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To the Graduate Council:

I am submitting herewith a thesis written by David Herbert Gordon entitled "The Accuracy of Pregnancy Determination by Rectal Palpation at Various Post-breeding Intervals." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Dairying.

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THE ACCURACY OF PREGNANCY DETERMINATION BY RECTAL PALPATION AT VARIOUS POST-BREEDING INTERVALS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

David Herbert Gordon

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CHAPTER I

INTRODUCTION

In the last 15 years the dairy industry has undergone some great changes. One of the areas that has changed is herd size with a continuing trend toward fewer but larger herds. Management of large dairy herds requires a specialist in this field. Increasingly, the owners of these large farms are hiring qualified personnel to manage their large investment.

These managers know that if they are to exist they must do an outstanding job for the owner. They must reduce the problems and increase the profits to become a successful manager. They increase milk production to increase profits. The best method to increase production is to feed a better quality or a larger quantity of feed.

To achieve increased production per cow it is necessary to maintain optimum reproductive efficiency. To achieve this the program calls for: (1) examining cow for heat following calving, (2) examining by rectal palpation to determine if any abnormality or problem occurs to prevent

pregnancy, (3) breeding cow first heat period after sixty days following calving, and (4) examining by rectal palpation to determine if pregnancy has occurred.

It is believed that it costs the dairy farmer between thirty cents and one dollar per day for every day a cow is open over sixty days. With this in mind an experiment was conducted to determine the earliest possible date following breeding that pregnancy could be determined with the greatest amount of accuracy.

CHAPTER II

REVIEW OF LITERATURE

In keeping with the idea of a calf per year to obtain maximum production per unit of investment, the author would like to discuss the gestation period of the cow. For ease in describing the gestation period it is divided into three areas as follows: (a) The period of the ovum which is from fertilization until about the 12th day of pregnancy. (b) The period of the embryo which is the interval from the 13th day to the 45th day. (c) The period of the fetus which is the interval between the 46th day and birth.

The period of the ovum consists of a series of cell divisions. While the fertilized egg is dividing, it is also migrating through the oviduct of the cow. Winters, et al. (19) found a fertilized single-cell egg in the upper oviduct 18 hours after ovulation. Cell division proceeds very rapidly after this time. Winters, et al. (19) timed the travel of an egg from ovulation until it reached the uterine horn and estimated that it required about four days for the tubal journey. This agrees with the findings of Hamilton

and Laing (10). The xygote floats free in the uterine horn for another 8 or 9 days. At about 12 or 13 days, Winters, et al. (19) determined that the blastula forms a weak attachment to the uterine wall.

The period of the embryo is characterized by the formation of most of the body parts and organs. During this period the extra-embryonic membranes are also developed.

The extra-embryonic membranes consist of the amnion, the serosa, and the allantois. Greenstein and Foley (9) stated that the amnion has enclosed the embryo by the 18th day of gestation. This membrane is double-walled and is filled with a clear watery fluid which holds the embryo suspended. The amnion forms a protective cushion against external shock and pressure from the adjacent body organs. The serosa's main objective is the early absorption of nutrients. This membrane layer later merges with the allantoic membrane to form the chorion, which serves in conveying nutrients to the embryo.

The allantois acts as a reservoir for waste material from the developing embryo. Greenstein and Foley (9) reported a 23 day-old embryo as having a well-developed allantoic membrane.

The placenta is the source of transfer of oxygen, carbon dioxide and nutrients to and from the embryo to the mother. This intimate union of the chorion and the uterine mucosa of the mother forms the placenta. This union occurs about day 33 in cattle according to Salisbury (15).

The extra-embryonic membranes develop very rapidly. By day 32 the serosa has extended to the tip of the pregnant horn of the uterus, and by day 36 has extended to the tip of the non-pregnant horn of the uterus, as reported by two investigators (12, 19). Within 35 to 45 days of age the cotyledons are recognizable, and the embryo is receiving some of its nutrients through them according to Foley and Melton (7, 12). Melton (12) stated that the allantoic sac had filled the chorionic sac of the pregnant horn of the uterus by day 32, and by day 36 it had filled the non-pregnant horn. Winters (19) stated by the end of the embryonic period, the placenta is the sole source of nutrients for the developing calf.

Salisbury (15) states that the period of the fetus is mainly a growth period however, the differentiation of the various parts and organs which were partially developed during the period of the embryo is completed.

Diagnostic procedures. Early detection of pregnancy is very important, economically, to the dairyman. Cowie (4) stated that there is no adequate biochemical or biological test that can be used in detecting pregnancy in cattle as there is for the horse, human and other animals. The only available methods of determining bovine pregnancy is of a clinical nature. The method most commonly used is the absence of estrus, but this method can be altered by several items to be mentioned later.

The other method of pregnancy determination is by rectal palpation. The accuracy of this method depends largely on the training, skill and experience of the practitioner. This method is accomplished by the palpation of the reproductive organ through the wall of the rectum. The criteria on which the diagnosis is made are based on the condition of the uterus, the ovaries and the uterine arteries, and the presence or absence of fetal membranes in the uterus as stated by Cowie (4).

The ovaries are the primary organs of the reproductive system in that they produce the female sex cells essential for the starting of a new individual. They also provide the female hormones that are essential in initiating and

maintaining pregnancy. Hammond (11) found that the average size of a normal bovine ovary is 32-42 mm in length, 19-32 mm deep and 13-19 mm wide, with a weight of 10-19 grams. There are many deviations from this normal because of individuality, cystic ovary, and an enlarged corpus luteum. In determining pregnancy by ovaries the examiner first determines the ovary that has the persistent corpus luteum. This corpus luteum marks the site on the ovary from which the egg was shed. The embryo at that time is located in the uterine horn which is connected to the ovary that has the persistent corpus luteum. While conducting a study of 1,182 pregnant uteri, Erdheim (6) found one fetus in the uterine horn where the corpus luteum was located on the opposite ovary. Moore (14) found that the corpus luteum grows larger and rounder, and sinks deeper into the ovary until around 120 days post-breeding; thereafter, it remains constant till parturition. This accounts for the many ovarian changes during pregnancy.

The uterine horns are good indicators in diagnosing pregnancy. Hammond (11) describes the normal mature non-gravid uterine horns as being about 2-4 cm in diameter and 20-35 cm in length. The measurements vary with individuality, age of cow and the number of calvings. Authur (2) measured

the amount of fluid which had collected in the extra-embryonic membranes at various intervals post-breeding. The increased volume was accompanied with an increase in uterine horn size. The results are shown in Table I. The gravid uterine horn contains most of the fetal fluid. This causes the uterine horn to increase in diameter and have a softer feeling when palpated.

Swett (16) obtained weight, crown-rump length, and height at withers at various post-breeding intervals to study embryo growth. Table II shows the results. With reference to Table II, it is possible to see that the fetus has only obtained about one per cent of its total weight by the fourth month as compared to 16 per cent of its height at withers and 23.5 per cent of its crown-rump length. With this additional growth in height and length, the fetus is able to be palpated very early in the gestation period.

The position of the cervix is another reference point to use in determining pregnancy. The cervix is a thick-walled portion of the reproductive tract connecting the uterus with the vagina. The cervix is about 5-10 cm long and 3.0-4.4 cm in diameter. This portion of the tract aids in sealing off the uterus by a cervical plug during pregnancy.

TABLE I

QUANTITIES OF FETAL FLUIDS IN RUMINANTS[a]

Days After Conception	Amnionic Fluid (cc's)	Allantoic Fluid (cc's)	Total (cc's)
56	12	100	112
71	100	375	475
80	275	240	515
90	480	375	855
100	750	460	1210
110	1750	800	2550
118	2150	930	3080
130	4000	1150	5150
140	2750	3250	6000
170	3870	2950	6820
220	1988	8520	10508
260	2400	9600	12000
285	5330	14742	20072

[a]Data extracted from Authur (2).

TABLE II

AVERAGE MEASUREMENTS OF FETUSES OF ALL BREEDS[a]

Stage of Gestation In Days	Wgt. in Grams	Hgt. at Withers in cm.	Crown-Rump Length in cm.
0-30	.5	1.1	1.6
31-60	10.3	2.5	4.6
61-90	12.0	6.7	12.0
91-120	440	12.1	21.4
121-150	1988	21.7	33.4
151-180	3990	27.9	40.1
181-210	9442	46.0	61.5
211-240	17,507	59.0	72.9
241-270	28,373	68.5	84.3
271-300	39,803	74.8	91.0

[a]Data extracted from Swett (16).

Warnick (18) stated the cervix increased two to three times the normal size during pregnancy. The position of the cervix is altered by the age of the cow, the number of calvings and the length of gestation. The cervix tends to be pulled into the abdominal cavity as gestation proceeds toward parturition.

The increased blood flow in the mid-uterine artery is not a symptom the examiner can use for early pregnancy determination. It is evidence to assure his previous diagnosis was correct. The blood flow cannot be palpated until about 42 day post-breeding according to Moore (14). There is an increase in the pulse of the mid-uterine artery leading to the gravid uterine horn. This increased pulse becomes more apparent as gestation progresses. The mid-uterine artery becomes larger to enable more blood to flow to the uterine horn en route to the placenta. The blood of the fetus and the blood of the dam never mix, but there is an exchange of gases and nutrients at the cotyledonary attachments.

The technique of "slipping membranes" is the most reliable device for the earliest detection of pregnancy according to Wisnicky (20). This membrane can be felt by day 30-35 post-breeding. By holding the uterine horns between the thumb and the first two fingers, the examiner can proceed to

examine the uterine horn for the amnionic vesicle. Two investigators (14, 20) found that the amnionic vesicle is extremely turgid until about day 42 of gestation. At this time it begins to elongate and becomes less turgid. The examiner must also keep in mind that at this early date the amnionic vesicle could be ruptured thus causing death to the embryo. Fosgate (8) conducted an experiment to determine the fetal death rate in early pregnant diagnosis as compared to a later date. In the first group 449 cows were determined pregnant by the presence of the amnionic vesicle at an average date of 33 day post-breeding. The fetal death rate was 9.98 per cent. In the second group pregnancy was determined for 690 cows on an average date of 42 day post-breeding. The fetal death rate was 3.62 per cent. Barrett, et al. (3) reported nearly 4 per cent of the cows diagnosed pregnant at 35-49 days post-breeding lost their fetuses within four months. It was concluded by two investigators (3, 20) that 60 day post-breeding was the safer date to check pregnancy.

The accuracy of using the absence of estrus as the only method of pregnancy diagnosis can be misleading. Ardell (1) reported 1.8 per cent cows become sterile although showing signs of estrus; 3.5 per cent of the cows return to heat

although they were pregnant according to Donald (5). Trimberger (17) stated that 8.8 per cent of the cows had "silent estrus", and 15.2 per cent had a persistent corpus luteum and 3.6 per cent had smooth non-functional ovaries. By the previous percentages one can easily see that using the absence of estrus was not a reliable procedure for diagnosing pregnancy.

In using rectal palpation Warnick (18) was able to detect pregnancy between 42-49 days of gestation with an accuracy of 98-100 per cent. Merriman (13), palpating beef cattle 60 days after the bull had been removed from the herd, had a 95 per cent calf crop from 133 cows that were diagnosed pregnant. Wisnicky (20) states that by having ample experience and developing a system of measuring, one can predict the breeding date plus or minus two days.

Although several investigators (3, 6, 13, 14, 18, 20) have conducted experiments using rectal palpation to determine pregnancy, very little has been published in the literature concerning the precision of the method at various time periods.

CHAPTER III

EXPERIMENTAL PROCEDURES

An experiment was conducted in the Dairy Department of the University of Tennessee to determine the accuracy of pregnancy determination by rectal palpation at various post-breeding intervals. The University of Tennessee made available the dairy herd at the Knoxville Station for the experiment which began on July 1, 1966. The experiment included every cow that had previously calved. A file was kept on the reproductive performance of each cow on the experiment. This included illness following calving, pre-breeding estrus cycles, and date of breeding. Rectal examinations of the reproductive organs were made at 50 days post-calving, and at 28, 35, 42, 49, 56, 63, 70, and 91-days post-breeding. There was a two days plus or minus grace period allowed on each examination period.

Each rectal examination included a check on the status of the ovaries, horns, cervix position, and uterine artery. The ovarian status included the size, shape, and contour of the ovary which enable the examiner to decide which ovary

contains the corpus luteum. The size of the ovary was rated and recorded as being either small, medium, large or very large. The small ovaries were less than 15 mm.in length, and 10 mm.in width. The medium ovaries were 17 to 24 mm.in length and 12-15 mm.in width. The large ovaries were 24-35 mm.in length and 15-20 mm.in width. The very large ovaries were larger in both measurements. The shape was noted as being round, oblong, or flat. The contour was either smooth or rough.

The horn status included size and tone of each uterine horn. The size of the uterine horn was determined at the largest point. The tone of the uterine horn was also taken at this point. The tone was rated as either firm, spongy, or soft. The firm uterine horn is similar to the touch of a portion of an one-inch round hollow, rubber tubing. The spongy uterine horn is similar to the touch of a dry sponge, while the soft uterine horn has a touch similar to a water-filled balloon.

The cervix position was recorded in reference to the pelvic arch. The uterine artery was included to check the accuracy of the previous examinations and to determine the earliest possible detection time of the increased blood flow

to the gravid horn of the uterus.

Palpation of the amnionic vesicle was accomplished by the slipping of the amnionic vessicle between the thumb and the first two fingers.

The paraphernalia for a rectal palpation included; water, soap, disinfectant, brush, pail, rubber sleeve, and a mild lubricant.

The procedure for each examination included locating the ovaries, cervix, uterine horns, uterine arteries. By locating the junction of the uterine horns to the body of the uterus, the examiner was able to search the uterine horn to determine if the amnionic vesicle could be located. In this experiment the 91 day examination was the basis for determining the pregnancy status of each animal.

The Student "t" test was employed to determine if there was any significant differences among the many changes in the reproductive tract during early pregnancy.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the pregnancy diagnostic examinations were recorded as pregnant, probably pregnant, or open. In every case when a probable pregnancy diagnosis was made, a diagnosis of pregnancy was recorded the following week. The correct pregnancy diagnosis was considered to be the 91 day examination. The accuracy of rectal palpation was expressed by two different methods. One method included as correct the animals diagnosed pregnant which were pregnant, those diagnosed not pregnant which were not pregnant, and those diagas probable pregnant which were pregnant. The other method included as correct those animals diagnosed pregnant which were pregnant and those diagnosed open which were open. The accuracy at different post-breeding periods are shown in Table III.

With reference to Table III it was possible to see that as the time interval post-breeding increased the accuracy of the examination increased. The largest increase in accuracy during any weekly interval was from the 35th day to

TABLE III

ACCURACY OF RECTAL PALPATION

Intervals Days	PREGNANT			OPEN			Total No. of Cows	Percent Correct Including Probable Pregnant	Percent Correct Omitting Probable Pregnant
	Called Pregnant	Called Probably Pregnant	Called Open	Called Pregnant	Called Probably Pregnant	Called Open			
28	0	8	98	0	0	45	151	35	29
35	31	50	25	0	2	31	139	80	44
42	92	2	3	0	1	26	124	97	95
49	97	5	0	0	0	17	119	100	96
56	102	3	0	0	0	9	114	100	97
63	105	1	0	0	0	2	108	100	99
70	106	0	0	0	0	1	107	100	100
91	106	0	0	0	0	1	107	100	100

the 42nd day examination when the probable pregnancy diagnosis were considered incorrect. The increase in accuracy appeared between the 28th and the 35th day examination when the probable pregnancy diagnosis were considered as correct.

The 91 day examination period was completed on 107 cows. This large number was divided into three groups to determine if experience and skill would have any effect on the ability to recognize key factors of early pregnancy diagnosis. The data were divided into three groups representing the first, second, and third one-thirds of the data by time of collection.

In the first group there was an average of 49 days required to palpate the amnionic vesicle and 70 days to detect the increased blood flow of the uterine artery. The second group required an average of 42 days to palpate the amnionic vesicle and 61 days to detect the increased blood flow. The third group required an average of 41 days to palpate the amnionic vesicle and 53 days to determine the increased blood flow.

This steady drop in the number of days required to palpate the amnionic vesicle and the increased blood flow indicates that experience and skill aid in the determination

of pregnancy by rectal palpation.

Key factors to indicate pregnancy. The 50 day post-partum check was designed to determine if the cow's reproductive tract was in normal condition before the breeding date.

The first feature recognized by rectal palpation in determining pregnancy occurs on the 28 day examination. This is the palpating of the persistent corpus luteum. There were five cases in the University of Tennessee dairy herd during the year where a corpus luteum which persisted after breeding was not accompanied by pregnancy. The accuracy of the 28 day examination was 35 per cent. Table IV includes the status of the reproductive tract at various post-breeding intervals. The 35 day examination brought about an increase of nearly one centimeter in the size of the pregnant horn of the uterus while the non-pregnant horn remained about 2.8 centimeter. This size increase was accompanied by a softer feeling of the uterine horn which allowed the amnionic vesicle at an average age of 41 days.

The 42 day examination was characterized by the gravid horn of the uterus being 2.2 cm. larger than the non-gravid horn. The gravid horn was about 5.2 cm. in diameter, while

TABLE IV

STATUS OF REPRODUCTIVE TRACT AT VARIOUS POST-BREEDING INTERVALS

	Pre-breeding	28	35	42	49	56	63	70	91
Horn Diameter in cm									
Pregnant	2.8	3.0	3.9[a]	5.2[a]	6.2[a]	7.7[a]	8.6[a]	9.8[a]	13.8[a]
Non-Pregnant	2.8	2.8	2.7	3.0	3.2	3.5	3.8	3.8	4.0
Tone[b]									
Pregnant	1.0	1.3[a]	2.1[a]	2.8[a]	3.0[a]	3.0[a]	3.0[a]	3.0[a]	3.0[a]
Non-Pregnant	1.0	1.0	1.1	1.3	1.5	1.7	1.8	2.0	2.1
Position of Cervix cm from Pelvic Arch	2.2	3.3	3.2	2.6	2.5	2.6	2.8	2.4	1.0
Percent Amnionic Vesicle Palpated	---	---	21.5	63.6	94.4	100	100	100	100
Percent Uterine Artery Palpated	---	---	---	9.3	31.8	53.3	62.6	70.0	76.6

[a]Differences between pregnant and non-pregnant horns are significant ($P < .01$).

[b]Code for tone of uterine horn: 1- firm, 2- spongy, 3- soft.

the non-gravid was 3 cm.in diameter. With the increased size of the uterine horn due to the development of the fetus and the accompanying membranes, the accuracy of diagnosing pregnancy was 97 per cent at 42 day examination.

On the 49 day examination the gravid horn of the uterus had increased to 6.2 cm.in diameter. The non-gravid uterine horn was 3.2 cm.in diameter and had a softer feeling when compared to the 42 day examination. At this time the fetus was easily palpated and in some instances the uterine artery was palpated. There was a 100 per cent accuracy in determining pregnancy at this date.

During the remaining four examination periods there was merely an increase in the diameter of the uterine horns accompanied with an increase in the size of the embryo. The blood flow through the uterine artery and cotyledonary attachment was easily palpated during this time.

A 91 day check examination was obtained to determine if pregnancy was continuing toward parturition. A typical 91 day pregnant reproductive tract was described as having a gravid uterine horn at 13.8 cm.in diameter, while the non-gravid horn was 4.0 cm.in diameter. Both horns were soft and the fetus could easily be palpated. The uterine artery's

blood flow had increased in pulse rate as compared to the 70 day examination.

The usefulness of such a program was to determine if pregnancy existed. This program in conjunction with a production record would aid in the culling of open, low-producing cows from the herd. It has been estimated that it cost between 25 to 50 dollars to winter a cow. If a dairy farmer employed this program of rectal palpation, it may increase the profits from the herd and also increase the reproduction efficiency of the herd. The rectal palpation program at the University of Tennessee dairy herd lowered the percentages of cows open beyond 42 day post-breeding. The five previous years the percentages were 27.30, 19.17, 19.61, 23.58, and 27.84 per cent as compared to 17.57 per cent for this year.

This program would help the detection of a herd-wide sterility problem due to disease. The diagnosing of twins would be very helpful, thus allowing the owner to allow a few extra days to the dry period in order to condition the cow for the next lactation.

This type program would aid the beef farmer in

predicting the calving dates for his herd. The herd manager could divide his herd according to calving dates and give special attention to the group nearest parturition.

CHAPTER V

SUMMARY AND CONCLUSIONS

An experiment was conducted in the Dairy Department of the University of Tennessee to determine the accuracy of pregnancy determination by rectal palpation at various post-breeding intervals. A reproductive performance history was kept on each cow at the University. Examinations were scheduled 50 days following calving to check normality of reproductive tract. A series of rectal examinations were made at 28, 35, 42, 49, 56, 63, 70 and 91 days post-breeding. Each examination was taken with a plus or minus two days grace period of the scheduled dates. A total of 107 cows were examined at 91 days. Each examination included a careful palpation of the cervix, uterine body, uterine horns and ovaries.

The accuracy of the 28, 35, 42, 49, and 56 day examinations were 33, 83, 98, 100, and 100 per cent respectively. In employing the Student "t" test, there was a significant difference between the tone of the pregnant and the non-pregnant on the 28 day examination post-breeding. This difference remained through the 91 day examination. There was a

significant difference between the diameter of the pregnant and the non-pregnant uterine horn on the 35 day examination. The diameter of the gravid uterine horn increased from 2.8 to 13.8 cm., while the non-pregnant horn increased from 2.8 to 4.0 cm.

A program of pregnancy determination can help eliminate a sterility problem due to disease, help cull low-producing open cows, help to prevent irregularity of the estrus cycles, and also help to ensure a 12 to 13 month calving interval.

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