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A STUDY OF SOME OF THE ECONOMIC LOSSES DUE TO  
ABORTION INFECTION IN DAIRY CATTIE.

by

Albert Parken Wertman

T H E S I S

on

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ABORTION INFECTION IN DAIRY CATTLE.

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Submitted to the  
OREGON STATE AGRICULTURAL COLLEGE

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In partial fulfillment of  
the requirements for the  
Degree of

MASTER OF SCIENCE

by

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June 1929.

APPROVED:

Redacted for privacy

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OFFICE OF THE CHIEF OF BUREAU

#### ACKNOWLEDGMENT

The writer wishes to express his appreciation of the many courtesies extended by those persons who have cooperated with him in carrying on this study. Through the kindness of Mr. C. C. Dickson the records of the Jersey herd of J. M. Dickson and Son were made available. Dr. B. T. Simms and Dr. C. R. Donham of the Department of Veterinary Medicine have given much constructive criticism. Professor F. C. Kent of the Department of Mathematics has given valuable assistance in the interpretation of the data. Many helpful suggestions were also made by Dr. I. R. Jones of the Department of Dairy Husbandry. Especial credit is due to Professor P. M. Brandt, Head of the Department of Dairy Husbandry for his inspirational and patient guidance in planning this study, and in criticising the manuscript.



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## INTRODUCTION.

Infectious Abortion, caused by *Brucella melitensis abortus*, is perhaps the most important of those diseases affecting dairy cattle. Approximately twenty per cent (1) of the cows tested in Oregon have shown the presence of the infection.

Dairymen are aware of the calf loss, but the economic importance of numerous other losses is neither very apparent nor generally recognized. A decline in milk production, following an abortion, is regarded as a natural sequence, but the aborting cow is too often believed to breed efficiently and produce normally thereafter.

The actual facts are not in accordance with this belief. The causative organism has been found to be harbored in the genital organs and in the udder. It seems logical to conclude that there might be sufficient interference with the normal functioning of those organs to curtail the breeding and productive ability of the cow, not only immediately following an abortion, but also during the remainder of her life. The apparent inability of the average herd badly infected with abortion, to make a satisfactory income for the owner is further reason that more than loss of calves occurs, and is justification for giving further attention to the problem.

With this in mind, the accompanying study was undertaken in order to secure information that might throw some light on the breeding and producing efficiency of abortion infected cows throughout their lifetime.

## HISTORICAL REVIEW.

The information available on the economic losses due to abortion infection is very limited. The calf is the first loss, and by far too many people, it has been considered the only loss. Dairymen who have had experience with the disease know that there are other losses of more importance than that of losing the calf.

White (2) and his associates have made a very extensive study of some of the losses caused by abortion infection in the dairy herd of the Connecticut Agricultural College. In that herd a group of reactors representing 176 cow years produced 995,228 pounds of milk, or an average of 5654.6 pounds, while the non-reactors produced 1,006,061 pounds in 151 cow years, or an average of 6662.6 pounds of milk per cow per year. This means that the reacting cows produced only 84.72 per cent as much milk as did the non-reacting cows.

Based on the prevailing feed prices, and considering the feed cost as sixty per cent of the cost of producing milk, and valuing milk at an average of \$ 3.51 per hundredweight, the net profit on the non-reacting cows averaged \$ 21.29 per cow per year, while the reacting cows showed an average loss of \$ 2.30 annually.

The average sale value of fiftynine reacting animals was \$65.85, while thirtyseven non-reacting cows sold for an average of \$101.21, a difference of \$ 35.36 in favor of the non-reactors. The value of the calf was estimated at \$ 20.59, which was the average net return on 82 male calves sold from the herd. The reacting cows produced 37 dead calves, while the non-reacting cows dropped only 5 dead calves.

White and his associates (2) have estimated the annual loss per cow to be \$ 44.01 in the Connecticut Station herd. This loss included values of \$ 28.41 representing the difference in milk yield, \$ 11.86 for the yearly difference in depreciation over that of the normal cow, and \$ 3.74 as a proportionate value for the lost calves.

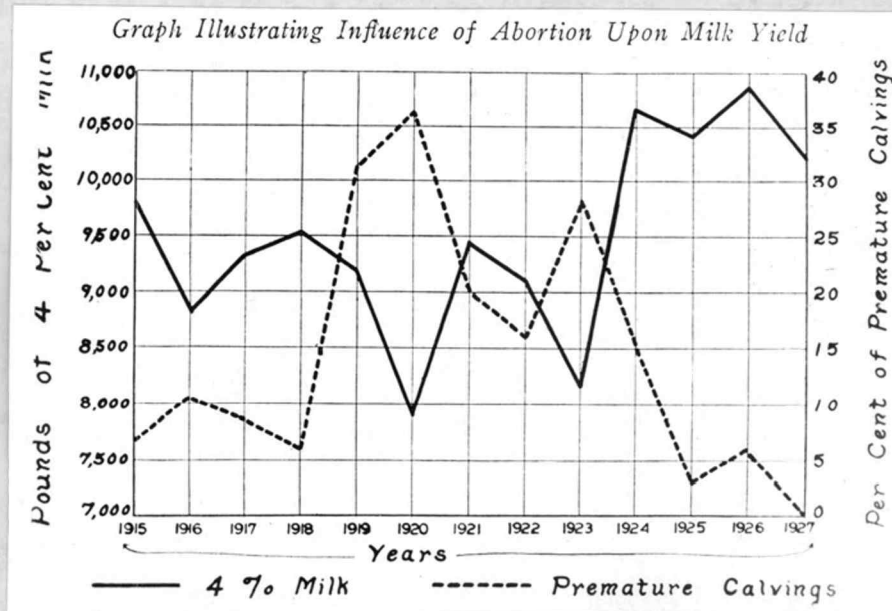
On comparing the normal production of twentyseven cows with their production in the lactation immediately following a premature calving, they found that the production following the abortion was only 83.32 per cent of the normal. Fourteen of those cows later dropped normal calves, and subsequently yielded more milk per lactation than they did prior to aborting. They state, "These data seem to prove that the decreased flow is confined to the lactation following the premature calving.

In a more recent publication from the Connecticut Station (3), the graph shown as Figure 1 is presented. The solid line represents the average yearly mature equivalent production of 4 per cent milk per cow in the station herd from 1915 to 1927. The dotted line shows the percentage of premature calvings during the same years. A study of this graph shows that the average production fluctuated between 7995 and 9795 pounds of milk per cow per year from 1915 to 1923, the period when the number of abortions was high. It is noteworthy that the average production was lowest in 1920 when the percentage of premature calvings was highest. From 1924 to 1927, as a result of the segregation of the reactors from the non-reactors, the average yearly production increased to between 10,190 and



Figure 1.

Comparison of the average mature equivalent production of four per cent milk with the percentage of premature calvings in the Connecticut Agricultural College dairy herd.



The above is a photograph of the graph appearing in Connecticut Experiment Station Bulletin Number 154 (1928) p 142.

10,863 pounds milk per cow per year.

Simms and Miller (4) mention the loss of the calf, sterility, garget, and decreased milk production as some of the factors causing loss from abortion. They state that the calf loss varies from five to eighty or ninety per cent in infected herds. Permanently sterile animals were conservatively estimated at from 10 to 15 per cent of all abortion infected cows and the shy breeders at from 15 to 20 per cent of all infected cows. In a herd under observation there were 31 cases of garget among 44 infected cows, while only 2 cows in a group of 27 abortion-free animals developed garget. Reports on the decline of milk production as observed by dairymen varied from nothing to almost 100 per cent, and averaged about 25 per cent.

Later Simms and Miller (5) report on the average milk production of the reacting and non-reacting cows in the herd at Oregon State Agricultural College. Table I shows the average annual production of those cows for the years 1919 to 1924.

Table I.

The average annual milk production of the reacting and non-reacting cows in the Oregon State Agricultural College dairy herd from 1919 to 1924.

Year	Reactors		Non-reactors	
	No. cows	Production	No. cows	Production
1919	41	4964.93	13	6693.21
1920	36	4506.36	16	5704.32
1921	40	5616.70	24	7976.70
1922	48	4710.22	31	8542.00
1923	26	4543.91	33	7343.43
1924	24	3261.70	46	6290.79
Average ratio		65.41	:	100.00

Through the six year period the reacting cows produced an average of only 65.41 per cent as well as did the non-reacting cows.

In Oregon Station Bulletin No. 232 (6), it is stated that infected cows are unprofitable because; They gave less milk; they had more garget; they had more breeding trouble; they developed more cases of chronic inflammation of the joints; and they produced fewer living calves. Also,

"One group of eight half-sisters (sired by the same bull) passed through their first pregnancies abortion-free and gave birth to normal calves. Their first calf production records were used as a basis for estimating their production at maturity. Six of these

became abortion infected. Only one of these six animals ever reached her estimated (mature) production. As a group the six lacked an average of 84 pounds of butterfat of producing the estimated maximum, but the two which did not become abortion infected exceeded their maximums, one by 38 pounds and the other by 79 pounds of butterfat, or an average of  $53\frac{1}{2}$  pounds each."

Thompson (7) kept cost records on his reacting herd and on his abortion-free herd at Oak Hill Estate. During two years 24 cows in the reacting herd produced 64,477 quarts of milk at a cost of 16.8 cents per quart. At the same time 18 cows in the non-reacting herd produced 94,458 quarts at an average cost of 10.4 cents. This shows that the reacting cows produced an average of only 51.17 per cent as much milk as did the abortion-free cows. The difference in the cost of producing milk was sufficient to mean a profit or a loss to the owner.

At the Colorado Experiment Station, Newsom and Cross (8), report that 15 reacting cows were sold to the butcher for \$ 1058.23 less than their estimated sale value had they not become infected with abortion.

Barnes (9) made observations on a number of infected herds in Pennsylvania, including the herd of Thompson (7). He concluded that where there is 20 per cent abortion infection and 10 per cent sterility in a purebred herd, an equivalent of the value of the entire herd is lost every three or four years. For the state of Pennsylvania he estimated the loss at over \$ 5,000,000.00 annually.



## SOURCES OF MATERIAL

The material for this study was secured from the herd records of the Oregon State Agricultural College, Corvallis, Oregon, and the Jersey herd of J. M. Dickson and Son, Shedd, Oregon.

### The Oregon State Agricultural College Herd.

Accurate breeding and calving records have been kept on each cow in the college dairy herd since 1913, and in the case of a few cows since 1911. Formerly the information for these records was secured directly by the person in charge of the herd. At the present time the herdsman makes out a daily barn report showing all cows that are in heat, have calved, have aborted, are off feed, and noting any other information of value to those responsible for the management of the herd. A sample of this report is shown in the appendix. The information on these reports is entered in a permanent breeding record book. A sample page from this book is also shown in the appendix. The intervals between heat periods, breeding dates, calving dates, number of services per pregnancy, and number of days gestation are all available on this page.

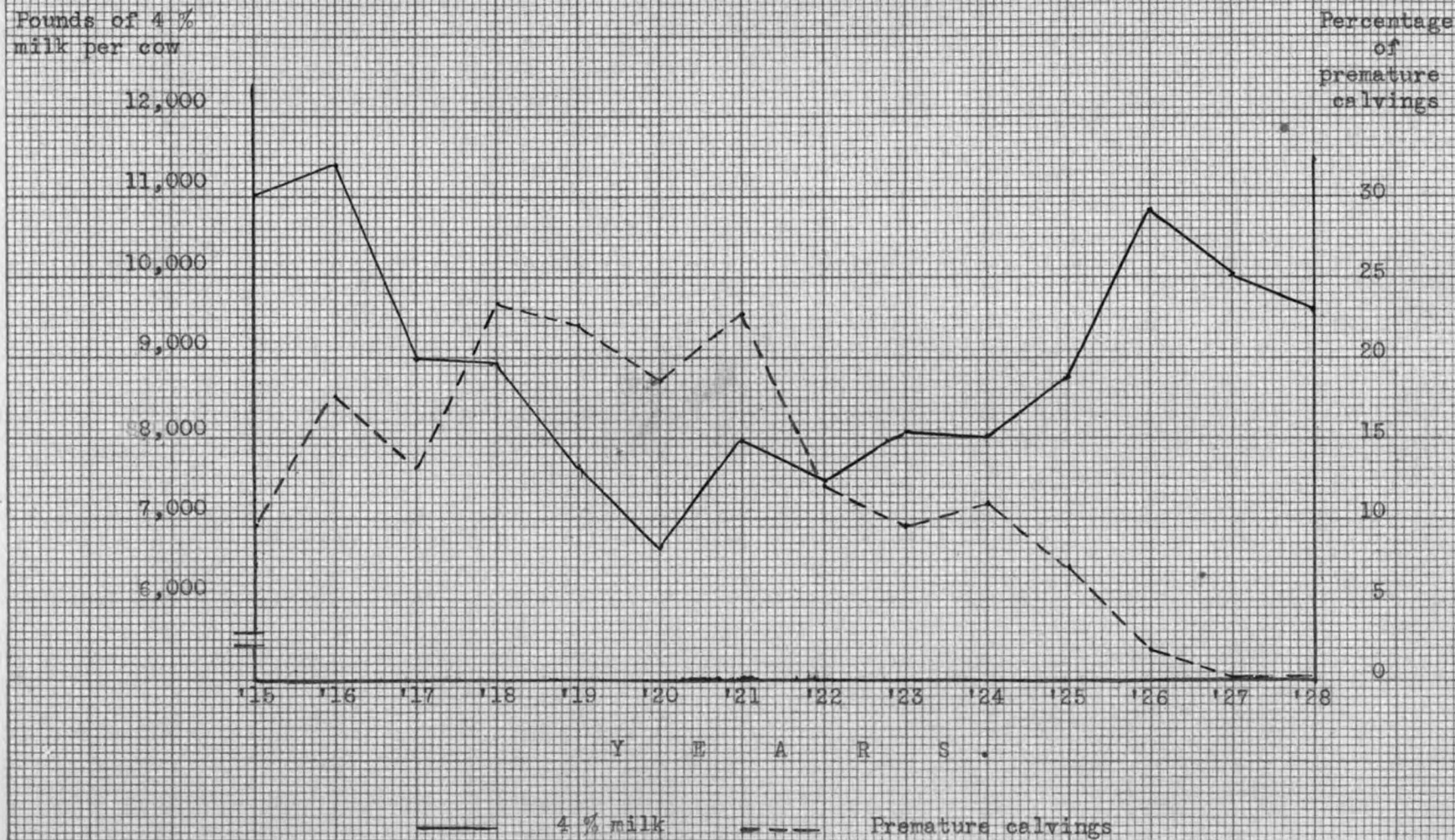
All milk is weighed and the weight is recorded immediately after each cow is milked. The milk sheets are totaled each month, and the totals, together with the butterfat test and computed butterfat production for the month, is recorded in a permanent herdbook. This herdbook contains forms as described by Eckles (10).

Each female is given a number at the time of her birth. This

number is tattooed into the ear and serves as a permanent means of identifying the animals. The Jersey numbers begin with 1, the Holstein with 201, the Ayrshire with 401, and the Guernsey with 601.

So far as available records indicate, there were no abortions in the herd prior to 1915. In 1915 four pregnant females were purchased. Three of those females later aborted. Other cows became infected and the number of abortions gradually increased. Figure II shows the percentage of abortions and the computed mature equivalent of four per cent milk produced by the average cow in the college dairy herd by years since 1915.

Figure II. The average production of four per cent milk and the percentage of premature calvings in the dairy herd at the Oregon Agricultural College during the years 1915 to 1928.



The Jersey Herd of J. M. Dickson and Son.

This herd of registered Jerseys was established in 1909. There was no trouble with abortion infection until in 1922 when one cow aborted shortly after her return from a stock show. The infection then spread to other cows, and as a result a large part of the herd became infected. The average yearly production per cow dropped appreciably. This decrease in production continued for the years following as shown by Figure III, which gives the average of the actual production per cow by years from 1919 to 1928. The percentage of abortions was not available as several occurred that were not recorded.

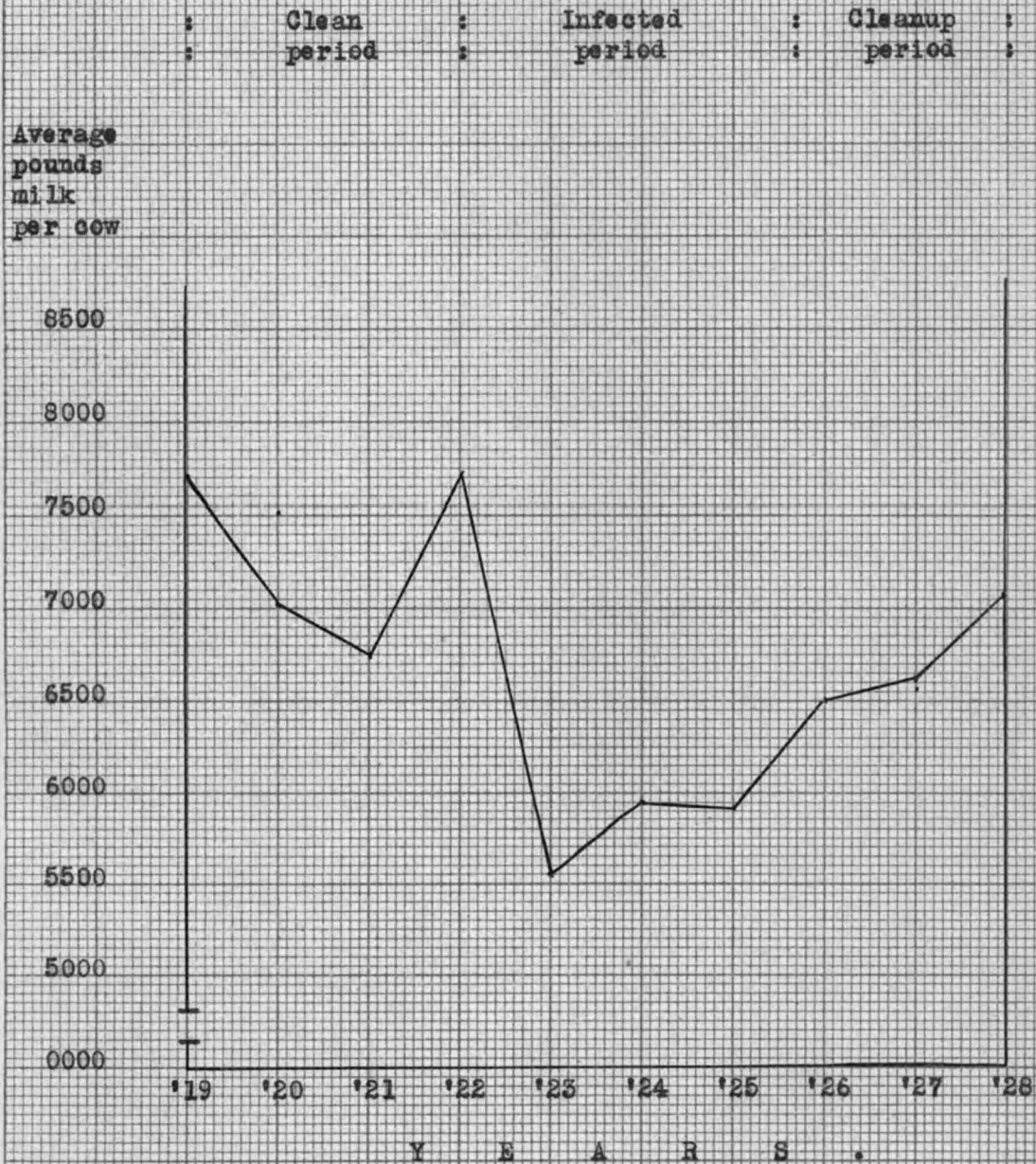
In 1927 the reactors were eliminated from the herd and were replaced by young stock previously raised from the infected cows in accordance with the plan of the Oregon Experiment Station (6). Another group of females known to be free from the disease were added to the herd in 1928. This herd has recently become accredited as free from abortion.

Individual records of milk production have been kept since the establishment of the herd. The breeding records were available for the period that the infection was going through the herd. Necessary breeding information prior to 1922 was obtained from the registration papers and hardbooks of the American Jersey Cattle Club (11).



Figure III.

The average production per cow in the Dickson herd 1919 to 1928.



## STUDY AND INTERPRETATION OF DATA.

This study has been divided into several parts. The following terms are used frequently and should perhaps be made clear.

A reactor is a cow that shows a positive reaction to the serological test for the abortion disease.

A non-reactor is a cow that shows a negative reaction to the serological test for the abortion infection. Non-reactor, abortion-free and clean cow are used synonymously.

An abortion is considered as the termination of a gestation on or before the 265th day.

A normal calving or normal gestation is considered as the delivery of a normal calf on the 266th day or later.

A normal lactation is a lactation following a normal calving.

### The Interval Between Calvings.

The cows used in this study were those of the college dairy herd. In order that the influence of abortion infection on the interval between calvings might be compared, the cows were divided into four groups, as given in Table II. Group one consisted of cows in the abortion-free herd. Group two consisted of all cows having dropped two or more normal calves prior to an abortion. Some of these cows later became infected, while others remained abortion-free. Group three consisted of cows that had aborted. The interval represented is the number of days from the abortion to the following normal calving. Group four was made up of cows that dropped two or more normal calves subsequent to an abortion.

All intervals between calvings available on cows in the college dairy herd before January 1, 1928, are included in this compilation.

Table II.

The influence of the abortion infection on the interval between calvings of cows in the college dairy herd.

	No. of intervals	Av. interval in days
1. Between normal calvings prior to an abortion, including only abortion-free cows. . . . .	144	407.8
2. Between normal calvings prior to an abortion, including all cows, (some later became abortion infected, while others remained abortion-free. . . . .	329	417.8
3. From an abortion to the succeeding normal calving . . . . .	48	563.8
4. Between normal calvings subsequent to an abortion . . . . .	66	425.9

The interval between normal calvings prior to an abortion for both the abortion-free group and for the group composed of all cows is larger than would ordinarily be expected. This wide interval might be accounted for in part by the fact that a large number of 365 day semi-official tests have been conducted on the cows in these groups. Many cows on those tests have not been bred to calve until the fourteenth or fifteenth month after they are put on test. During the period for which this study was made it was the policy of those in charge of the herd to give all heifers a chance to prove

their worth in the Register of Merit, or Advanced Registry tests during their first or second lactation, and again when they were mature. This should partially account for the discrepancy between groups one and two, since the cows in group two were younger cows and would thus be on test for a greater percentage of the time. Also some of the cows in group two later became infected, and this infection might have been effective in reducing the breeding efficiency prior to the time of its being diagnosed as abortion.

The interval between an abortion and the following normal calving is due to several factors. First, the breeding of an aborting cow is often delayed for ninety days or longer, until cessation of discharges from the genital organs. Second, frequently a cow will abort two or more times in succession. In this study the interval is considered as the time from the first abortion to the dropping of a normal calf. In the third place, as is shown later, the number of services required for a pregnancy following an abortion is usually greater than at other times.

The data show that if a cow should abort her first calf, and live to be approximately seven and one half years of age, she would lose about two thirds of a lactation during her productive life. This means considerable expense for feed, labor, housing, and probably veterinary services, with little or no returns.

It may also be observed that there is probably a tendency for a lowered breeding efficiency in cows that have aborted and are considered to have returned to the so called "normal" breeding. The



interval between calvings in that group averaged 425.9 days, compared to 407.8 and 417.8 days for the average interval between calvings of clean cows and all cows previous to aborting. Very few of the abortion infected cows were placed on test after they had apparently returned to normal. This average loss amounts to from two to three weeks per year, and during the lifetime of the average cow would be from three to four months, should she become infected as a heifer and then return to breed regularly.

Wide variation was noticed between individual cows studied. Cow No. 421 dropped eight calves subsequent to aborting at an average interval of  $352\frac{1}{2}$  days, or slightly less than a year. Cow No. 212 dropped seven normal calves after having aborted, at an average interval of  $472\frac{1}{2}$  days, or approximately eighteen months. More complete information on most of the sections of this treatise may be found in tabular form following the summary.

#### The Number of Services per Pregnancy.

All services required for each pregnancy in the college dairy herd for as long as records were available previous to January 1, 1928 were used in this study. Table III presents a summary of this compilation.

Table III.

The influence of abortion infection on the number of services per pregnancy in the college dairy herd.

	No. of pregnancies	Av. No. of services
1. Abortion-free cows . . . . .	237	2.17
2. All cows prior to an abortion, (some of these later became infected, while others re- mained abortion-free . . . . .	499	2.09
3. First pregnancy following an abortion . . . . .	48	3.35
4. Cows having dropped a normal calf subsequent to an abortion	141	2.41

The cows were also divided into four groups for this study. As indicated in table III, group one consisted of only cows that were free from the disease. Group two was made up of those cows that were free from the infection (group one) and also cows that had not aborted, but later became infected. Some of these cows appear also in groups three and four. Group three includes only the pregnancies of those aborting cows immediately following the abortion. Group four includes those cows that have apparently returned to normal after having aborted.

A service as herein referred to means each time that the cow was mated with the bull. Usually only one cover was made at those times, but occasionally more covers were given.

To secure a pregnancy in the period following an abortion required 60 per cent more services than for pregnancies prior to an abortion. Nearly 16 per cent more services were necessary to secure pregnancies following normal gestations subsequent to abortions, than were needed for the pregnancies prior to the abortions.

Interpreted in another way, the data show that the cost of the bull would be increased from 16 to 60 per cent per cow in an infected herd, since the service requirement would be correspondingly greater. In many instances this extra need of service would tend to cause a bull to become incapable of securing pregnancies, not only in the infected cows, but also in the cows that are free from the disease.

The difference between the abortion-free group and the group composed of all cows is small. It may be partly accounted for by the fact that the abortion-free group was composed of cows of all ages, while the other group was made up largely of young cows. The bulls have been changed from time to time and it may be that the sires being used in more recent years on the abortion-free cows are not as sure breeders as some of the bulls used in the past.

#### The Age at which Cows are Discarded.

One hundred thirteen cows in the college herd were available for this comparison. These cows either died while in the herd, or were sold to the butcher because they were non-breeders or were unprofitable for milk production. Table IV is a summary of the ages of these cows.

Table IV.

The influence of abortion infection on the age at which cows have been discarded from the college dairy herd.

	Age in years	
	Clean cows	Reacting cows
Jerseys	7.1	7.3
Holsteins	6.2	5.4
Ayrshires	6.9	6.8
Guernseys	6.5	5.4
All breeds	6.7	6.2
Average for the United States (12)	7.3	

The average age of discarded cows in the United States is based on a statistical computation. By averaging the number of heifers 1 to 2 years of age being kept for dairy purposes in this country during the years 1920-1926, the average number of heifers kept for replacement is obtained. The average number of dairy cows in the United States during the same years was divided by the number kept for replacement, and the result, namely 5.3 years, represents the number of years required to replace the average cow. This may also be interpreted to be the average life of the cow after she is two years old. As a cow requires two years for growth and development the actual age at time of discarding is 7.3 years.



Table IV shows that the cows in the college herd have not been kept as long as the average dairy cows in the United States. This has been due to more careful weeding out of poor producers and cows of poor type from the college herd. There was not a wide difference between the average age at which clean cows and reacting cows were discarded. Undoubtedly many of these reacting cows would have been sold had they not been kept for experimental purposes. From the standpoint of commercial dairying this comparison is not especially significant.

Seventeen cows failed to produce normal calves after aborting. Of these cows, 7 were sold to the butcher because they were non-breeders, 6 were sold to the butcher because of poor production, and 4 died from various causes. These cows were in the herd an average of 11.2 months following the abortion. The average age at time of sale or death was 5.6 years. These cows represent 29.31 per cent of the total number of cows that aborted. This is evidently a much greater percentage of discarded cows than would be the case with normal cows of that age.

#### The Number of Calves per Cow.

The one hundred thirteen cows that were in the college herd for their entire useful life were used for this study. Table V compares the average number of calves produced by the reactors and by the non-reactors. A calf is considered as a living calf at time of birth.

Table V.

The influence of abortion infection of the number of calves produced per cow in the college dairy herd.

	Clean cows	Reacting cows
Number of cows studied	57	56
Average number of calves per cow	3.05	2.37
Percentage of normal	100.0	77.7

This table shows that the reacting cows produced only 77.7 per cent as many calves as did the clean cows. If the value of \$20.59 as estimated by White (2) is credited to each cow per calf produced, the clean cows will return \$61.87, while the reacting cows return only \$48.80. In the college herd the conditions are not what would be found on many farms, since many of the reacting cows were retained for experimental purposes after they had ceased to be profitable.

In the Dickson herd the average number of calves registered during the three years 1919 to 1921 inclusive was 21. After many of the cows became infected, the number registered dropped to an average of 15.5 per year from 1923 to 1926. That is only 73.81 per cent as many calves, while the average number of cows remained at twenty eight. This agrees quite closely with the college herd.

The Butterfat percentage.

To ascertain if there was any appreciable influence of the abortion infection on the butterfat content of the milk, the average tests of the cows for each lactation used later in this study were compared. Table VI shows the average tests of the cows prior to an abortion, immediately following the abortion, and in normal lactations subsequent to an abortion.

Table VI.

The influence of the abortion infection on the butterfat content of the milk.

	Average butterfat percentage
Lactations prior to an abortion	4.236
Lactations immediately following an abortion	4.270
Normal lactations subsequent to an abortion	4.172
Total variation in the averages	.098

The above table includes averages of 7 Jersey, 6 Holstein and 8 Ayrshire cows in each group. The variation was very slight, and presumably may be due to errors in the technique of testing rather than to the influence of the abortion infection.

The Milk Production During the Lactation Immediately Following an Abortion.

A group of twenty one cows in the college dairy herd, and seven cows in the herd of J. M. Dickson and Son, were available for this study. Each of these cows had completed one or more normal lactations prior to an abortion. They later aborted and their production for the lactation following was available for one or more lactations immediately following the abortions. Subsequently they calved normally and completed normal lactations. Table VII is a summary of the average production of these cows.

Table VII.

The influence of the abortion infection on milk production in the lactation immediately following an abortion.

	No. of cows	Milk production	
		Prior to abortion	Following abortion
(The O.S.A.C. Herd)			
Jersey	7	7046.5	3988.8
Holstein	6	10097.2	8469.9
Ayrshire	8	10234.2	7993.4
Average all breeds	21	9125.9	6817.4
Percentage of normal		100.00	74.70
(The Dickson Herd)			
Jersey	7	8142.2	5931.6
Percentage of normal		100.00	72.82



The length of the actual lactations varied widely. In order to overcome this variation, the production during the 305 day period following the calving or abortion was determined for each lactation. The 305 day period represents the normal average lactation. By using this standard lactation period all cows are put on an equal basis.

To compare these lactations it was necessary to compute them to the mature equivalent production. Clark (13), Ragsdale, Turner, et al (14), Pearl and Miner (15), Gowen (16), (17), and (18), Graves and Fohrman (19), and Fohrman (20) have each published factors for computing the mature equivalent production of cows of various breeds. The factors published by Clark are based on a study of the records of cows kept in college dairy herds, including the herd at Oregon State Agricultural College, hence they were selected for use in this study.

Many of the cows were on Advanced Registry or Register of Merit tests for one or more lactations. During these lactations the cows were usually milked three times per day. Eckles (10) estimated the production of cows under herd conditions to be 58 per cent of their production when under official test conditions. Woodward (21) found that cows in the government herd at Beltsville, Maryland produced approximately 50 per cent more milk when they were kept under official test conditions, than when they were under ordinary herd conditions at that place. The writer compared the productions of thirty six cows in the college herd kept under ordinary herd and

official test conditions. He found that the mature equivalent production of the cows under herd conditions was 72.9 per cent of their production when under test conditions.

The study by Eckles (10) included many cows milked four times daily, and the yearly production of test cows was compared with the production of other cows when they were bred to calve within twelve months. In Woodward's study the lactations were all standardized to equal length. The cows were milked three times daily, and were stabled in box stalls when on test. In the college herd the cows were also milked three times daily, but were stabled in the regular stanchions beside the other cows. The average of the factors found in the Beltsville herd, and in the Oregon State Agricultural College herd was 69.8. It was therefore decided to use .7 as a factor for converting the records made while the cows were on test to herd conditions. This is the same as the factor used by White and his associates (3) in computing the mature equivalent productions shown in figure I.

In some instances the cows had two or more normal lactations prior to aborting. In such cases all records were computed to the mature equivalent, and the average of these equivalents was used as a basis for comparing the lactations of that particular cow.

The difference between the different breeds is not considered of special significance. This does not mean that one breed is any more susceptible than any other, but that the cows used in this study happened to vary more in one breed than in the others. The

results agree quite closely on the two herds as a whole. There is a somewhat greater decline than found in the Connecticut station herd (2) where the decline was reported as 16.1 per cent. It is approximately the same as estimated by Simms and Miller (4), namely a 25 per cent decline.

The difference in the production of the average cow studied and her production following the abortion is 2308.5 pounds. Valuing milk at \$3.00 per hundredweight, the return from an abortion infected cow would be \$69.25 less than for a cow free from the disease, during the lactation immediately following the abortion. This loss of 2308.5 pounds of milk is also nearly one half of the average annual milk production per cow in Oregon.

The Pearsonian coefficient of correlation (22) between the average annual milk production and the percentage of decline following the abortion, was found to be  $.327 \pm .112$ . This indicates that there may be some relationship between the normal plane of production and the percentage of loss following the abortion. The number of cows used was too small for the correlation to be significant.

#### Milk Production in a Normal Lactation Subsequent to an Abortion.

Twenty one cows in the college herd and seven cows in the Dickson herd were available for this comparison. Their records were computed

to the 305 day mature herd equivalent as previously discussed in this paper. Table VIII gives the summary of this study.

Table VIII.

The influence of abortion infection on the milk production in the normal lactations subsequent to an abortion. ( See appendix ).

	Number of cows	Milk production Prior to abortion	Nor. Lac. Sub. to abortion
(The O.S.A.C. Herd)			
Jersey	7	7046.5	5324.2
Holstein	6	10097.2	8820.8
Ayrshire	8	10234.2	7876.1
All breeds	21	9125.9	7340.4
Percentage of normal		100.0	80.4
(The Dickson Herd)			
Jersey	7	8142.2	7119.5
Percentage of normal		100.0	87.4

There was a variation in the amount of decline in the production during the normal lactations subsequent to an abortion, ranging from nothing to as much as 50 per cent, and averaging between 15 and 20 per cent. Variation was observed between breeds. This was not thought to be due to one breed being any more resistant, or any



more susceptible than any other breed. The main variation in production was that of the individuals regardless of the breed. One of the important factors concerned in this variation was undoubtedly the amount and intensity of udder infections in the individual animals. The yield of the seven Jerseys was 75.5 per cent, the six Holsteins 87.3 per cent, and the eight Ayrshires was 76.9 per cent of their normal mature equivalent milk yield. The mean percentage in these normal lactations subsequent to aborting was 81.8 per cent of the normal yield previous to aborting.

Only three cows in the college herd, Nos. 8, 10 and 415, and one cow, Lass, in the Dickson herd yielded as high a mature milk equivalent in the normal lactations subsequent to the abortion as they did before aborting. The chances that a cow will return to normal are only one in seven, or 14.3 per cent, if these data can be applied universally.

It was thought that the developing fetus might inhibit the milk production in the latter part of some of these lactations. The number of days in the normal lactations that a fetus was carried averaged 127 days in the group prior to the abortion, and 117 days in the group subsequent to the abortion, for the cows in the college herd. No attempt was made to establish a correction for this condition.

#### Milk Production by Half-sisters.

A group of half-sisters, 20 daughters of Oregon Peter Pan, and 14 daughters of Willowmoor Robinhood 26th, all Ayrshires, and from cows

having similar breeding and production records, were compared. Their records were studied with relation to the actual milk yield during the 305 days following the abortion or calving, except in the case of records made while the cows were on test, when the factor of .7 was used to convert these records to herd equivalent yields. Table IX shows the average production per lactation for the first four lactations of these cows.

Table IX.

The influence of the abortion infection on the records of half-sisters.

Lactation	Clean cows		Reactors		Percent- age
	No.	Lbs. milk	No.	Lbs Milk	
(Daughters of Willowmoor Robinhood 26th)					
First	11	6093.5	3	5255.2	86.2
Second	7	7216.8	6	5761.4	79.8
Third	4	7906.4	6	7437.8	94.1
Fourth	3	8047.5	4	7131.5	88.6
Average		7180.6		6264.3	87.2
(Daughters of Oregon Peter Pan)					
First	15	7115.0	5	6205.2	87.2
Second	8	7281.7	5	6278.6	86.3
Third	5	8742.6	3	6181.4	91.7
Fourth	3	8712.9	2734	5734.6	65.8
Average	7530.7	7580.7		6099.9	80.5

The average age of these cows was nearly the same for each lactation, there being only a month or two difference in each instance.

The average yield of the reactors was lower in every lactation than was the yield of the clean cows. The reacting daughters of Willowmoor Robinhood 26th produced only 87.2 per cent as much milk as did their half-sisters that were abortion-free. The daughters of Oregon Peter Pan showed a greater variation. The reactors yielded only 80.5 per cent as well as did the clean cows. This difference may be partly due to the fact that the daughters of Oregon Peter Pan were on a higher plane of production. The correlation previously mentioned shows that there may be some relationship between the plane of production and the subsequent production following an abortion, but the number of cows available for correlating was too limited for there to be any significance to the result.

Of the thirty four lactations of reacting cows included in this study, only 16 were made immediately following an abortion. Two cows, Nos. 428 and 438, never aborted, but were reactors to the test for the infection. These data agree with those of the previous section, and show more conclusively that reacting cows are poorer producers than are cows that have not become infected.

#### Milk Yield and the Time the Aborted Fetus was Carried.

A correlation was made between the number of days that the aborted fetus was carried and the percentage of the normal milk yield produced immediately following the abortion. Twenty eight cows were available for this correlation. The coefficient of correlation was

found to be  $.399 \pm .111$ . Since the probable error of this value of  $r$  is more than one seventh (23) of its computed value, there can be no significance attached to the correlation. It is possible that with a larger number of cows it might be observed that some relationship exists.

A history of these cows reveals other factors of importance in determining the resultant production besides the length of time the fetus was carried. Cow No. 8 produced 79.3 per cent of her normal yield following an abortion 62 days after being served. There were apparently no secondary infections and the cow was still producing well from the stimulus of the previous calving. Cow No. 20 aborted a fetus that had been carried 265 days. She produced 60.9 per cent of her previous normal yield. This cow had aborted earlier in life and was having some udder trouble. Cow No. 5 aborted a fetus 211 days old. Her udder became so badly infected that she produced only 163.4 pounds of milk during the following year. Cow No. 10 aborted 190 days after service. She was one of the few cows that produced their normal amount of milk following an abortion.

#### The Lifetime Milk Production.

The total production of the 57 clean cows and the 56 reacting cows that spent their entire useful life in the college dairy herd, was determined. Table X gives the average lifetime productions of these cows.



Table X.

The influence of the abortion infection on the lifetime production of cows in the college dairy herd.

Group	Number of cows	Average production of milk	Percentage of normal production
Abortion-free cows	57	25,525.57	100.00
Cows that aborted their first calf	22	13,556.64	53.11
Cows that aborted during their first or second gestations, and reactors that did not abort	43	18,893.21	73.62

The above table represents the actual production of the cows, and has not been computed for age, length of lactation or for the conditions under which the cow was kept. The data are in accordance with what might be expected when the decreased breeding efficiency and lowered productive ability are both considered.

On observing the above, the thought may come to the reader that the production of the abortion-free cows is much lower than it should be. This may be the case, for the college herd has been closely culled to eliminate the low producing and poorer type cows. This culling has shortened the average life of the cows to nearly one year less than the average for the United States.

Another comparison of lifetime production was made by calculating the production of a typical clean cow as found in the preceeding

sections, and of a typical aborting cow. Based on the mature equivalent herd average for 1928 of 9594.8 pounds of milk, dropping of the first calf at two years three months, and calving every 407 days thereafter, until the age of 6.7 years, and using Clark's (13) factors for computing the production at any age based on the mature herd equivalent, it was found that an average clean cow would produce 28,036.4 pounds of milk in her lifetime.

The computed production for the aborting cow was 15,942.3 pounds. This is based upon the cow aborting at two years and producing 73 per cent of her normal for that age. She should calve again 563 days following the abortion, and every 425 days thereafter until she reaches the age of 6.2 years. Following each of these normal calvings she should produce 80 per cent of her normal for that age.

It may be observed that from this computation the aborting heifer will produce only 56.86 per cent of her yield had she not aborted. This is very close to the actual conditions found in the college herd, of 53.11 per cent of the normal. At Oak Hill Estate, Thompson's (7) reacting herd produced an average of only 51.17 per cent of the average yield of the clean herd during a period of two years.

The average cow in Oregon produces approximately 190 pounds of butterfat per year. At 48 cents per pound this butterfat would be worth \$91.20. Forty hundredweight of skimmilk at 20 cents per hundred would be worth \$10.00. This makes an average gross annual return of \$101.20 per cow from products. If this return were reduced to 55 per cent due to abortion infection, it would be only \$55.66. This means

a loss of \$51.14 per cow. If twenty per cent of the 216,000 dairy cows, estimated to be on farms in Oregon January 1, 1928 by the United States Department of Agriculture (12) are infected with abortion, there would be 43,200 infected cows in the state. At \$51.14 per cow, this would mean an annual loss of over \$2,000,000.00 from milk production alone, due to abortion infection.

A Jersey breeder near Corvallis has estimated that the losses in his herd from the decreased milk production have been only 15 per cent of the total loss. Other losses estimated were: calves, depreciation in value of cows, increased mortality among cows, improper matings, loss of prestige, and veterinarians services, remedies, etc, necessitated by the infection. All of these losses will not occur in every herd, but most of them will be present to a greater or lesser extent.

## SUMMARY AND CONCLUSIONS

No definite forecast can be made relative to the economic usefulness of infected cows. Their usefulness will depend upon whether or not they are purebred or grade, the blood lines, the plane of production, the breeding efficiency, the intensity of the infection, the ages of the cows, secondary infections such as udder trouble, and the natural resistances of the animals. Based on the results of this study, the usefulness of a large group of cows may be summarized as follows:

1. Interference with the normal reproduction was found to cause a loss of over one half year of the productive life of the cows that aborted.

2. Cows that have aborted apparently do not completely return to their normal breeding efficiency later in life.

3. The useful life of a cow infected with abortion is probably shortened by at least 20 per cent.

4. Nearly 30 per cent of the cows that aborted failed to drop normal calves again.

5. In a badly infected herd the calf crop is reduced by approximately 35 per cent.

6. The butterfat content of the milk is apparently uninfluenced by the infection.

7. The most serious decline in milk production comes in the lactation immediately following the abortion. This decline averages nearly 30 per cent.



8. A decline of nearly 20 per cent in the milk yield is observed in the normal lactations of infected cows.

9. When the decreased milk yield and the loss of productive life are both considered, a heifer that aborts her first calf may be expected to produce only about 55 to 60 per cent of the yield that would be expected had she not become infected.

10. Of the 56 cows in the college herd that were observed to abort during a period of 15 years, only 21, or  $37\frac{1}{2}$  per cent completed a normal gestation and lactation cycle following the abortion. Of these 21 cows, only three, or 14.3 per cent produced as much milk as was to be expected.

T A B L E S.

Table XI.

The computed average production of 4 per cent milk per cow in the college dairy herd, by years from 1915 to 1928.

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Year	Average pounds of 4 % milk per cow
1915	11,000.8
1916	11,399.3
1917	8,961.0
1918	8,943.8
1919	7,638.9
1920	6,635.4
1921	7,997.8
1922	7,484.8
1923	8,078.4
1924	8,012.0
1925	8,774.8
1926	10,824.9
1927	10,011.0
1928	9,594.8

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Table XII.

The number and percentage of calvings, abortions, sterile cows and total breeding cows in the college dairy herd from 1915 to 1928.

Year	Calvings		Abortions		Sterile cows		Total No. cows
	No.	Pct.	No.	Pct.	No.	Pct.	
1915	15	71.4	2	9.5	4	19.1	21
1916	24	68.8	6	17.6	4	11.8	34
1917	19	50.0	5	13.2	14	36.8	38
1918	25	58.1	10	23.3	8	18.6	43
1919	40	67.8	13	22.0	6	10.2	59
1920	39	66.1	11	18.6	9	15.3	59
1921	41	60.3	15	22.7	12	17.6	68
1922	50	75.8	8	12.1	8	12.1	66
1923	30	71.4	4	9.5	8	19.1	42
1924	46	83.7	6	10.9	3	5.4	55
1925	38	88.4	3	7.0	2	5.6	43
1926	50	94.4	1	1.9	2	3.9	53
1927	46	93.8	0	0.0	3	6.5	49
1928	58	87.8	3*	4.6	5	7.6	66

Note: The three abortions that occurred in 1928 were apparently due to causes other than abortion infection, since the organism could not be isolated from any of the fetal membranes.



Table XIII.

The dates at which the cows in the college dairy herd first showed a negative reaction to the test for Abortion infection.

Cow No.	Date	Cow No.	Date	Cow No.	Date
2	1-17-19	212	4-17-19	436	3-10-21
3	12-9-18	215	1-21-19	437	6-7-20
4	1-17-19	216	1-8-26	438	11-14-21
5	12-9-18	217	3-8-19	440	2-7-22
8	4-19-19	224	9-15-21	441	3-10-21
10	5-7-19	226	5-22-23	442	12-11-21
12	4-19-19	227	6-14-21	446	5-3-24
15	1-17-19	232	3-2-26	454	2-18-23
16	4-19-19	236	1-4-24	467	5-13-24
17	12-9-18	248	7-17-28	602	3-13-19
19	4-19-19	404	7-7-19	606	1-17-19
20	1-17-19	405	3-8-19	607	1-10-19
21	1-17-19	407	1-17-19	609	3-13-19
22	1-10-19	409	4-19-19	610	7-7-19
23	4-19-19	413	1-21-19	612	3-13-19
24	1-10-19	414	1-21-19	614	5-28-19
27	7-12-20	415	12-10-18	615	3-13-19
28	12-15-20	416	1-17-19	616	3-13-19
29	4-12-21	418	1-21-19	618	7-7-19
30	11-14-21	419	1-17-19	619	10-7-19
36	3-15-22	420	1-17-19	622	10-10-21
37	7-1-22	421	1-17-19	624	3-11-22
40	4-2-24	425	3-10-21	625	6-1-23
44	8-7-24	428	1-12-20	626	10-5-22
47	5-13-24	429	8-9-20	632	2-7-23
202	4-17-19	430	5-5-25	634	6-5-24
204B	1-21-19	432	7-12-20	635	3-3-25
		636	3-30-25		

Note: Throughout this study dates are indicated as 3-30-25, which gives the month, day and year respectively.

Serological testing for abortion infection began in December 1918.

Table XIV.

The variation in the length of the intervals between normal calvings of abortion-free cows in the college dairy herd. From the breeding record books of the Department of Dairy Husbandry, Oregon State Agricultural College.

Length of interval in days	No. of intervals	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
650-699	5	6	30	180
600-649	3	5	15	75
550-599	1	4	4	16
500-549	7	3	21	63
450-499	17	2	34	68
400-449	27	1	27	27
350-399	47	0	0	0
300-349	35	-1	-35	-35
250-299	2	-2	-4	8
Totals	144		92	472

Geometric mean  $406.44 \pm 50.08$

Arithmetic mean 407.8

Standard deviation 90.5

Table XV.

The variation in the length of the intervals between normal calvings in all cows in the college dairy herd prior to the time of their aborting. Some of these cows later became infected while others remained abortion-free. From the breeding records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Length of intervals in days	No. of intervals	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
800-899	2	4	8	32
700-799	2	3	6	18
600-699	14	2	28	56
500-599	27	1	27	27
400-499	138	0	0	0
300-399	143	-1	-143	143
200-299	3	-2	-6	12
Totals	329		-80	286

Geometric mean  $425 \pm 3.48$

Arithmetic mean 417.8

Standard deviation 93.5

Table XVI

The variation in the length of the intervals between an abortion and the following normal calving in cows of the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Length of intervals in days	No. of intervals	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
2100-2199	1	16	16	256
1800-1899	1	13	13	169
900-999	2	4	8	36
800-899	5	3	15	45
700-799	2	2	4	8
600-699	2	1	2	2
500-599	7	0	0	0
400-499	15	-1	-15	15
300-399	13	-2	-26	52
Totals	48		17	583

Geometric mean  $584.9 \pm 37.33$

Arithmetic mean 563.8

Standard deviation 346.8



Table XVII

The variation in the length of the intervals between normal calvings subsequent to an abortion in cows of the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Length of intervals in days	No. of intervals	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
700-799	1	3	3	9
600-699	2	2	4	8
500-599	11	1	11	11
400-499	19	0	0	0
300-399	32	-1	-32	32
200-299	1	-2	-2	4
Totals	66		-16	64

Geometric mean 425.26  $\pm$  8.19

Arithmetic mean 425.9

Standard deviation 98.4

Table XVIII.

A comparison of the average interval between normal calvings and abortions to normal calvings, by breeds in the college dairy herd. Data from the breeding records of the Department of Dairy Husbandry, Oregon State Agricultural College.

	Jersey	Guernsey	Ayrshire	Holstein	All breeds
Abortion-free cows:					
No. intervals	39	15	48	42	144
Av. no. days	390.4	414.7	399.6	430.7	407.8
All cows, (Some later aborted, others remained clean):					
No. intervals	83	37	133	76	329
Av. no. days	422.1	422.9	397.2	446.9	417.8
Abortion to normal calving:					
No. intervals:	14	4	19	9	46
Av. no. days	748.8	565.0	466.2	513.0	563.8
Normal calvings subsequent to an abortion:					
No. intervals	20	4	28	14	66
Av. no. days	437.7	411.5	410.9	443.3	425.9

Table XIX

The variation in the number of services per pregnancy in the abortion-free cows of the college dairy herd. Data from the breeding records of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of Services per Pregnancy	No. of Pregnancies	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
8	4	6	24	144
7	6	5	30	150
6	3	4	12	48
5	11	3	33	99
4	21	2	42	84
3	25	1	25	25
2	42	0	0	0
1	125	-1	-125	125
Totals	237		41	675

Geometric mean  $2.173 \pm .0735$

Arithmetic mean 2.17

Standard deviation 1.68

Table XX.

The variation in the number of services per pregnancy in all cows in the college dairy herd prior to an abortion. Some of these cows later became infected, while others remained abortion-free. Data from the breeding records of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of services per pregnancy	No. of pregnancies	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
15	1	13	13	169
11	1	9	9	81
10	2	8	16	128
9	1	7	7	49
8	6	6	36	216
7	8	5	40	200
6	8	4	32	128
5	19	3	57	171
4	35	2	70	140
3	52	1	52	52
2	84	0	0	0
1	282	-1	-282	282
Totals	499		50	1616

Geometric mean  $2.10 \pm .054$  , Standard deviation 1.79 , Arithmetic  
mean 2.09



Table XXI

The variation in the number of services required per pregnancy immediately following an abortion, in cows in the college dairy herd. Data from the breeding records of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of Services per Pregnancy	No. of Pregnancies	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
13	1	10	10	100
12	0	9	0	0
11	1	8	8	64
10	0	7	0	0
9	2	6	12	72
8	0	5	0	0
7	2	4	8	32
6	1	3	3	9
5	3	2	6	12
4	7	1	7	7
3	6	0	0	0
2	11	-1	-11	11
1	14	-2	-28	56
Totals	48		15	363

Geometric mean  $3.312 \pm .267$  Arithmetic mean 3.35 Standard deviation 2.74

Table XXII

The variation in the number of services required per pregnancy following a normal calving in cows that have aborted in the college dairy herd. Data from the breeding record books of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of services per pregnancy	No. of pregnancies	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
13	1	11	11	121
12	0	10	0	0
11	1	9	9	81
10	0	8	0	0
9	3	7	21	147
8	1	6	6	36
7	5	5	25	125
6	3	4	12	48
5	3	3	9	27
4	9	2	18	36
3	16	1	16	16
2	30	0	0	0
1	69	-1	-69	69
Totals	141		58	706

Geometric mean  $2.411 \pm .126$  Arithmetic mean 2.41 Standard  
deviation 2.24

Table XXIII.

The average number of services per pregnancy by breeds in the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

	Jersey	Guernsey	Ayrshire	Holstein	All breeds
<hr/>					
Abortion-free cows:					
No. pregnancies	57	28	87	65	237
Av. no. services per pregnancy	2.05	1.82	1.90	2.80	2.17
All cows prior to an abortion, (Some later became infected, others free from the infection):					
No. pregnancies	122	67	192	118	499
Av. no. services per pregnancy	1.96	2.37	1.67	2.73	2.09
First pregnancy following an abortion:					
No. pregnancies	16	5	16	11	48
Av. no. services per pregnancy	3.56	3.40	1.88	3.27	3.35
Following normal calvings subsequent to an abortion:					
No. Pregnancies	49	13	50	29	141
Av. no. services per pregnancy	2.88	2.92	1.62	2.76	2.41

Table XXIV

The variation in the ages at which clean cows were discarded from the college dairy herd. Data from the breeding record books of the Department of Dairy Husbandry, Oregon State Agricultural College.

Age when discarded	No. of cows	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
14	1	8	8	64
13	1	7	7	49
12	2	6	12	72
11	4	5	20	100
10	2	4	8	32
9	6	3	18	54
8	1	2	2	4
7	5	1	5	5
6	5	0	0	0
5	9	-1	-9	9
4	4	-2	-8	16
3	9	-3	-27	81
2	6	-4	-24	96
1	2	-5	-10	50
Totals	57		2	632

Geometric mean  $6.535 \pm .298$  Arithmetic mean 6.7 Standard deviation 3.32



Table XXV.

The variation in the ages of the reacting cows at the time they were discarded from the college dairy herd. Data from the breeding record books of the Department of Dairy Husbandry, Oregon State Agricultural College.

Age when discarded	No. of cows	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
13	1	8	8	64
12	1	7	7	49
11	4	6	24	144
10	4	5	20	100
9	5	4	20	80
8	3	3	9	27
7	6	2	12	24
6	5	1	5	5
5	5	0	0	0
4	11	-1	-11	11
3	7	-2	-14	28
2	4	-3	-12	36
Totals	56		68	568

Geometric mean 6.71  $\pm$  .286

Arithmetic mean 6.2

Standard deviation 3.18

Table XXVI.

The variation in the number of living calves dropped by the clean cows discarded from the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of calves per cow	No. of cows	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
12	1	9	9	81
11	0	8	0	0
10	0	7	0	0
9	1	6	6	36
8	2	5	10	50
7	3	4	12	48
6	2	3	6	18
5	7	2	14	28
4	8	1	8	8
3	4	0	0	0
2	7	-1	-7	7
1	14	-2	-28	56
0	8	-3	-24	72
Totals	57		6	404

Geometric mean  $3.10 \pm .239$

Arithmetic mean 3.05

Standard deviation 2.66

Table XXVII.

The variation in the number of living calves dropped by the reacting cows discarded from the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

No. of calves per cow	No. of cows	Deviation	Deviation x number	Product of (deviation) <sup>2</sup> x number
7	5	5	25	125
6	1	4	4	16
5	3	3	9	27
4	4	2	8	16
3	10	1	10	110
2	10	0	0	0
1	12	-1	-12	12
0	11	-2	-22	44
Totals	56		22	250

Geometric mean  $2.393 \pm .189$

Arithmetic mean 2.37

Standard deviation 2.11

Table XXVIII.

Milk production data on cows in the college dairy herd prior to an abortion. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Cow No.	Age yr. mo.	Actual 305 day prdn. milk lbs.	Computed 305 day prdn. lbs.	Carried calf da.
4	2 8	4554.2	5419.5	85
4	4 1	6214.9	6774.2	173
5	1 10	4579.9	5953.9	34
5	3 4	6240.6	7501.9	148
5	4 8	9336.1T	6917.4	142
8	2 11	7054.2T	5777.4	1400
8	4 1	6770.3T	5165.7	152
10	3 11	7117.8T	5530.5	---
16	2 3	8491.1T	7251.4	68
16	3 8	8749.5T	6859.6	115
19	2 7	6757.3T	5676.1	177
20	2 1	7814.8T	6783.2	136
201	3 3	9299.5T	8592.7	198
201	4 4	11361.0T	9225.1	227
204B	2 4	9097.3	13373.0	119
217	2 0	8677.5T	9172.1	207
223	2 10	10958.1T	10585.5	50
212	2 8	10996.1T	9964.8	177
216	2 2	7459.2T	9257.7	157
216	3 4	6805.8	8915.6	100
216	4 8	5692.5	6489.4	165
216	5 11	14791.7T	11493.1	122
216	7 3	9209.8	9301.9	---
216	9 6	5326.4	5326.4	247
216	10 5	9266.7	9266.7	210
407	2 9	6751.2T	6899.7	143
407	4 0	7283.4	9686.9	234
407	4 11	10726.9T	9160.8	219
409	2 4	8932.4T	9374.7	175
409	3 6	10027.2T	9686.2	207
409	4 6	9981.6	12676.6	---
409	6 1	12975.5T	10263.6T	125
409	7 4	10298.9T	10916.8	176
409	8 6	11744.4T	8221.0	182



Table XXVIII (Continued).

Cow No.	Age yr. mo.		Actual 305 day prdn. milk lbs.	Computed 305 day prdn lbs.	Carried calf days
415	2	2	5975.2	8963.8	---
418	2	7	6864.5	10090.8	111
421	2	4	6350;9	9462.8	188
431	2	6	7627.4	11288.5	164
432	2	4	9282.9T	9681.1	143
446	2	4	9137.0	13614.1	---

Note: The column headed "cow No." represents the number of the cow in question. The Jersey numbers begin with 1 and continue to 200. The Holstein numbers are between 201 and 400. The Ayrshire numbers start with 401 and end with 600. The age is at the time the lactation was started. The actual production column shows the amount of milk produced during the 305 day period following the calving or abortion. When this production is followed by the letter T, the cow was kept under official test conditions while that production was made. The computed mature herd equivalent, as discussed previously is shown in the column headed "computed 305 day prdn. lbs." The number of days that a developing fetus was carried is shown in the right column. This represents the interval elapsing between the time of service and the close of the 305 day lactation period chosen for this study. It does not mean that the fetus was expelled or died at that time.

Table XXIX.

Milk production data on cows in the college herd during lactations immediately following an abortion. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Cow no.	Age yr. mo.		Actual 305 day prdn. milk lbs.	Computed 305 day prdn. lbs	Carried calf days
4	4	10	3333.8	3533.8	181
4	5	9	2251.6	2319.1	103
5	5	7	163.4	168.3	183
8	4	8	5846.5T	4338.0	208
8	5	7	6218.6	6405.1	116
10	5	11	5608.5	5720.7	---
16	4	8	4092.0	4337.5	246
16	7	8	4107.8	4107.8	221
19	3	5	4659.8	5265.5	---
20	3	1	3756.8	4357.8	168
20	3	9	3736.8	4136.2	221
201	5	2	8999.0	9898.9	241
201	8	3	5140.3	5140.3	224
204B	2	10	7010.0	9680.8	132
217	3	0	10495.4T	9540.1	67
223	4	2	9083.1	10718.1	156
212	3	8	6820.9	8594.3	157
216	11	2	4673.4	4766.9	169
407	5	11	5360.6	6111.1	---
409	9	6	6526.0	6526.0	231
415	3	9	6306.9	8514.3	115
418	3	7	4133.9	5663.4	265
421	3	7	6711.1	9194.2	126
431	3	7	10695.2T	10256.7	234
432	3	3	7059.8	9954.3	164
446	3	11	5810.0	7727.3	63

Table XXX.

Milk production data on cows in the college herd during lactations following a normal calving subsequent to an abortion. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Cow No.	Age yr. mo.	Actual 305 day prdn. milk lbs.	Computed 305 day prdn. lbs.	Carried calf days
4	7 10	8588.7T	6072.1	141
4	8 3	5002.4	5002.4	48
4	9 8	2691.1	2691.1	75
5	6 8	6308.2	6371.3	163
5	7 10	1363.4	1363.4	207
5	8 10	884.9	884.9	152
8	6 11	7562.3	7637.9	154
8	8 0	7226.2	7226.2	---
10	9 7	9076.4T	6353.5	---
10	10 9	5201.3	5305.3	52
16	5 7	6393.9T	4609.9	50
19	6 3	7014.6T	5008.4	55
20	4 9	7801.7	8269.8	147
20	5 11	10173.1T	7263.5	84
20	7 4	1609.3	1609.3	271
20	8 6	3643.6	3643.6	26
201	6 2	14007.3T	10197.2	235
201	7 1	14535.5T	10378.3	---
201	9 3	4195.9	4195.9	233
201	10 5	8235.6	8235.6	234
204B	4 1	12021.2T	10013.6	---
217	5 4	14767.1T	11163.9	65
217	6 9	6145.4	6238.3	262
223	5 4	6329.7	6836.0	258
212	4 10	10116.7T	7931.4	157
212	6 1	10227.4	10738.7	211
212	7 1	13321.6T	9511.6	3
212	8 9	6993.0	6993.0	91
212	10 1	6875.3	6875.2	142
212	11 4	7957.5	8116.6	47
212	12 10	8448.9	8702.3	196
216	12 4	7692.7	7923.5	74

Table XXX (Continued).

Cow No.	Age yr. mo.		Actual 305 day prdn. milk lbs.	Computed 305 day prdn. lbs.	Carried calf days
407	7	6	8320.7T	6115.7	107
409	10	5	4559.2	4559.2	---
415	6	1	8431.2	9527.2	146
418	4	5	6706.0	8583.7	182
418	5	6	6460.6	7623.5	235
421	4	8	8529.9	10662.3	220
421	5	8	10361.8T	8413.7	130
421	6	11	5635.7	6086.5	252
421	7	10	7003.7	7213.8	218
421	8	10	7359.7	7359.7	251
421	9	9	6730.2	6730.2	265
421	10	8	6261.7	6261.7	211
431	4	6	10237.0T	9100.6	50
432	4	6	7885.8	10014.9	1197
432	5	6	7524.4	8678.8	270
432	6	4	7172.9	8033.6	275
432	7	2	8528.1	9125.1	275
432	8	1	3912.8	3991.0	211
446	5	5	7390.5	8720.7	269
446	6	4	9899.4	11087.3	185



Table XXXI.

Summary of the data on aborting cows in the college herd, from Tables XXVIII, XXIX and XXX.

	Prior to aborting	Following an abortion	Nor. Lact. Sub. Abor.
Jerseys ( 7 cows ):			
No. of lactations	12	11	16
Av. no. days calf was carried	111	131	86
Av. length of gestation	nor.	182.	nor.
Av. computed prdn. milk lbs.	7046.5	3988.8	5324.2
Percentage of normal prdn.	100.00	56.6	75.5
Holsteins ( 6 cows ):			
No. of lactations	13	7	16
Av. no. days calf was carried	151	152	132
Av. length of gestation	nor.	211	nor.
Av. computed prdn. milk lbs.	10097.2	8469.9	8820.8
Percentage of normal prdn.	100.00	83.8	87.3
Ayrshires ( 8 cows ):			
No. of lactations	15	8	21
Av. no. days calf was carried	119	150	134
Av. length of gestation	nor.	225	nor.
Av. computed prdn. milk lbs.	10234.2	7993.4	7876.1
Percentage of normal prdn.	100.00	78.1	76.9
All breeds ( 21 cows ):			
No. of lactations	40	26	53
Percentage of normal prdn.	100.00	74.7	80.4

Table XXXII.

Data on cows in the Dickson herd having records prior to, immediately following, and subsequent to an abortion. Data from herd records of J. M. Dickson and Son.

Cow	Age		Actual 305 day	Computed 305	Pet.
	yr.	mo.	prdn, milk lbs.	day prdn lbs.	normal
(Prior to aborting)					
Birdie	1	8	6282.0	8355.0	
Cadie	2	6	8898.0	10704.3	
Susy	2	3	7411.0	9034.0	
Susy	4	8	8029.0	8631.2	
Flora	2	9	5645.0	6779.6	
Lass	5	9	10222.4T	7370.4	
Bo Peep	2	3	4563.0	5562.3	
Florine	2	4	7768.0	9391.5	
Average				8142.2	100.00
(Following the abortion)					
Birdie	3	0	5108.0	5904.8	
Cadie	5	4	7595.0	7906.4	
Susy	5	7	6876.0	7096.0	
Flora	3	7	4922.0	5527.4	
Lass	6	7	6888.0T	4927.6	
Bo Peep	3	1	2607.0	2998.0	
Florine	4	0	6516.0	7161.1	
Average				5931.6	72.82
(Normal lactations subsequent to an abortion)					
Birdie	4	11	7650.0	8047.8	
Cadie	6	5	8344.0	8510.9	
Cadie	7	9	7871.0	7871.0	
Susy	7	5	7664.0	7664.0	
Flora	4	10	4806.0	5075.1	
Lass	8	0	9974.0	9974.0	
Lass	10	0	8436.0	8436.0	
Bo Peep	4	2	6552.0T	4980.8	
Florine	5	3	6293.0	6576.2	
Average				7119.5	87.43

Table XXXIII.

Comparison of the records of half-sisters -- Daughters of Willowmoor Robinhood 26th. (First lactations).

Cow No.	Age yr. mo.	305 day milk prdn, lbs.	Computed for test	Carried calf
(Abortion cows)				
416	2 11	5419.8	5419.8	19
420	2 7	4663.8	4663.8	91
428	3 1	8117.3T	5682.1	115
Average	2 10.3		5255.2	75
( Clean cows )				
414	2 3	6873.5T	4711.5	70
415	2 2	5975.2	5975.2	---
417	2 3	6383.3	6383.3	116
418	2 7	6864.5	6864.5	111
419	2 8	6722.6	6722.6	90
421	2 4	6350.9	6350.9	87
423	2 8	6662.9	6662.9	186
424	2 2	4577.7	4577.7	88
425	2 6	8368.6T	5858.0	115
426	2 6	7764.8T	5435.4	161
427	3 4	7487.1	7487.1	209
Average	2 6		6093.5	112
Difference	4.3		838.3	37

Average production of dams of abortion cows	9291.8 lbs.
Average production of dams of clean cows	10648.5 lbs.
Difference in average production of dams	1356.7 lbs.

Table XXXIV.

Comparison of the records of half-sisters -- Daughters of  
Willowmoor Robinhood 26th. (Second lactation).

Cow No.	Age yr. mo.		305 day milk prdn lbs.	Computed for test.	Carried calf.
(Abortion cows.)					
415	3	9	6976.9	6976.9	115
416	4	5	9327.0T	6528.9	151
418	3	7	4133.9	4133.9	267
420	3	8	647.8	647.8	190
421	3	7	6711.1	6711.1	178
428	4	4	14628.6T	10240.0	---
Average	3	10.5		5761.4	150
(Clean cows.)					
414	3	6	6981.8	6981.8	172
417	3	7	7261.1	7261.1	---
423	3	9	7804.1	7804.1	122
424	3	6	7547.8	7547.8	171
425	3	8	7758.8	7758.8	121
426	3	8	7718.7	7718.7	209
427	4	4	9065.2T	6345.6	17
Average	3	8.5		7216.8	136
Difference	2			1455.4	34

Average production of dams of abortion cows	9945.1
Average production of dams of clean cows	10555.2
Difference in average production of dams	610.1



Table XXXV.

Comparison of the records of half-sisters -- Daughters of Willowmoor Robinhood 26th. (Third lactations ).

Cow No.	Age yr. mo.	305 day milk prdn. lbs.	Computed for test	Carried calf.
(Abortion cows)				
415	6 1	8431.2	8431.2	198
416	5 7	7276.8	7276.8	236
418	5 5	6706.0	6706.0	181
420	4 7	5472.3	5472.3	71
421	4 8	8529.9	8529.9	63
428	6 2	8627.5	8627.5	104
Average	5 3		7437.8	142
(Clean cows)				
414	4 7	6440.5	6440.5	96
423	4 11	13336.5T	9335.6	159
424	4 8	11495.8T	8147.1	121
427	6 0	7702.4	7702.4	254
Average	5 .5		7906.4	157
Difference	2.5		469.4	15

Average production of dams of abortion cows 9945.1 lbs.

Average production of dams of clean cows 9832.6 lbs.

Difference in average production of dams 112.5 lbs.

Table XXXVI.

Comparison of records of half-sisters -- Daughters of  
Willowmoor Robinhood 26th. (Fourth lactations).

Cow No.	Age yr. mo.	305 day milk prdn. lbs.	Computed for test	Carried calf.
-----				
(Abortion cows)				
416	6 7	8778.7	8778.7	104
418	5 6	6460.6	6460.6	238
420	5 8	6528.4	6528.4	91
421	5 8	10361.8T	7253.3	219
Average	5 10		7131.5	164
(Clean cows)				
423	6 2	9620.2	9620.2	51
424	5 10	7128.4	7128.4	156
427	6 11	7393.8	7393.8	254
Average	6 4		8047.5	154
Difference	6		916.0	10
-----				

Average production of dams of abortion cows 10571.2 lbs.

Average production of dams of clean cows 9358.8 lbs.

Difference in average production of dams 1212.4 lbs.

Table XXXVII.

Comparison of records of half-sisters -- Daughters of Oregon  
Peter Pan. (First lactations.)

Cow No.	Age yr. mo.		305 day milk prdn. lbs.	Computed for test	Carried calf da.
(Abortion cows)					
429	2	4	8447.9T	5903.6	164
437	2	5	5984.5T	4189.1	103
440	3	2	7856.7	7856.7	215
441	2	3	7582.3	7582.3	197
442	2	3	5494.6	5494.6	257
Average	2	6.16		6205.2	187
(Clean cows)					
430	2	6	9666.1T	6766.3	15
431	2	6	7648.1T	5353.7	224
432	2	4	9315.1T	6520.6	205
435	2	2	9912.9T	6939.1	198
436	2	0	6376.2	6376.2	224
438	2	3	11765.7T	8237.0	175
439	2	4	11880.4T	8316.3	201
443	2	4	4784.4	4784.4	---
445	2	7	11732.5T	8212.7	222
446	2	4	9075.9T	6353.1	20
447	2	3	5047.1	5047.1	154
449	2	9	5217.2	5217.2	206
450	2	7	8688.9T	6082.2	227
451	2	6	5028.9	5028.9	202
452	2	1	10654.6T	7458.2	230
Average	2	4.4		7115.0	167
Difference		1.76		909.8	20

Average production of dams of abortion cows 12058.6 lbs.

Average production of dams of clean cows 10424.4 lbs.

Difference in average production of dams 1634.2 lbs.

## XXXVIII.

Comparison of records of half-sisters -- Daughters of Oregon  
Peter Pan. (Second lactation).

Cow No.	Age yr. mo.		305 day milk prdn lbs.	Computed for test	Carried calf days
(Abortion cows)					
431	3	6	6153.4	6153.4	147
432	3	3	7325.6	7325.6	186
437	3	11	6776.9	6776.9	191
438	3	6	6192.0	6192.0	158
446	3	11	5824.1	5824.1	129
Average	3	7.4		6378.6	162
(Clean cows)					
430	4	2	7330.2	7330.2	135
435	3	4	6521.3	6521.3	135
436	3	2	9793.7T	6855.6	224
443	4	1	5390.5	5390.5	155
445	3	9	14487.2T	10141.0	256
447	3	4	6686.9	6686.9	232
450	3	8	7368.0	7368.0	156
452	3	3	7960.0	7960.0	225
Average	3	7.1		7281.7	204
Difference	.3			903.1	42

Average production of dams of abortion cows 11363.5 lbs.

Average production of dams of clean cows 9908.7 lbs.

Difference in average production of dams 1454.8 lbs.



Table XXXIX.

Comparison of the records of half-sisters -- Daughters of Oregon Peter Pan. (Third lactation.)

Cow No.	Age yr. mo.	305 day milk prdn lbs.	Computed for test	Carried calf days
(Abortion cows)				
431	4 6	9678.7T	6773.3	51
432	4 6	7524.4	7524.4	202
437	4 11	4296.4	4296.4	275
Av.	4 8		6181.4	176
(Clean cows)				
430	5 1	2704.0	2704.0	41
435	4 8	5962.4	5962.4	42
445	4 10	8908.7	8908.7	201
450	4 9	6189.0	6189.0	54
452	4 4	9949.0	9949.0	154
Av.	4 8.8		6742.6	98
Difference	.8		561.2	78

Average production of dams of abortion cows 11363.5

Average production of dams of clean cows 9542.1

Difference in average production of dams 1821.4

Table XL

Comparison of the records of half-sisters -- Daughters of Oregon Peter Pan. (Fourth lactation.)

Cow No.	Age yr. mo.	305 day milk prdn. lbs.	Computed for test	Carried calf days
(Abortion cows)				
432	5 6	7172.9	7172.9	255
437	7 4	4296.4	4296.4	---
Average	6 5		5734.6	127
(Clean cows)				
430	6 0	8531.8	8531.8	---
445	5 10	10400.9	10400.9	229
450	5 9	7206.2	7206.2	---
Average	5 10.3		8712.9	76
Difference	6.7		2978.3	51

Average production of dams of abortion cows 10,759.2

Average production of dams of clean cows 9,321.5

Difference in average production of dams 1,437.7

Table XII.

Correlation of the percentage of normal production immediately following an abortion and the normal production of four per cent milk by the cows in the college dairy herd. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

Pct. of nor.	6000- 7999	8000- 9999	10000- 11999	12000- 13999	14000- 15999	F	D	FD	FD <sup>2</sup>	$\bar{x} \cdot \bar{y}$
prdn.										
101-	2	3	2			7	2	14	28	0
125-										
76-	2	2				4	1	4	4	2
100-										
51-	2	7	2	1	1	13	0	0	0	0
75-										
26-	1					1	-1	-1	1	-1
50-										
1-		1				1	-2	-2	4	0
25-										
F	7	13	4	1	1	29		15	37	1
D	1	0	-1	-2	-3					
FD <sup>2</sup>	14	0	-4	-2	-3	5				
FD <sup>2</sup>	14	0	4	4	9	31				

$$r = .327 \pm .111$$

Table XLII.

Correlation of the percentage of the normal milk production immediately following an abortion, and the number of days that the aborted fetus was carried. Data from the herd records of the Department of Dairy Husbandry, Oregon State Agricultural College.

	41- 85	86- 130	131- 175	176- 225	226- 265	F	D	FD	FD <sup>2</sup>	$\bar{x} \cdot \bar{y}$
101-	:	:	:	:	:	:	:	:	:	:
125	:	:	:	2	5	7	2	14	28	10
76-	:	:	:	:	:	:	:	:	:	:
100	:	:	1	:	3	4	1	4	4	2
51-	:	:	:	:	:	:	:	:	:	:
75	1	2	4	2	4	13	0	0	0	0
26-	:	:	:	:	:	:	:	:	:	:
50	:	:	:	1	:	1	-1	-1	1	0
1-	:	:	:	:	:	:	:	:	:	:
25	:	:	:	1	:	1	-2	-2	4	0
F	1	2	5	6	12	26	:	15	37	12
D	-3	-2	-1	0	1	:	:	:	:	:
FD	-3	-4	-5	0	12	-1	:	:	:	:
FD <sup>2</sup>	6	8	5	0	12	31	:	:	:	:

$$r = .399 \pm .111$$



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A P P E N D I X .

OREGON AGRICULTURAL COLLEGE

1

Dairy Production

Daily Barn Report

Date \_\_\_\_\_ 192\_\_

Breeding Record

HECTOR	:	BEAVER	:	PAUL	:	DIGNITY	:	MAJOR D	:	ROYAL	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:

In heat not bred \_\_\_\_\_

Cows Calving

NO.	:	SEX	:	WT.	:	NO.	:	SEX	:	WT.	:	NO.	:	SEX	:	WT.
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:

Cows Sick or Off Feed

NO.	:	APPARENT TROUBLE
:	:	
:	:	
:	:	
:	:	
:	:	
:	:	

Feed and Supplies Received

KIND	:	WEIGHT	:	FROM WHOM
:	:	:	:	
:	:	:	:	
:	:	:	:	
:	:	:	:	

Remarks \_\_\_\_\_

Report all details that may be of importance  
in management of herd or farm. Use back of  
sheet if necessary.

FOREMAN.



HERD NO \_\_\_\_\_

NAME \_\_\_\_\_ REG. NO \_\_\_\_\_

BORN \_\_\_\_\_ 19 \_\_\_\_\_

[illegible]

The above represents a part of one page in the breeding record book used by the Dairy Department, Oregon State Agricultural College.