average of 80 dairies, milking an average herd of 28, and producing nearly 9,000,000 pounds of milk annually, the compliance with these rules and regulations was approximately 85 per cent. These dairies are located within an area of approximately 300 square miles. Their distribution and location is shown by Plate 1.

This group of dairies may be considered typical for Grade A producer dairies in Oklahoma, and above the average of ungraded dairies, so far as fly control sanitation and sanitary construction are concerned. A description of the different types of construction is shown by Table 1.

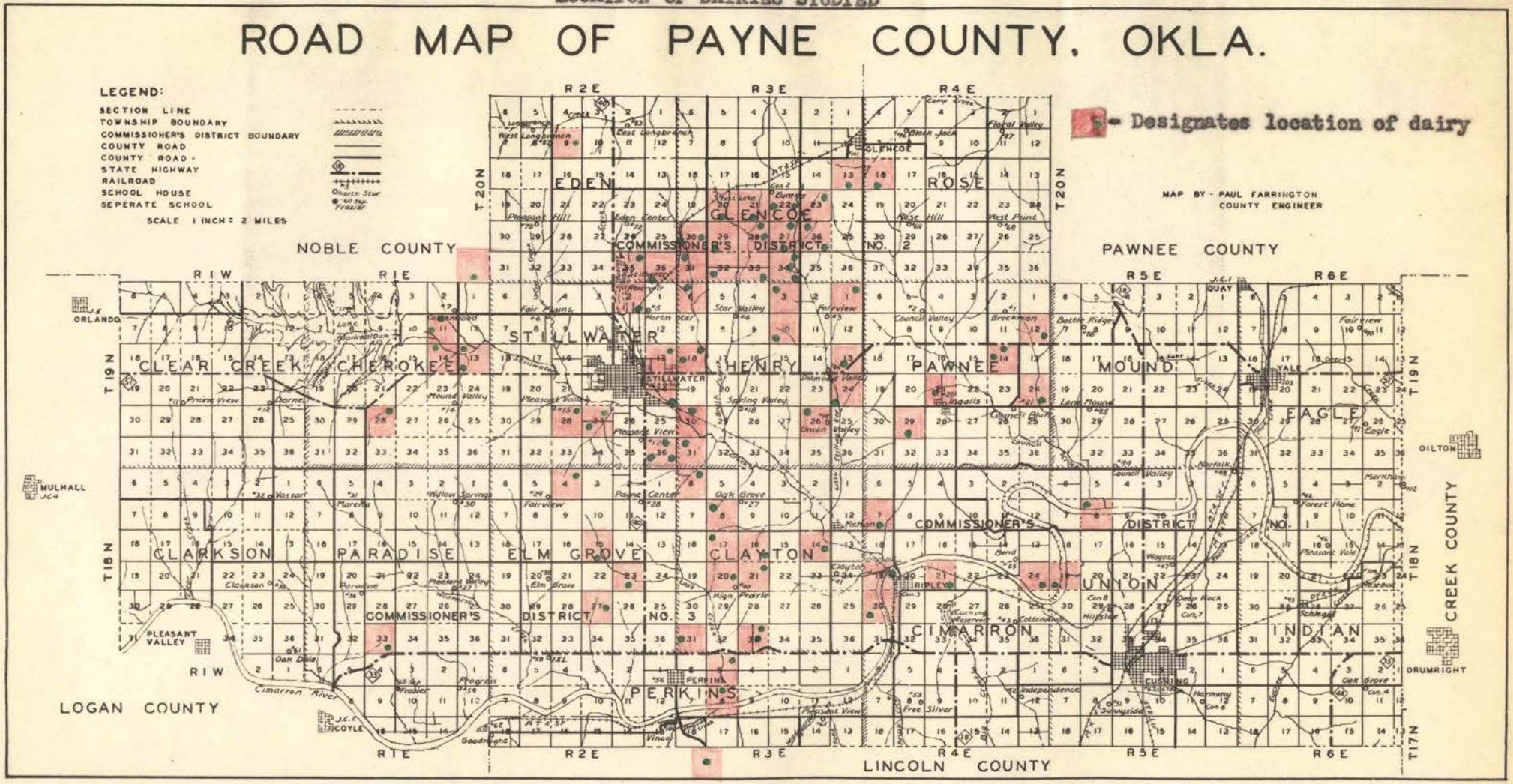
Table 1. Type of Structures Used for Dairies

	Frame	Concrete Block	Clay Tile	Rock and Frame	Concrete Block and Frame	Brick
Number of dairies	54	16	3	4	6	1
Per Cent of dairies	64.3	19.0	3.6	4.7	7.2	1.2

Total number of dairies studied was 84

The average number of stanchions per milking barn is 6.3. The number of stanchions indicates the size of the milking barn, since as an average there is 3½ feet by 14 feet of floor space per stanchion. The average milk house is 10 by 14 feet.

PLATE 1
LOCATION OF DAIRIES STUDIED



The Data

Most of the data were collected by the author during routine inspection trips to the dairies, while working as a part-time Sanitarian for the local City County Health Department, or by special trips made solely for that purpose. Additional information was obtained by conversations and correspondence with the dairy operators.

During the investigation the premises and animals were regularly examined for pests, but only the flies were found in sufficient numbers to be considered. Collections and determinations revealed that, with the exception of the "gnats", the flies in milking barns, milk houses and about the animals, were members of only three families of the order Diptera. The problem of control involved the Muscidae, Metopiidae and Oestridae, as used by Curran (14), with the principal problem being with the Muscidae. The common name of the species as given by Muesebeck (33) will be used for convenience. Using the designations as follows: Siphona irritans (Linn.) as horn fly, Stomoxys calcitrans (Linn.) as stable fly, Musca domestica Linn. as house fly, Fannia canicularis (Linn.) as lesser house fly, and all members of Metopiidae as flesh flies. Throughout this paper the word flies will refer to members of the families Muscidae or Metopiidae, unless otherwise qualified.

Fly counts, when the numbers are small, are based on the actual counts of all flies present. Where large populations were present counts were made by a modified grid count (38), and the number of flies calculated according to the size of the building. All reports of fly counts in barns are reported as the average number of flies per stanchion, because this is

the most constant size factor in relation to all types of milking barn structures. Since all the milk houses are approximately the same size, fly counts taken there were reported as found.

Where weights of milk are shown, these were taken from the regular daily weights as recorded in the receiving room at the pasteurization plants.

Where percentage of DDT concentrations used, as applied to spray mixtures, are given, these are calculated from mixtures as described to the author by the dairy operators. Further information was obtained by examination of the DDT materials and equipment used.

The numbers of bacteria found on flies under specified conditions were determined by collecting flies from 8 Grade A milking barns. At the time of collection the flies were introduced into a dilution bottle, containing 100cc. of sterile water, and the solution iced at approximately 34° F. until delivered to the laboratory. The plates were poured, for the standard plate count (2), on the same day collections were made. At the time dilutions were made, the flies were rapidly shaken more than 25 times, with each shake being an up-and-down excursion of about 1 foot (the entire shaking not exceeding 30 seconds). Further dilutions were made producing dilution factors of 1000 X, 10,000 X and 100,000 X, and then plated on tryptone glucose agar, with 1 per cent sterile skim milk added, for the standard plate count. The desoxycholate agar was used according to the American Public Health Association standards (2) for the coliform test. These plates were incubated for 24 hours at 35° F. for the coliform test and for 48 hours for the standard plate count, and were counted with the aid of a Quebec Colony Counter.

In a few cases it has been necessary to score certain items of sanitation as good, fair or poor. This scoring is based upon more than five years of experience by the author in the field of public health sanitation. In the case of scoring of the cow yards as good, or fair it means that the condition of the cow yard was not in such condition as to merit a score as a violation of the Standard Grading Ordinance (41), but in the case of the score fair, the conditions should be brought to the operators attention. When the lots were scored as poor it was considered in violation. When premises were scored as good, fair, or poor, this was done on the basis of the number of items observed which would tend to increase the number of flies found outside the immediate vicinity of the milking barn and milk house. This includes such items as hog pens, chicken pens, garbage and trash disposal, and general sanitation of these. The score poor, does not necessarily mean that the premise was unsanitary, as judged by farm standards for sanitation.

The meteorological data was obtained from the United States Weather Bureau when it had been published, and from Mr. L. V. Sargnet, the observer, when unpublished.

Milk samples for DDT analysis were collected at the receiving rooms of the pasteurization plants. Milk samples were taken from the producers' cans while they were on the conveyor previous to dumping. The milk was stirred thoroughly, to take as nearly as possible normal amounts of fats and solids not fat. 10 cc. samples were collected by means of the stirring rod and introduced into sterile glass tubes, which were iced and held at less than 40° F. until delivered to the laboratory. These 10cc. samples were considered as true samples of each producers' milk, during each samp-

ling period, amounting to samples of approximately 25,000 pounds of milk. Samples were mixed in chemically clean glasswear at the laboratory, then reduced to a composite sample of 100cc. for analysis. The analysis was made by Dr. V. G. Heller, Head of the Oklahoma Agricultural and Mechanical College Agricultural Research Laboratory. The DDT was separated from the milk and concentrated by a slight modification of Schechter's method (35). The color was developed by the procedure set forth by Schechter (36). The determinations were made with a Coleman Spectophotometer at 596mu. In every case milk free from DDT and milk containing known amounts of DDT were run as controls.

Dairy cattle were examined by the author for the third larval stage of Hypoderma lineatum de Villers. This examination was made by passing the hand over the back of the cow, starting well forward and feeling with the length of the hand on both sides, the location of the larva being indicated by the presence of a small to large swelling. Upon closer examination this swelling may be recognized as the swelling caused by the larva by the presence of a small hole and the presence of a scab-like exudate. Other dairy cattle were examined by the dairy operators and their findings reported to the author by such forms as shown in Figure 1. These forms were mailed with return stamped envelopes to 54 dairymen. 49 dairymen complied with this request for information. Cooperation was considered excellent and only 3 forms returned by the dairymen were rejected because of errors in completion.

As shown in Figure 1, the questionnaire contained a question concerning the prevalence of cattle lice, which was a source of information on these pests.

Figure 1

Dear Sir:

I would appreciate your aiding me in a personal research problem.

The information that I need for this problem is as follows.

Do your cows have cattle grubs (ox-warbles)? Yes ☐ or No ☐

If your cows do have cattle grubs, would you mark down the number of grubs that you are able to count per cow. (such as ☐2 ☐0 ☐4 etc.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Did you treat your cows for grubs last winter? Yes ☐ or No ☐.

Have you treated for grubs this winter? Yes ☐ of No ☐.

What was the treatment that you used for grubs? (product used)_____

_____

_____.

When did you last spray your cattle with DDT? (date)_____

Do your cows have lice? Yes ☐ or No ☐.

What treatment do you use for cattle lice?_____

_____.

Thank you for your consideration of this matter.

Very truly yours,

Clifford Gay

Clifford Gay

OBSERVATIONS

Bacterial Counts From Flies Collected in Milking Barns

It has been shown by Esten and Mason (16) that large numbers of bacteria are carried by flies, on their bodies. And as cited by Herms (21), Yao, Yuan and Huie have determined by the study of 381,193 flies that the bacterial count averages of flies varies with surroundings. They found an average of 3,863,000 bacteria per fly in the slum districts of Peiping, China as compared with 1,941,000 for the cleaner districts.

In order to compare the possible contamination of milk by flies in Grade A milking barns and milk houses, flies were collected from such places and bacterial counts were made. The results of these counts are shown in Table 2.

No attempt is made by the author to give expected bacterial counts from flies found in Grade A dairy barns, however, the bacterial counts made during this study may be indications of the following. That the house fly carries more bacteria externally than the stable fly. That flies in unclean milking barns have more coliform organisms than flies in clean milking barns. Flies taken from milking barns in which the floors were washed daily, had more bacteria on them than flies taken from milking barns in which the floors are cleaned and properly limed. There can be no doubt from the above data, that the fly carries many bacteria, and is a potential health hazard when allowed to contaminate milk, milk utensils or other equipment. There is no reason that can be given by the author to explain the small number of coliform organisms found on the flies. The work of various authors indicates that these organism should be found in large numbers on flies, and in many cases should constitute the majority of bacteria found. There may be a relation here that would give some more credit to the sanitation of the milking barns.

Table 2. Bacterial Counts on Flies Taken From Grade A Dairy Barns

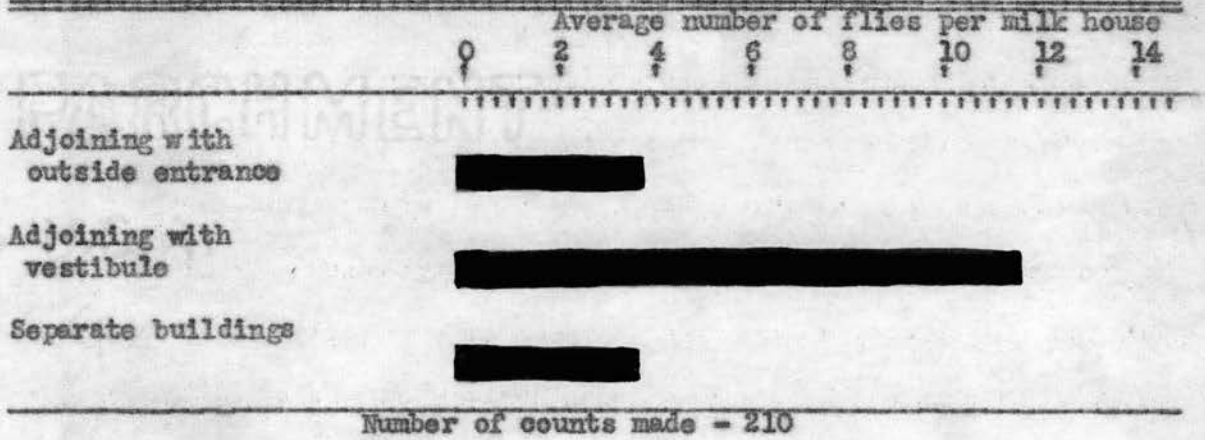
Dairy Number	Original Rinse Dil.	No. of flies	Recorded no. of bacteria per fly	Coliform organisms recorded per fly	Kind of flies	Condition dairy barn floor
1.	100cc.	2	11,000,000	less than 50	house	washed
2.	100cc.	2	1,100,000	less than 50	stable	limed
3.	100cc.	2	200,000	less than 25	stable	washed
4.	100cc.	2	350,000	less than 25	stable	limed
5.	100cc.	8	87,000	250	stable	washed
6.	100cc.	3	660,000	500	house	limed
7.	100cc.	1	300,000	less than 25	stable	washed
8.	100cc.	2	2,500,000	1400	house	dirty
Average number of bacteria per house fly					4,143,000	
Average number of bacteria per stable fly					285,000	
Average number of bacteria per fly taken in washed barns					2,892,000	
Average number of bacteria per fly taken in limed barns					703,000	
Average number of bacteria per fly taken in dirty barns					2,500,000	

The Number of Flies in Milk Houses in Relation to the Type Construction

Item 8 r (e) of the Standard Grading Ordinance (41) provides that milk houses must not open directly into the barn. The public-health reason for this requirement is given in the code (41) as, "The milking barn is usually infested with flies. If the milk room opens directly into the barn, so that a door is the only barrier between it and the barn, flies are certain to enter the milk house in larger numbers." This regulation has caused the construction of three major types of milking barn and milk house arrangements.

In one type, the milking barn may be directly joining the milk house if there is a partition between the milk house and the barn, with no entrance through the partition wall but an outside entrance is provided for the milk house. In another type of construction the milk house may be entered from the barn but the entrance is through self closing doors having a vestibule between them, and so arranged that both doors will not be open at the same time. And a third type of construction in which the milking barn and milk house are buildings entirely separated. A comparison of the fly counts in milk houses of the different type structures is shown in Table 3.

Table 3. Fly Counts in Milk Houses as Influenced by Type Structure



Number of counts made - 210

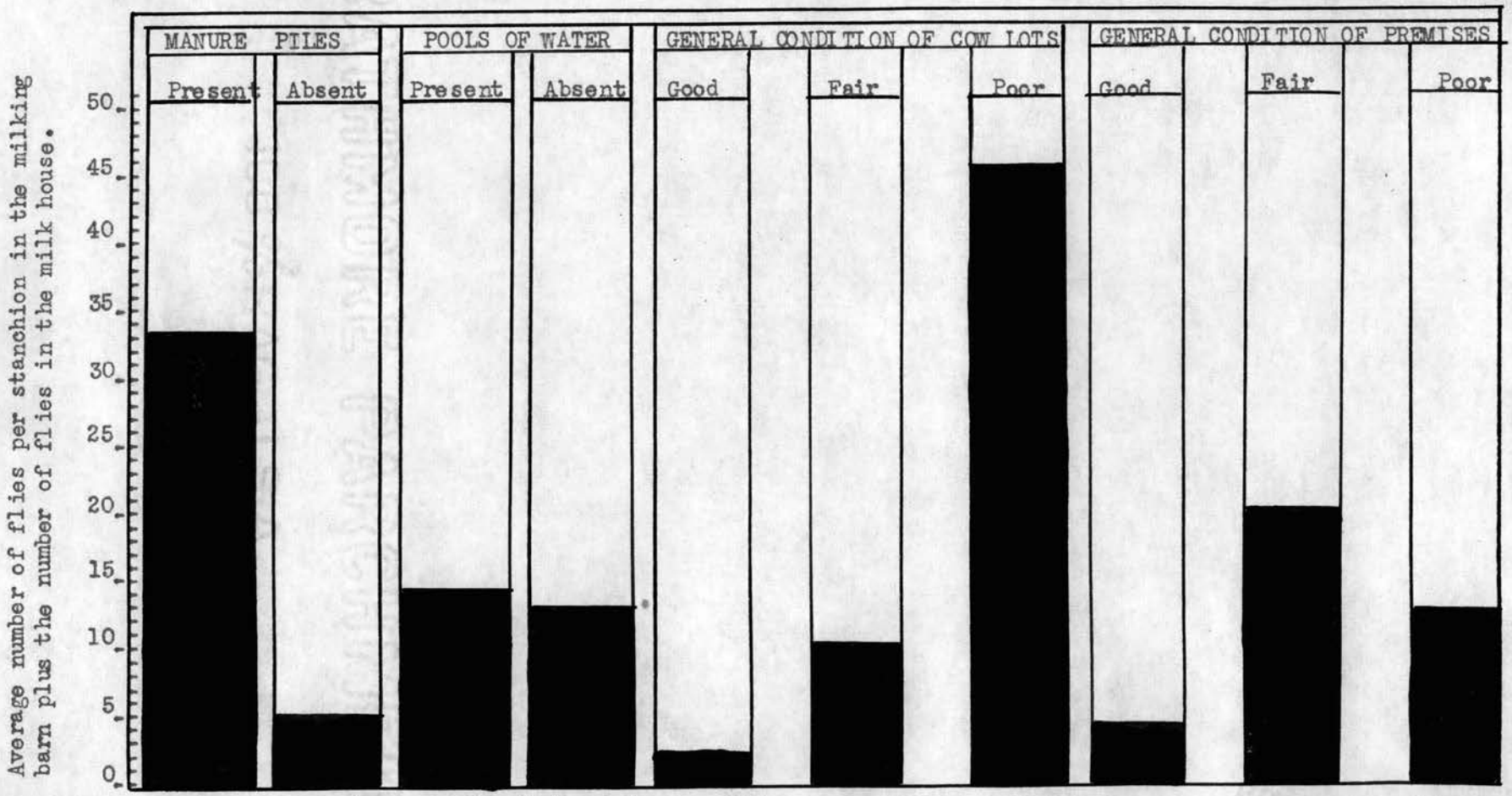
The data collected indicate that the poorest type construction as far as fly control in the milk house is concerned is with the milk house adjoining the milking barn having the vestibule with two doors to separate the rooms. Whether this is due to the faulty practice of propping one or both doors open at time of milking or to the proper use of these doors was not determined. Regardless of the reason, it is a much poorer type of construction as far as fly control in the milk house is concerned. Separate buildings and adjoining buildings with outside entrances were so nearly the same in average fly counts that no distinction could be made as to their relative effectiveness.

Fly Counts in Relation to Cleanliness of the Cow Yard and General Sanitation

The literature concerning the life histories of flies list manure as the primary breeding place. The protection of food from contamination by flies has been primarily to attack the fly at its breeding place. In the protection of milk, on the dairy farm from contamination by flies, the manure piles, general cleanliness of the cow yard, and general sanitation of the premise has received considerable attention. The Standard Grading Ordinance (41) cites as the first public-health rea sons for items; 6r (a) Grading and Draining of the Cow Yard; 6r (b) Cleanliness of the Cow Yard; and 7r. Manure Disposal, as measures to prevent the breeding of flies.

A study of these items was made with the thought in mind that it might be possible with a well planned DDT spraying program that such items were no longer of as much importance. It was found, however, that the relationship of general sanitation to the number of flies in the milk houses and milking barns were still of great importance. The reason for this statement is shown by the data in Table 4.

Table 4. Comparison of Fly Counts in Milking Barns and Milk Houses in Relation to Items of General Sanitation



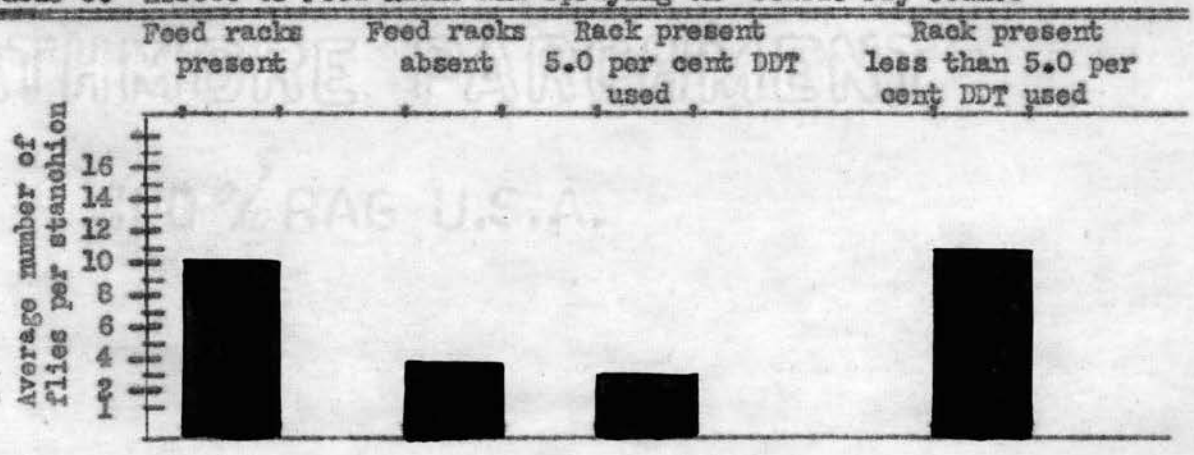
Number of counts made for this study was 330

Four times as many flies were present in milk houses and milking barns when manure piles were present than when absent. Pools of waste water in the cow yards apparently had no relation to the number of flies found. When the cow yards were scored poor, approximately 17 times as many flies were found in the milking barns and milk houses as when these were scored good. When the lots were scored fair, 4 times as many flies were found as when scored good. The sanitary condition of the cow yards was found to have the greatest influence on the number of flies observed. Scores of poor or fair on the general sanitation of the premises showed 2 to 3 times as many flies as when scores of good were made.

Effect of Feed Racks on Stable Fly Counts in Milking Barns

As described by Bishopp (4), (5) and by Herms (21), the feed racks for dairy cattle are considered as potential sources of heavy infestations of stable flies. Where stable flies were present, a check was made of the dairies having feed racks near the milking barns against barns not having feed racks near, as to the number of stable flies in the milking barn. The results of this study are shown in Table 5.

Table 5. Effect of Feed Racks and Spraying on Stable Fly Counts



It was found, in the 45 dairies observed, that feed racks did tend to increase the number of stable flies, unless a 5 per cent DDT spray was on the cattle. During May and June, 1948, stable flies were present on cattle after horn flies had been controlled by DDT sprays. The author has observed stable flies being knocked down 2 days after spraying milking barns with a 0.25 per cent DDT, but cows sprayed at the same time and with the same concentration, had numerous stable flies with apparently little or no effect on them. This indicates that somewhat stronger DDT concentrations would be needed to control the stable flies during this part of the year.

Effect of Different Methods of Cleaning Milking Barn Floors on Fly Counts

The Standard Grading Ordinance (41) does not list as a public-health reason, cleanliness of the barn floor as a method of fly control in barns. However, it does provide that the graded dairies are to clean the floors daily, with no accumulations beyond one milking.

All floors are constructed of concrete and are graded to drain, usually to gutters which are graded to the disposal. The floors are cleaned by various methods, some by sweeping, sweeping and liming, by washing, or by washing and liming, and sometimes accumulations for more than one milking are found on inspections.

Previous to the advent of DDT it was shown by Atkison et al. (3) that there were fewer flies in barns used for milking purposes only when the floors were cleaned daily. A comparison of the fly counts in milking barns according to the method of cleaning employed is shown in Table 6.

Table 6. Comparison of Milking Barn Floor Cleaning Methods on Fly Count Averages

Method employed for cleaning barn floor	Average number of flies per stanchion: 0 2 4 6 8 10 12 14 16 18 20 22 24
Sweeping	
Sweeping and liming	
Washing	
Washing and liming	
Accumulations	

Number of counts made for this comparison - 155.

By comparison with barn lot or dirt floor milking, the milking barn floor of graded dairies is never "dirty" but the indication of the above data is that cleaning, and the method of cleaning influences the number of flies in the milking barns. Sweeping and liming of the milking barn floor is shown to be the most effective method of cleaning to avoid flies in the milking barn. Where washing is employed as the method of cleaning, the floors appear to be in the best of sanitary conditions, however, the number of flies indicates that this practice attracts flies to the milking barn. If floors are washed and then limed the attraction seems to be greatly lessened. The data show that accumulations beyond one milking definitely are not conducive to good fly control. Other advantages of liming have been shown on page 11.

Comparison of Screens and No Screens in Controlling Flies in Milking Barns

The Standard Milk Ordinance (41) requires screens on the milk house windows and doors, but screens are not required on the milking barn.

The necessity of screens on milking barns has long been controversial, as brought out by Bishopp (5) and the Herdsman's Corner (20). It is maintained by some dairymen that when the doors are opened and the cows are brought in, a large number of flies follow the cows and the screens act as a trap to hold the flies in the milking barn. Others list screening of the milking barn as one of the first steps in controlling fly numbers here. It has been shown by Atkeson et al. (3), that screens on the milking barn windows did reduce the number of flies. This is contrary to the observations made by the author as is shown in Table 7.

Table 7. Screens VS. No Screens *

	Milking barns with screens	Milking barns without screens
Number of fly counts made	66	109
Average number per stanchion	12.95	4.21

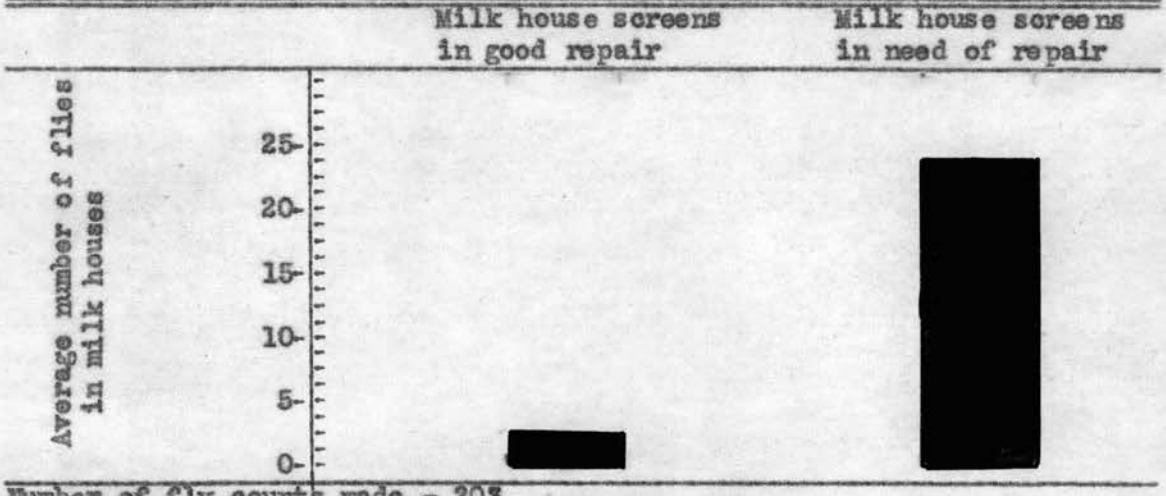
* All fly counts were made when milking barns were not in use.

Three times as many flies were found to be present in milking barns which had screens, as compared with those which had no screens. This would indicate that the screens did actually tend to trap the flies in barns resulting in a greater number of flies being present. The difference would probably have been even greater had the counts been made at milking time.

Fly Counts in Milk Houses as Influenced by Screens Needing Repair

The Standard Milk Ordinance (41) requires that the milk houses be effectively screened to give efficient fly exclusion, thereby preventing contamination of the milk and milk utensils by flies. However at times the screens become broken, torn or poorly fitted. When this occurs, the milk house screens are not considered as complying with the requirements of item 8r (d) of the Standard Milk Ordinance (41). The Table 8 shows the result of the study on this item.

Table 8. Good Screening and Poor Screening Influencing Fly Counts



Number of fly counts made - 203
Time-Sept., Oct., Nov., '47; Apr., May, June '48

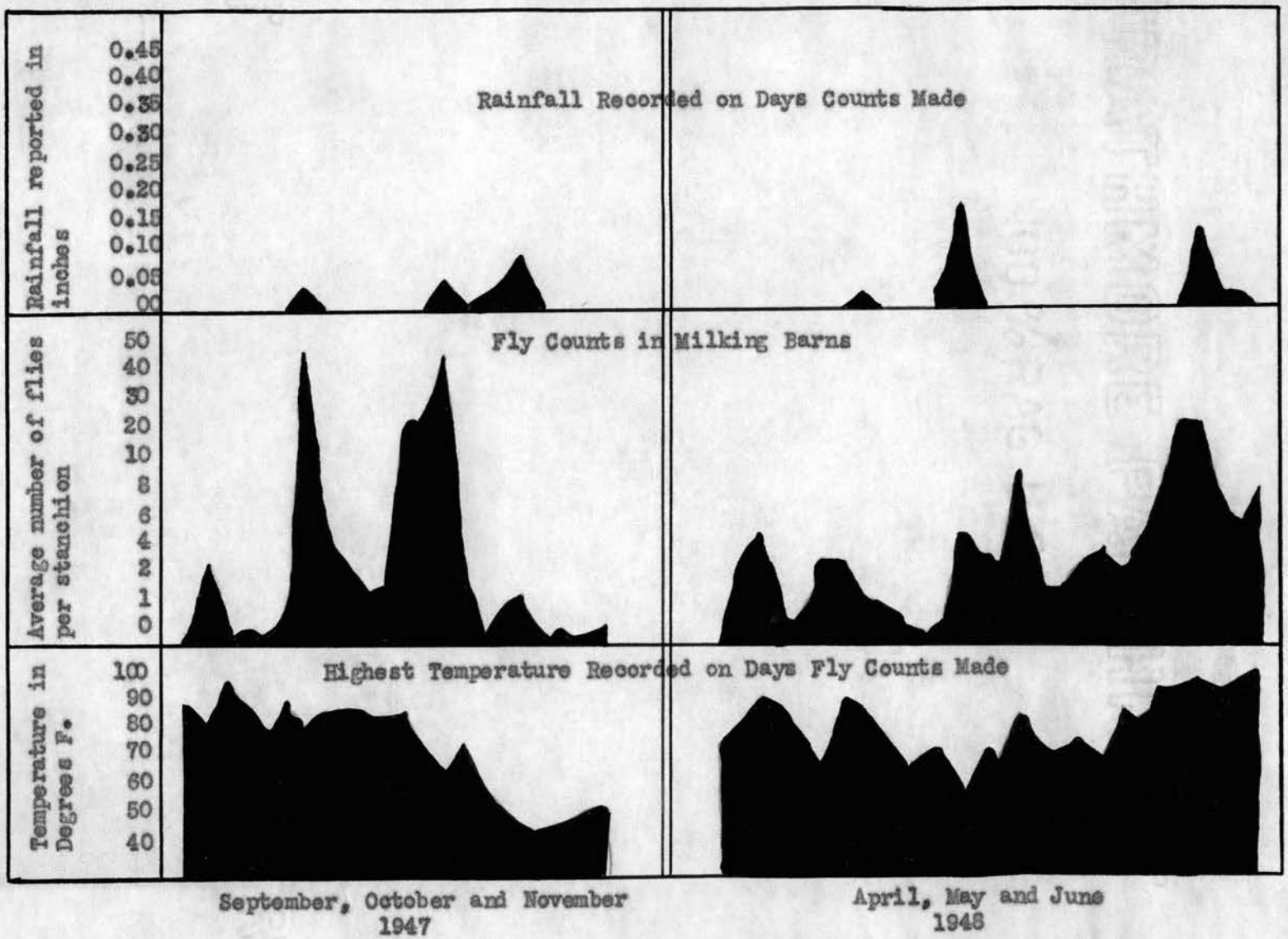
This observation indicates that, regardless of spraying with DDT, screens in good repair are extremely important to prevent flies in the milk house. When these counts were recorded no other considerations were made, that is for type construction, extent of repair needed or other factors that might influence the fly counts, however the effect of poor screening, as shown by Table 8, is obvious.

The Effect of Temperature and Rainfall on the Fly Counts in Milking Barns

Fenton and Bieberdorf (17) have shown, previous to the use of DDT, that there was an increase in the fly populations around barns, as measured by contents of fly traps, during September and October. Brett and Fenton (9) have shown, while using DDT, that populations in barns increased with a rise in temperature and decreased with a lowering of temperature, but with the use of a 5 per cent DDT spray there was no increase in September or October, on an experimental basis. These facts are of interest in this study because the average last DDT spraying date, for the dairies, was previous to October 1. If an increase in population could be shown in the fall months, the recommendations for the last spraying of the milking barn should show an increase in the concentration of DDT used, in order to effectively control this rise in population.

As shown by Figure 2 there was a definite increase in fly populations during October and the early part of November. The highest fly counts recorded during this study were in October, with the lowest fly counts being recorded in September and latter part of November. It was found that fly populations increased with a rise in temperature and decreased with a lowering in temperature during April, May and June. But in September, October and the early part of November (until frost), the effect of temperature was exactly the opposite. The fly counts in milking barns were more sharply affected by rainfall. As shown by Figure 2, when rainfall was recorded, there was always an increase in the number of flies in milking barns.

Figure 2. The Effect of Temperature and Rainfall on Fly Counts in Milking Barns



THE USE OF DDT

Type Materials and Concentrations of DDT Used

The type of DDT materials and concentrations used has been studied for the following reasons. Howell et al. (23) has shown that cows sprayed with a recommended formula for hornfly control secreted some DDT in the milk. Bruce (11) has shown that the material used and concentration of DDT influenced control results on an experimental basis. And too, the recommendations as given by the label on the materials constitute an influence upon the dairy operator as to the method of application, concentration as well as precautions taken. Because of the reason given, the labeling of DDT materials have been studied. The results of the study of these items are shown in Tables 9, 10, 11 and 12.

Table 9. Type of DDT Material Used by the Dairies in 1947 and 1948

Type of DDT or material used	Number of dairies	1947 percentage of dairies	Number of dairies	1948 percentage of dairies
50% wettable powder	18	40.8	12	18.5
20 or 25% emulsion	21	47.7	47	72.4
5% oil base space spray	3	6.8	2	3.0
50% wettable pwd and emulsion	1	2.3	1	1.5
Space spray no DDT	1	2.3	1	1.5
20% wettable powder	0	0	2	3.0

Table 10. Concentrations of DDT Materials used in 1947 and 1948

Average concentrations used	Wettable powders	Emulsions	Oil base space spray
On dairy cattle 1947	0.84%	1.21%	5.0%
On dairy cattle 1948	1.62%	0.64%	5.0%
On dairy buildings 1947	1.61%	1.70%	---
On dairy buildings 1948	1.80%	0.65%	---

Total number of dairies studied 90

Table 11. Comparison of Concentrations Used 1947 and 1948

	1947		1948	
	On Cattle	On Buildings	On Cattle	On Buildings
Average Concentrations used, regardless of the type material (DDT)	1.65%	1.65%	1.14%	1.36%

Total number of dairies studied 90

Table 12. Information Concerning Labeling of DDT Materials

Labeling information	Number of dairies	Percentage of dairies
Used DDT with label recommendations	46	66.6
Used DDT without label recommendations	23	33.3
Used more DDT than recommended*	34	49.3
Used less DDT than recommended	4	5.8
Used according to recommendations	31	44.9
DDT used had no Poison or caution label	24	34.7

Total number of dairies studied 69

* If label not present, source of material used to obtain recommendation

The observations made during 1947 and 1948 show that the DDT material most commonly used is the emulsion. However, as shown by Table 9, the emulsion was used by a higher percentage of dairies in 1948 than in 1947; and a much lower percentage of the dairies used wettable powders in 1948 than in 1947. Combined, these two types of material accounted for 88.5 per cent in 1947 and 90.9 per cent in 1948 of all the material used. The trend toward emulsions is probably due to the fact that a large percentage of the dairymen use hand sprayers (as shown by Table 13) and frequently complain that wettable powders cause clogging of the sprayer, while emulsions do not. The most satisfactory report on the use of wettable powders is made by the dairy operators who use the bucket type sprayer, however none of the operators who employ power sprayers use wettable powders.

The information contained in Tables 10 and 11 indicate that there is a trend to lessen the concentrations of DDT used on animals and on buildings. This is apparently due to the publicity being given the toxicity of DDT to man and higher animals, also to the decrease in concentrations recommended, and to the observation, by the operators, that there is an apparent decrease in the number of flies.

The data concerning the labeling of DDT materials are shown by Table 12, which indicates that the labeling is obviously inferior to the general conception of proper labeling. However, during these observations, most of the faulty labeling was created by one insecticide dealer, who bought DDT emulsion in large quantities and sold it in pint and quart containers. This material was labeled "20% DDT" and in some instances no label was observed. Recommendations for the use of this material were given by the

clerk who sold the material. Only a few instances, other than this, were noted as poor labeling. Nevertheless, a glance at Table 12 shows that the unbalancing of proper labeling may easily be done by one dealer. The labeling of wettable powders was found to be satisfactory, but there was a tendency for the dairy operator to use more concentration than asked for by the recommendations, as shown by Table 12. This probably accounts for the failure of the wettable powder to work satisfactorily in the hand sprays and consequently to cause the increased use of emulsions over wettable powders.

Methods of Applying DDT and Relative Efficiency of Sprays

As emphasised by Bruce and Blakeslee (11), the method of application and the type of spray equipment used in applying DDT will influence the control results. A study was made of the type of spray equipment used by the dairy farmer, this information is shown in Table 13.

Table 13. Apparatus Used for Applying Insecticides

Type of apparatus used for the application of DDT*	Dairies using this type apparatus	
	Number	Percentage
Hand Sprayer (flit-gun type)	37	41.11
1 to 3 gallon pressure sprayer	25	27.77
Bucket pump sprayer	4	4.44
Power sprayer	2	2.22
"Commercial"[1] Power sprayer	9	10.00
Hand sprayer for cattle Pressure sprayer for buildings	9	10.00
Sponge	1	1.11
Dipping	0	0.0
Painting[2]	3	3.33

* Apparatus as described by Metcalf and Flint (31).
1-"Commercial" designates a pest control operator.
2- Painting refers to white surfacing material containing DDT.

Previous to the use of DDT, the hand sprayer was most often used by the dairy operator for the control of flies on animals and in milking barns. This probably accounts for the large number that continue to use hand sprayers for the application of DDT. When hand sprayers are used, the length of time between spray applications and the quantity of DDT applied per animal per spray treatment is much less than when other types of sprayers are used. The general rule is to keep the hand sprayer in the milking barn and, when flies are present, to spray each cow, as had been the practice with oil base pyrethrum sprays. An effort was made by the author to determine the number of applications, the average quantity of spray mixture used per cow or the total DDT used per cow, per season, but this information was not obtainable due to the lack of a spraying schedule.

When the commercial spray service is used, hand spraying by the dairy operator, between the power spray treatments, is generally practiced.

During the two fly seasons studied, there was a slight trend to change from hand sprayers to the one to three gallon pressure sprayers. No other trend was observed.

Table 14. Relative Efficiency of Spray Equipment as Used by the Dairy Operator, Measured by Fly Counts in Milking Barns

Type of Equipment or method used	Average number of flies per stanchion: 0 2 4 6 8 10 12 14 16 18 20 22
Hand Sprayer	
1 to 3 gallon pr. sprayer	
Bucket pump	
Commercial power sprayer	
Barns not sprayed, cows sprayed in milking barn	
Milking barns not sprayed this season	

Number of counts made 171.

According to the information in Table 14, there is relatively little difference in the efficiency of the spray equipment used by the dairy operator as measured by fly counts in the milking barns. This Table compares the efficiency of spraying cows in the milking barn but not spraying the walls of this building directly. The indication is that this method is approximately 75 per cent less efficient than spraying the milking barn walls directly, and nearly 50 per cent more efficient than not spraying the walls with DDT this season.

Table 15. Relative Efficiency of Spray Equipment, as Used by the Dairy Operators, Measured by Fly Counts on Cattle

Type of Equipment or method used	Average number of flies per animal
	0 20 40 60 80 100 120 140
Hand Sprayer	[redacted]
1 to 3 Gal. Pres. Spray	[redacted]
Hand Spray no DDT	[redacted]
Cows Not Sprayed	[redacted]

Total number of cows observed 358, flies counted 26,103
Other type equipment not considered because of insufficient data

According to the data in Table 15, the type of spray equipment used by the dairy operators, considering only the two most used types, did not affect the fly counts found on cattle to any degree of importance. However when cows were sprayed with space sprays containing no DDT there was very little control of the flies indicated by this data, being only slightly more efficient than no spray at all.

DDT IN THE MILK SUPPLY

Milk samples were collected, during three special periods, from the dairies, to determine the amount of DDT being secreted in the milk. The first samples were collected, during a period of five days, from October 24, 1947 to October 29, 1947. This time was selected as being the end of the spraying season, and according to the work of Telford (40) should yield the greatest amounts of DDT being secreted in the milk at any time during the spraying season. The second sampling was made April 20, 1948. This time was selected because it was the first of the fly season and spraying had not begun, a positive test should show the hold over of DDT from the last spraying season. The third sampling was made June 22, 1948. This period was selected because the majority of the herds had been sprayed for horn fly and stable fly control by this time. The results of these various tests are shown in Table 16.

Table 16. The Amount of DDT Found in the Milk During Special Periods

Date samples taken	Group number	Sample number	Number of dairies represented by sample	DDT found in milk in p.p.m.
		1	30	0.35
10-23-47	A	2	24	0.30
		1	25	0.70
10-24-47	B	2	36	0.30

The data of Table 16 shows that DDT was present in all samples taken of the milk supply at the end of the spraying season. The significance of this quantity of DDT in the milk is not known.

Chemical analysis of the second and third samplings had not been completed by Agricultural Chemical Research laboratories at the time this paper was due and will appear in a later publication.

TABANIDS

The Tabanids of Payne County have been studied and reported by Schnorrenberg (37). The small amount of data collected by the author agrees closely with his work.

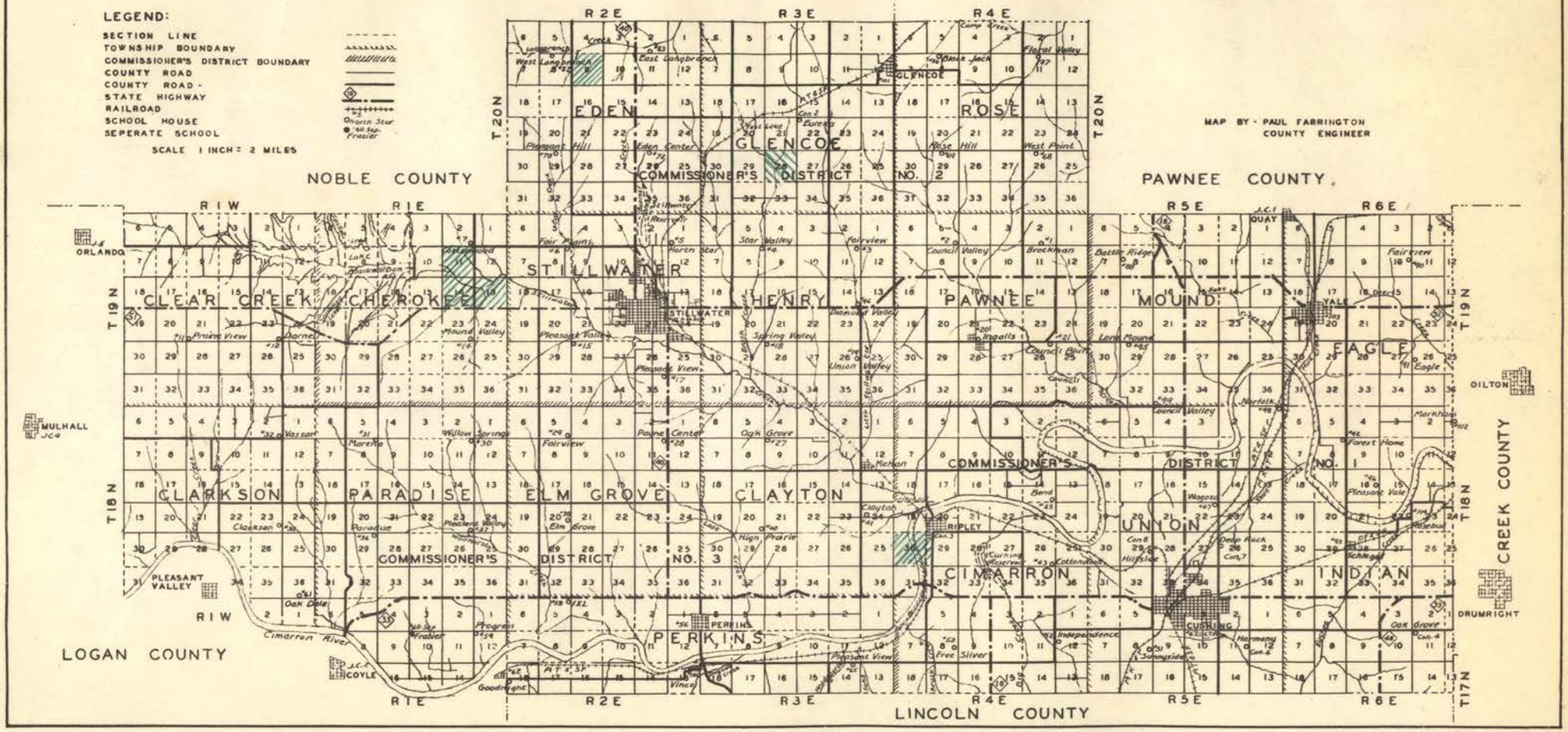
The damage caused by the Tabanids is considered as a very serious problem by the dairy operators, during the months of July, August and September. However the number of Tabanids observed during this study was small, except in a few localities, and in these localities, the numbers are small when compared with the reports of Howell (25) on Tabanids in northeastern Oklahoma. The locations where the damage from Tabanids were reportedly the greatest, are shown on Plate 2.

No controls are attempted by the dairy operators, other than the regular DDT sprays on animals for fly control.

PLATE II

LOCATION OF HEAVY TARAHILD INFESTATION

ROAD MAP OF PAYNE COUNTY, OKLA.



HEEL FLY OR GRUB PREVALENCE AND CONTROL RESULTS

The life history and control measures for Hypoderma lineatum de Villers, the heel fly found in this area of Oklahoma, is given by Bishopp et al. (7), (8). New characteristics of larval stages are given by Laake (30). Mote (32) has given the economic importance of this fly in detail. Howell et al. (24) has shown gains in weight of beef cattle by spray treatment for grubs. Howell (27) has also shown increase in milk flow by treatment for grubs.

Table 17. Life History of Hypoderma lineatum de Villers in Payne County, Okla.

Heel fly adults present	Grubs in the body of cows	First appearance of grubs in back	Disappearance from back
March 29, 1948 to April 12, 1948	March 29, 1947 to November 18, 1947	November 18, 1947	Feb. 25, 1948

History given as observed by the author

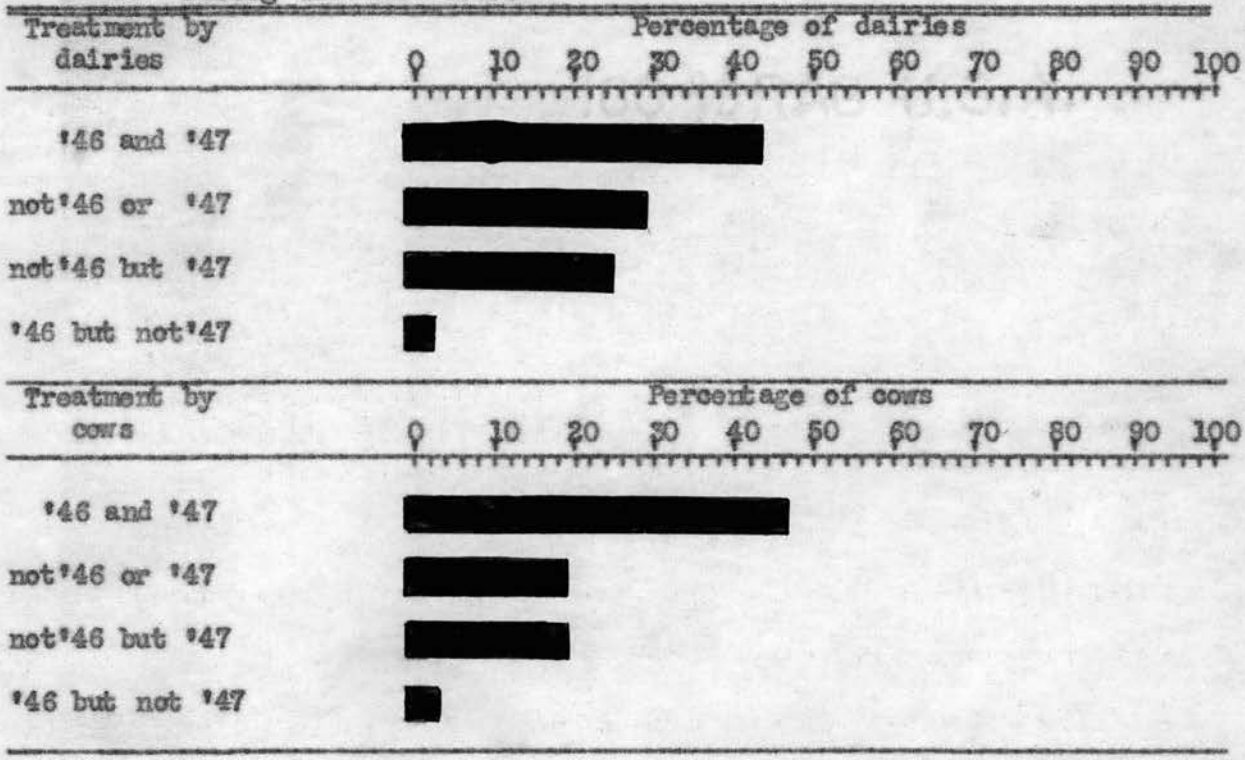
Of the 807 cows examined for grubs during this study a large number were found to have no grubs, and many had only a few grubs. Information concerning the distribution of the grubs found is shown in Table 18.

Table 18. Distribution of Grubs in 807 Cows

Number of grubs	Number of cows	Percentage of cows (0 10 20 30 40 50 60 70 80 90)
0	346	
0 to 5	312	
5 to 10	85	
10 to 15	36	
15 to 20	15	
20 to 30	9	
over 30	4	

Various materials were used for treatment of grubs, the extent to which treatment was made is shown by Table 19.

Table 19. Percentage of Dairies Treating and Cows Treated for Grubs, During 1946 and 1947.



Several types of treatments were used against the grubs of dairy cattle, by chemicals applied to the back of the cow, by extraction and destruction of the grub, or by the injection of chemicals into the hole cut by the grub. The most common method employed is the application of dry derris powder, containing from 1.67 to 5.0 per cent rotenone, to the back of the cow by means of a shaker type container. After covering the back with dust, it is worked into the grub holes with the hands or with brushes. The cows are usually treated in this manner, 2 or 3 times a season. Derris sprays were not used, and only one instance of a derris wash being used was recorded.

The second most used method was the extraction, by squeezing the grubs out of the back with the fingers, when they were "ripe". Three operators preferred to treat the cows with common table salt, using this remedy in the same manner as described for the derris dusts. The use of a larvicidal injection, composed of a 12 per cent hydrogen peroxide plus methylene blue, and used according to the method of Kurtpinar (28) was observed. The results of these various methods of treatment are shown in Table 20.

Table 20. Grub Treatment Results on Herds Treated in 1946 and 1947

Number of cows in the herd	Number of grubs observed (avg.)	Number of cows in the herd	Number of grubs observed (avg.)
15	0.93	20	12.25
12	0.67	20	0.15
12	2.00	30	0.33
15	2.40	20	1.20
18	1.83	16	1.62
16	0.37	13	4.15
16	3.69	24	0.79
16	0.00	85	0.39
21	0.00	2	2.50
4	0.74		

Average number of grubs reported per cow when Hydrogen peroxide	0.39
Average number of grubs reported per cow when "squeezing" used	1.03
Average number of grubs reported per cow when derris dust used	1.17
Average number of grubs reported per cow when table salt used	1.90
Average number of grubs reported per cow when derris wash used	12.25

The average number of grubs in the 375 cows treated both 1946 and 1947 was 1.59 grubs per animal. The most effective treatment being the use of the hydrogen peroxide larvicidal injection. The other treatments used, with the exception of the derris wash, were approximately equal in effeciency, with the "squeezing" being the most effecient of these.

The number of animals treated both 1946 and 1947 was nearly five times the expected number. According to Cuffs' report (13), only 10 per cent of all the cattle west of the Mississippi were treated during the 1946 and 1947 grub season.

Table 21. Grubs in Herds Not Treated in 1946 or 1947

Number of cows in the herd	Number of grubs observed (avg.)	Number of cows in the herd	Number of grubs observed (avg.)
9	7.77	13	14.25
9	6.11	5	5.40
12	11.25	9	2.11
19	10.89	10	4.20
20	3.95	22	10.00
4	20.75	2	50.00
16	1.81		
Total number of cows not treated 1946 and 1947			150
Average number of grubs per cow in this group			8.32

Table 22. Grubs in Herds Treated in 1947 but Not in 1946

Number of Cows in the herd	Number of grubs observed (avg.)	Number of cows in the herd	Number of grubs observed (avg.)
20	1.35	3	4.00
4	7.50	11	9.18
19	1.05	14	0.71
30	2.20	12	2.33
10	5.10	15	8.13
12	3.66		
Total number of cows treated 1947 but not 1946			150
Average number of grubs per cow in this group			5.02

Table 23. Grubs in Herds Treated in 1946 but Not in 1947

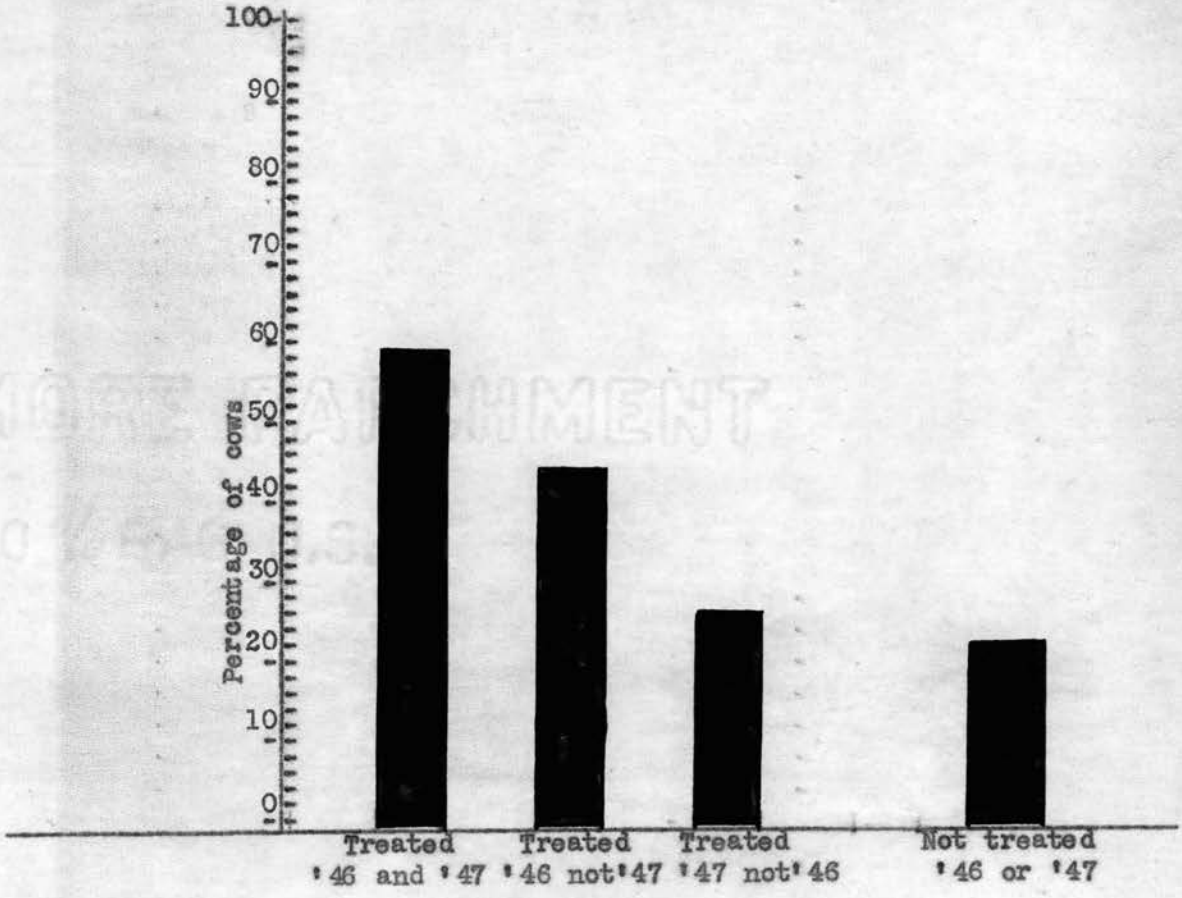
Number of cows in the herd	Number of grubs observed (avg.)
21*	2.14
26	3.30
85*	2.23
Total number of cows treated 1946 but not 1947	132
Average number of grubs per cow in this group	2.42

* Herd also used in data after treatment this year.

The efficiency of treatment for grubs is clearly illustrated in the Tables 20, 21, 22, and 23. When the cows were treated both grub seasons, the average number of grubs per animal was 1.59. If the cows were treated last season but not this season the average number of grubs was 2.42. Some of the cows were not treated last season but they were treated this season, the average number of grubs for this group was 5.02. And those not treated this season or last season had the highest average of 8.32 per animal. These data confirm the recommendations of the Bureau of Entomology and Plant Quarantine.

The efficiency of treatment is also reflected in the number of cows which have no grubs, as shown in Table 24.

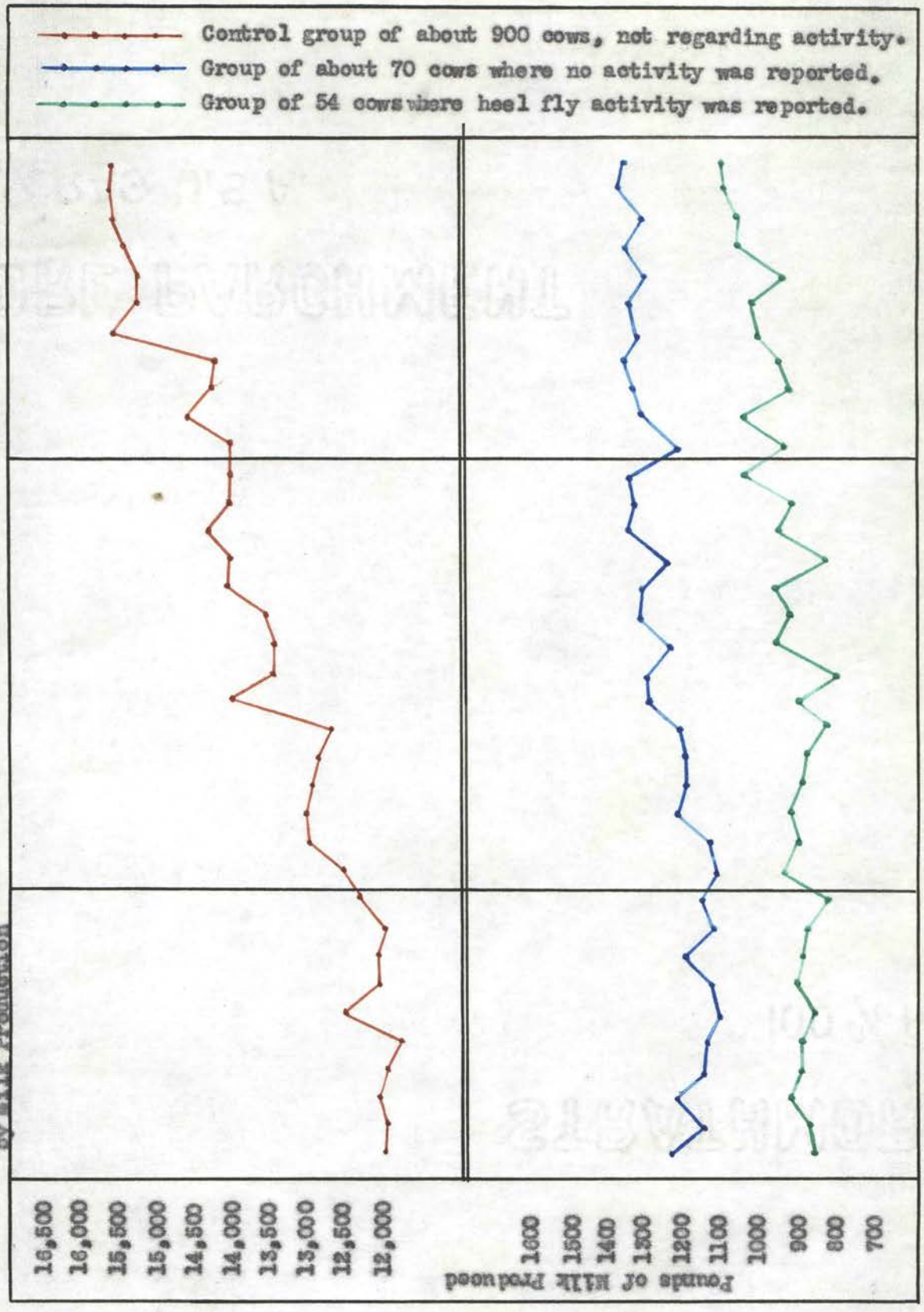
Table 24. The Influence of Treatment on the Number of Cows Having No Grubs



Loss in Milk Production Due to Heel Fly Activity

It is the belief of people who have studied the heel fly that the activity of this pest causes a decrease in milk flow. This is shown by Bishopp (8). An effort was made to measure the loss in milk production caused by heel fly activity, on these dairies, where the number of grubs per animal was relatively low.

It was found, as shown by Graph 1, that over a period of 35 days, some difference in the amount of milk produced might have been caused by heel fly activity. The heel flies were reported and observed from March 29 to April 12, 1948. Weights of milk produced were taken for the 10 days before this period, during the 15 day period of activity, and 10 days after activity ceased. A comparison of these figures revealed that a 2.5 factor gain was experienced, by the control group over the period of 35 days, indicating the amount of milk flow increase where activity and no activity was experienced together. In the group where no activity was reported the factor gain was approximately the same or 2.4. But in the group where heel fly activity was reported only a 1.25 factor gain was shown. On the basis of 1000 pounds of milk this indicates that the control group would have increased milk production to 1250 pounds or 25 per cent gain, while the group with no activity would have increased production to 1240 pounds or 24 per cent gain. But in the group where heel fly activity was present in all the herds, production would only increase to 1125 pounds showing a gain of only 12.5 per cent. If it had been possible to obtain more data on cows which had definitely experienced heel fly activity, the factor of gain would probably have been even less.



Graph 1. Comparison of Heel Fly Activity with no Heel Fly Activity as Measured by Milk Production

DISCUSSION

This study has been made to report as nearly as possible the facts concerning pest control on the dairy farms, not as an attempt to prove particular points. It is reasonable to assume, however, that the study might show trends, needs for more or particular recommendations to the dairy operators, and the needs for further study of the actual application of the recommendations and legislation concerning this problem. It is with these thoughts in mind that the following discussion is made.

There is evidence that a construction that allows the milking barn and milk house to be connected by a vestibule with two doors is not sufficient protection to prevent the entrance of flies from the milking barn into the milk house. This is particularly true if the prevention of contamination of milk and milk utensils by flies is based on the theory that one fly in the milk house is "too many". The bacterial counts made from flies substantiates this theory.

According to the data, fly counts in dairy buildings are definitely in ratio to the cleanliness of the cow yard, but it should be pointed out that this is based on averages. Many instances have been observed where practically all the rules of sanitation, pertaining to the control of flies, were disregarded, and with a well planned DDT spraying program the dairy had fewer flies than when good sanitation was maintained, plus a poor spraying program. It is not reasonable to assume that the average dairyman could maintain fly control with poor sanitation, yet it is the opinion of the author that the well planned and executed spray program is more important for the control of flies since DDT, than the cleanliness of the cow yard.

Of course many other reasons may be given for the necessity of maintaining the cow yard in a sanitary condition.

According to the literature, stable flies are generally thought to avoid the inside of buildings. During May and June, 1948 this was studied. The stable flies could have been conveyed into the milking barns on the cows, but with the windows (1 per stanchion) open they made no apparent effort to leave, and were not buzzing at the windows, but were found on walls and mangers. The stable flies were found in the milking barns and in greater relative numbers than the literature would indicate. Stable flies are not generally distinguished from other flies by the dairy operators. If more recommendations were made concerning the breeding places of stable flies, and treatments necessary, more control would result.

Sweeping and liming of the milking barn floor has long been thought to be a very efficient method of cleaning. The smallest number of flies were found under these conditions which indicates the lack of attractiveness of clean floors properly limed and dry. The cleanliness of the floors when limed was shown again by the bacterial counts made from flies, yielding the smallest number of coliform organisms when collected from barns with limed floors. More credit is shown this method of cleaning than any of the others observed and it is the opinion of the author that this method should be recommended.

It has been the opinion of many milk inspectors that screens on the milking barn windows and doors did tend to trap the flies in the milking barn. This opinion is strengthened by the data in this paper. It is the opinion of the author that screens on milking barns should be discouraged.

That milk houses are attractive to flies is shown very clearly by the data. Broken or torn screens act as a definite fly trap for flies, increasing the number and not allowing them to leave. Repair of screens on milk houses is an important item.

That temperature and rainfall does effect the number of flies in the milking barns is fairly well shown. It is the opinion of the author that the increase in the number of flies at this time is due to the effort of the flies to seek more comfortable surroundings.

The use of DDT is widespread, so much so that it was extremely difficult to obtain milk, for controls on DDT analysis, from cows that had not been sprayed with DDT. There seems to be a trend toward lower concentrations of DDT in sprays used, and to use more emulsion type sprays. The weakest part of the spraying program, seems to be the lack of recommendations as to the amount of DDT to apply per animal, how to apply this spray and when or how often to apply it.

The use of DDT materials without labels and recommendations for its use, or without caution notices, other than that given by the salesman in the "feed-stores", should be eliminated through better labeling laws, properly enforced. Poor labeling is an advantage to no one, and is a liability to all concerned.

The fact that 25 per cent more cows were treated for grubs, by the dairies studied, during 1947 season than were treated during the 1946 grub season, was probably due to the conversations and correspondence with the dairy operators concerning grubs, treatment practices, damage, etc. This would indicate that field work by the extension entomologist, county agents, industry field men, milk inspectors and others, could create still further interest in the elimination of this pest in Oklahoma.

SUMMARY

The prevalence and methods of control of pests of dairy cattle were studied on approximately 80 Grade A dairies in Payne County, Oklahoma, during 1947 and 1948. The influence of sanitary constructions and methods on fly prevalence was also studied.

Only flies were of importance as pests of dairy cattle during this period.

Approximately 98 per cent of the dairy operators used DDT. The type of spray equipment, methods of application, DDT material used and efficiency of treatment is shown in this paper. Samples of milk showed that DDT was present in the milk supply, and is reported in this paper in parts per million.

Milking barns with a vestibule connection to the milk house was a poor fly control construction. Barns with screens had more flies than barns without screens. The number of flies in dairy buildings were in direct ratio to the cleanliness of the cow yard and general sanitation of the premises. When feed racks were present and DDT was not applied in sufficient concentrations, control of stable flies was poor. When screens on the milk house needed repair the number of flies found in the milk house was greatly increased. Of all the methods used for cleaning of the milking barn floor, sweeping and liming was found to be the least attractive to flies. An average of 1,200,000 bacteria per fly, were found to be carried by flies collected from dairy buildings, and the number of bacteria varied with the species and the cleanliness of the surroundings from which they were taken.

Grubs were important pests and several methods of control were employed. Approximately 48 per cent of the cattle examined were treated in 1947 and 1948 grub seasons. Different methods of treatment varied in their effectiveness, and these variations are reported in this paper. Heel fly activity was shown to decrease the milk production to a slight degree.

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