FURTHER STUDIES OF THE PHOSPHORUS REQUIREMENTS OF DAIRY BULLS

By

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REQUIREMENTS OF DAIRY BULLS

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TABLE OF CONTENTS

INTRODUCTION

Dairy sires vary in their length of life, the age at which puberty is reached, and in the degree to which libido is exhibited. They also differ in the amount and quality of semen produced. Undoubtedly many factors contribute to the differences noted in sexual expression. Since the nutritional requirements of bulls have not been fully established, it is possible that a difference in nutrient intake may be more important than is currently recognized. Therefore, the Oklahoma Agricultural and Mechanical College has a study underway to evaluate the nutrient requirements for the growth, maintenance, and reproduction of dairy bulls.

As phosphorus is deficient in many soils, this study has been initiated to compare the effects of three different levels of that element. Experimental rations have been formulated so that various levels of phosphorus could be maintained (70). Three groups of animals have been started on this experiment (31) (70). A study of the semen characteristics from the first two groups of animals has been made (60).

Data presented herein constitute a continuation of the above experiment and cover the calendar period from June 5, 1955, through June 2, 1956.

LITERATURE

Many excellent reports on the feeding and care of dairy animals have been published (3, 8, 12, 19, 30, 37, 42, 43, 50, 55, 58, 61, 72, 74, 75, 85, 91, 92, 96, 97, 99).

Most of these papers cover experimental studies dealing with dairy females, with but few reports concerning males. Branton and co-workers (9), in trials using 18 bulls for a 270 day period, developed a suggested feeding standard for mature bulls. They recommended one pound of hay and 0.4 to 0.5 pounds of concentrate per 100 pounds of body weight. These recommendations were approximately the same as those of Morrison (62), Mitchell (59), and the National Research Council (64). Musgrave (63) and Dunn (23) found that bulls fed at higher levels than those recommended by Morrison for growing heifers would reach sexual maturity earlier than bulls receiving the amounts recommended for heifers. Those bulls that received less than the recommended amounts were further delayed in reaching puberty. Hawk (35) concluded that inbreeding and scouring would retard growth and delay puberty. Phillips (69) found that a low plane of nutrition delayed the sexual maturity of boars.

Asdell, in a review of dairy cattle nutrition and sterility (5), stated that phosphorus deficiencies were the first problem in the field. He recommended that adult bovine animals receive 10 to 12 grams of phosphorus per day. Duncan (21) raised two groups of calves

on rations that were the same with the exception of the phosphorus content of the hay. Body weight, height at withers, and chest circumference measurements were more than seventy per cent greater for animals receiving the hay with the higher level of phosphorus.

The need for adequate phosphorus in the rations of growing animals and cows in milk was demonstrated by Eckles (25) in 1926. In 1932, Eckles (26) stated that phosphorus deficiencies were evident in Wisconsin, North and South Dakota, Colorado, Utah, Nevada, New Mexico, California, Florida and other areas. Henderson and co-workers (38), in 1929, stated that rations may be dangerously near the lower limit for phosphorus under practical conditions. During the same period, Reed (73) demonstrated the need for phosphorus supplements for growing animals and milking cows in Michigan. Riddle (77), in 1934, conducted extensive studies on the effects of low phosphorus rations on cows in milk. He found that appetite, weight gains, manifestations of estrus, pulse rates, respiration rate, and inorganic phosphorus percentages in the blood gave rapid and marked responses to phosphorus supplements. There were no differences in milk production, digestion coefficients, or body temperature. Palmer and co-workers (68) demonstrated that combined deficiencies of phosphorus and protein delayed sexual maturity and depressed normal manifestations of estrus, but did not delay the regularity of ovulation or affect conception rates.

Mitchell (59), in discussing the mineral requirements of farm animals, stated that phosphorus was the most important mineral and the deficiency most prevalent in this country. Mitchell stated that although seventy five per cent of the skeleton was phosphorus, the

greatest need was in the tissues which could not readily draw on bone phosphorus reserves. The role of phosphorus in metabolism was stressed by McElroy (57).

In a study of the mineral levels in bovine semen, Cragle (18) found that semen contained 79 milligrams per cent phosphorus, and seminal plasma contained 40 milligrams per cent phosphorus. This demonstrated that concentrations of phosphorus were higher in spermatozoan cells than in the accompanying seminal fluids. Flerchinger (29) found a correlation of 0.88 between concentration of spermatozoa and total phosphorus content.

Reid (76) obtained a negative correlation between phosphatase activity and concentration of spermatozoa. Kay (45) found that plasma phosphatase changed more than inorganic phosphorus during bone involvement. McAlpine (56) showed a marked increase in phosphatase activity during the differentiative phase of thyroid development in the rat.

Plasma inorganic phosphorus levels in twenty samples of bovine blood ranged from 3.09 to 6.17 milligrams per cent in a study by Anderson (2). Palmer and co-workers (67) found that inorganic phosphorus values changed from hour to hour and were affected by exercise, feeding, and excitement. They reported that phosphorus levels averaged 5.97 milligrams per cent at birth; increased to 7.89 milligrams per cent at six months; and decreased to 5.87 milligrams per cent after two years. Stare (86) found the inorganic phosphorus level of calves suffering from Vitamin D rickets to be 3.0 milligrams per cent as compared to 6.2 milligrams per cent for healthy calves. Havard (36) found that exercise in man would cause inorganic phosphorus levels to increase slightly and then fall considerably below

normal. Turner and associates (93) found that thirty minutes exercise daily slightly increased the blood phosphorus level of two cows in milk.

Assimilation of phosphorus was studied by Kleiber (47), using radio-active phosphorus as a tracer. He found the true digestibility of phosphorus to be 50 per cent as compared to an apparent digestion coefficient of 12 per cent on a high phosphorus intake. Low phosphorus rations had a true digestibility of 64 per cent as compared to a negative apparent digestibility. He explained that endogenous fecal phosphorus diffused from the blood or interstitial tissue to become a part of the saliva or other secretions, or a component of cells and cell fragments. Kleiber calculated that mature cattle need from 10 to 14 grams of phosphorus daily. In another report, Lofgreen and Kleiber (51) reported the true digestibility of phosphorus to be 93 per cent. This was five times the metabolic fecal phosphorus excretion. Hansard (33), using radio-active calcium, obtained a similar mineral metabolism. Smith and co-workers (81) (82), and Hansard and co-workers (32) demonstrated with sheep, swine, and Hereford steers that mineral uptake was slower in older animals and stayed in the body longer.

Williams (101) demonstrated that rats had a higher phosphorus retention and body growth when fed a high phosphorus content legume than did rats receiving the same species of legume that had a low phosphorus content.

Arrington (4) reported a higher tissue deposition of phosphorus when rats received higher calcium content feeds. House (41) observed a deposition of calcium phosphate in the soft tissues of guinea pigs when a diet low in magnesium and potassium and high in calcium and phosphorus was fed.

Fiske and SubbaRow (28) reported a colorimetric method for the determination of phosphorus in 1925.

Long and associates (52) determined blood levels of beef cattle on a high plane of feeding. Calcium and phosphorus levels ranged from 10.1 and 3.75 milligrams per cent to 12.2 and 7.75 milligrams per cent respectively. The authors stated that levels below 4.0 milligrams per cent would maintain reproduction. They found that blood phosphorus levels were greatly affected by dietary change and that the blood phosphorus level decreased with age.

Rusoff (78) reported that mean calcium and inorganic phosphorus blood levels in breeding bulls were 10.21 and 4.86 milligrams per cent for Guernseys, 10.47 and 4.55 milligrams per cent for Jerseys, and 10.26 and 4.50 milligrams per cent for Holsteins. Although plasma alkaline phosphatase levels decreased in the summer months, inorganic phosphorus, calcium, and leucocyte levels remained constant throughout the year.

Several methods have been advanced for the laboratory evaluation of bovine semen. Early work by Herman (39) showed that ejaculates with a pH above 7.0 had poor viability. Semen with more than 30 per cent abnormal spermatozoa or with poor initial motility was considered poor. Branton (10) stated that semen should have an initial motility of at least 50 per cent; a concentration of at least 500 million per milliliter; and a modified methylene blue reduction time of less than 9 minutes. He recommended that semen be extended to contain 12 to 15 million live spermatozoa per milliliter. In a later report (11), Branton advised that each extended sample should contain at least 6 million live spermatozoa per

milliliter. Bratton and associates (15) ran 12 different tests on semen and found that spermatozoan concentration and the percentages of abnormal spermatozoa were the best criteria for rapid evaluation. Significant linear correlations were found between the fertility of bovine ejaculates diluted 1:100 and 1:300 and the concentrations of spermatozoa per ejaculate, per cent of motile spermatozoa, methylene blue reduction time, pH, the per cent of abnormal sperm, livability at 5°C., and oxygen uptake at 37.5° Centigrade.

The colorimetric method was as accurate as the hemacytometer counting method for determining numbers of spermatozoa, according to Salisbury (79). For photelometer readings, Willett (98) recommended mixing 0.1 milliliter of semen in 4 milliliters of physiological sodium citrate in a 17 millimeter diameter absorption cell. He found readings were reproduced better by a photelometer than by a hemacytometer. Willett recommended that semen be extended to contain not less than twelve million spermatozoa per milliliter. Lasley (48), using the hemacytometer for counting spermatozoa, found the percentage of motile sperm significantly related with fertility.

Mayer (54) used a differential stain, Eosin B, to distinguish between live and dead spermatozoa.

Stone (87) found a correlation of 0.69 between spermatozoan concentration and the percentage of spermatozoa surviving at 0° Centigrade. Swanson (89) found little correlation between pH, abnormals, or low concentrations, except as related to the survival in cold storage. He recommended that samples have a motility rate of at least 3 and have at least forty-five per cent progressively motile spermatozoa.

Fructose utilization tests for estimating the fertilizing capacity of spermatozoa were developed by Erb and associates (27).

At present, most semen extenders contain either boiled milk or a mixture of egg yolk and sodium citrate. Little difference in the two methods was noted by Almquist (1) when bulls with high fertility rates were used. However, when bulls with lower fertility rates were used, slightly higher conception rates were obtained from semen extended with boiled skim milk containing penicillin and streptomycin. Sixty-ninety day non-returns above seventy per cent were reported for both diluents by Thacker (90). Dreher (20) found boiled milk superior to yolk-phosphate extenders. Dunn (23) and Olds (66) mixed equal volumes of a 2.9 per cent sodium citrate solution and egg yolk. Egg yolk-citrate extenders frozen for a month were equal to freshly prepared diluents in tests by Hurst (44). Kampschmidt (46) separated a lipoprotein from egg yolk that was effective in protecting spermatozoa from temperature shock in cold storage.

In chemical tests, Smith (83) (84) demonstrated that egg yolk-citrate extenders did not prevent osmotic pressure changes. Egg yolk stimulated dehydrogenase while lecithin slightly inhibited succinic dehydrogenase activity.

Swanson (88) used various mixtures of egg yolk and citrate with almost equal results. He suggested an egg yolk-citrate extender that contained seventy five per cent by volume of 3 per cent citrate.

Satisfactory storage livability, based on sixty-ninety day non-returns, was reported by Bratton and associates, (14) for the following extenders; 3.6 per cent sodium citrate-egg yolk, phosphate-egg yolk, 2.9 per cent sodium citrate-sulfanilamide-egg yolk, 3.6 per cent

sodium citrate-sulfanilamide-egg yolk, Ortho tablet-egg yolk, and Ortho liquid.

In earlier studies of semen from bulls on this experiment, Montgomery (60) showed a correlation of 0.85 between hemacytometer counts and colorimetric readings. Statistical analysis of the experimental data indicated that rate, per cent motility, and pH were fairly good measures of livability of semen in cold storage. Percentages of abnormal spermatozoa and percentages of live spermatozoa per ejaculate did not indicate livability under these conditions.

The artificial vagina described by Herman (39) has been used extensively to collect semen. An electro-ejaculation method was described by Dziuk (24) and Marden (53).

Little difference in semen volume or quality was found by Baker (7) from bulls collected once, twice, or three times per week. Van Demark (94) successfully collected semen from a bull three times a week for four years. Bratton (13) concluded that one ejaculate every four days or two ejaculates every eight days was not detrimental to the reproductive capacity of the bull.

EXPERIMENTAL PROCEDURE

Three groups of dairy bulls were used to compare the effects of three different levels of phosphorus intake on growth and reproduction. With the exception of phosphorus, the rations were calculated to offer to each animal the amount of feed nutrients recommended by the National Research Council for growing heifers (64). The phosphorus intake was calculated to provide 67 per cent of the NRC recommendations to group I, 33 per cent to group II, and 100 per cent to group III.

Table 1 shows the ingredient composition of the rations fed to the three groups of bulls.

At the beginning of the current experimental period, June 5, 1955, group I contained three Holsteins and one Guernsey that averaged 27 months of age. The average age of the four Ayrshire bulls that composed group II was 20.5 months. Group III was composed of two Holstein, two Ayrshires, and two Guernseys, with an average age of 7.5 months.

At first, all animals were housed in the main dairy barn of the Oklahoma Experiment Station. Animals were secured by the conventional swing-type stanchions which allowed only limited movement within the stalls. On November 25, 1955, group I bulls were transferred to the dairy nutrition barn where stronger tie-stalls were available. The temperature in this barn was maintained between 70°F. and 85°F. by a large water-type air conditioner in the summer and by an overhead gas heater in the winter.

TABLE 1

Composition of Concentrate Rations

Ingredients	Ration I	Ration I Revised Oct. 1, 1955	Ration II	Ration III
	lb.	lb.	lb.	lb.
Cracked corn	400	400	400	400
Crimped oats	200	220	200	200
Dried beet pulp	320	320	420	200
Dried beef blood fibrin*	80	80	120	---
Urea	40	40	40	50
Omalass	300	300	300	350
Cracked rice	---	---	480	---
White Hominy	600	600	---	600
Cottonseed meal	---	---	---	200
Iodized salt	20	20	20	20
Steamed bone meal	20	---	---	36
Calcium carbonate	20	20	20	---
Quadrex**	4.6	4.6	4.6	4.6
Aureomycin***	0.5	---	---	0.5
Total	2005.1	2004.6	2004.6	2011.1

*Purchased from Adhesive Division, Armour and Co., 1355 W. 31st St., Chicago, Illinois.

**Donated by Nopco Chemical Co., Inc.

***Lederle Laboratories, Pearl River, New York, contributed the 89 per cent pure aureomycin used in this experiment.

Water was supplied to each animal by automatic drinking cups. Each animal was fed separately twice daily. Feed offered to each animal was weighed to the nearest 0.1 pound. The orts were weighed back each day and representative samples thereof stored for chemical analyses.*

Wood shavings were used for bedding. A rubber mat was used instead of shavings under No. 21, after November 25, 1955, to prevent consumption of the bedding material.

The concentrate rations were mixed in one-half or one ton batches in a one and one-half upright electric feed mixer. Representative samples of each mix were taken for chemical analyses.

To insure a roughage in which the phosphorus content would be uniformly low, an acid-treated wood pulp cellulose** was fed. Blackstrap molasses was mixed with the wood pulp at a 3:2 ratio by weight. The wood pulp and molasses were first mixed in an open wooden box with a hoe and then run through a modified beet chopper twice to insure even mixture of the ingredients. Added bulk for the roughage ration was obtained by feeding one pound of beet pulp to each animal daily.

For the first four months of the trial, groups I, II, and III received concentrate rations I, II, and III, respectively, and a wood pulp-molasses roughage substitute. The amounts of feed offered to each bull were adjusted at weekly intervals, according to their individual body weights. In addition, each animal in groups I and II received one pound of beet pulp daily from July 25 to October 1, 1955.

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*All chemical analyses reported herein were by the Agricultural Chemistry Department.

**Solka-Floc-BW-20, purchased from Brown Co., 110 S. Dearborn, Chicago 3, Illinois.

After October 1, 1955, the beet pulp was eliminated for all groups and molasses was removed from the wood pulp fed to groups I and II. To increase palatability of the dry wood pulp, it was mixed with the concentrate at feeding time.

Prior to October 1, 1955, the amount of feed offered to each animal was adjusted at weekly intervals, according to the body weight of each animal. Thereafter, bulls of group I and II were limited to five pounds of concentrate II per day plus all the wood pulp they would consume. Group III animals continued to receive pulp-molasses at the rate of six pounds daily. They also were offered from 5.4 pounds to 5.7 pounds of concentrate ration I per animal daily.

Due to the failure to receive materials, it was necessary to substitute concentrate III for animals in groups I and II during the last two weeks of the experimental year.

All animals were weighed and measured for height at withers and chest circumference at weekly intervals.

At monthly intervals, blood was taken from the jugular vein. The serum portion of the blood was analyzed for calcium and inorganic phosphorus by a modified Fiske and SubbaRow procedure (34).

An attempt was made to collect semen from each animal once each week, using the artificial vagina method. One of the animals of the group was used as a mount for the other animals. One false mount was allowed each bull before the collection of semen was attempted. A second ejaculate was taken only if the first ejaculate was lost. Semen was collected from animals of group I by the electro-ejaculate method on three occasions.

The semen obtained was processed immediately after collection.

The volume of semen was measured by using 15 milliliter graduated centrifuge vials for collection tubes. Colorimetric readings obtained on an Evelyn Photelometer were used to estimate the concentration of spermatozoa and pH readings were made with a Beckman #H-2 pH-meter. Direct microscopic observations were made to estimate the percentage of live spermatozoa, the rate of motility, and the percentage of abnormal spermatozoa. Rose-Bengal stains were made to estimate further the percentage of abnormal sperm. Samples were stored in the ice-compartment of a refrigerator for later hemacytometer counts to calibrate the colorimeter readings. Livability of spermatozoa stored at 5^{o}C. was determined by daily microscopic examination of samples extended 1:40 in a 1:1 solution of egg yolk-sodium citrate. The sodium citrate consisted of 2.9 grams of sodium citrate dihydrate and 0.6 grams of sulfanilamide dissolved in 100 milliliters of double distilled water.

Digestion trials I through V were reported earlier (70) (31). Digestion trial VI was completed on January 22, 1956. Group III bulls were used. A ten day preliminary period was allowed before the ten day collection period. The animals were weighed and body measurements taken before and after the preliminary and collection periods.

The metabolism stalls used were similar to those described by Briggs (16) and modified by Hall (31). Concentrate ration I and the wood pulp-molasses roughage were fed twice daily in enclosed feed boxes. The feed boxes were removed between feedings to permit the animals to lie down. Water was offered in 12 quart buckets before and after each feeding. Orts were removed daily and stored for chemical analyses.

Urine was collected in 8 or 12 liter bottles to which was added 20 to 30 milliliters of a 1:1 dilution of hydrochloric acid to insure acidity of the urine. Urine was collected twice daily, diluted to 15 liters with tap water, and a one per cent aliquot taken. Feces were collected at 24 hour intervals, weighed on a gram balance, thoroughly mixed, and a 10 per cent (by weight) representative sample taken. Urine and fecal samples were stored in 5 pound chemical bottles in a commercial freezer at approximately -20°F.

Samples of feed offered, orts, urine, and feces were analyzed for moisture content, ash, protein, ether extract, crude fiber, calcium, and inorganic phosphorus content, at the end of the trial.

A digestion trial using group II animals was completed March 31, 1956. The same procedures described for trial VI were used in trial VII, with the exception that urine and fecal samples were stored in a commercial refrigerator at 30° to 40° F. The animals were fed concentrate ration II and dry wood pulp.

RESULTS AND DISCUSSION

The effects of three different levels of phosphorus on growth and reproduction were measured in the following categories: (1) growth in body weight, height at withers, and chest circumference; (2) digestion trials; (3) chemical determinations of blood serum levels of calcium and inorganic phosphorus; and (4) laboratory analyses of semen collected at regular intervals.

GROWTH:

The weights, measures, and feed consumption for all animals are given in Appendix Tables II through XV and the chemical analyses of the rations are presented in Appendix Table XXXIII.

From June 5 to October 1, 1955, average gains in body weight for animals in groups I, II, and III were 1.24, 1.0, and 1.8 pounds per day respectively. The bulls were fed according to their individual body weights during this period. Results from chemical analyses of the rations as fed indicated that phosphorus levels for all animals were much higher than had been anticipated for that period. All rations were then changed to bring phosphorus intakes back to the levels planned for the experiment.

After October 1, 1955, animals in group I received an average of 112 per cent of the NRC recommended amounts of TDN. Phosphorus levels averaged 50.5 per cent of the NRC recommendations. Three of the four bulls made positive weight gains that averaged 12 pounds for the

following eight months period. The fourth bull lost more than 100 pounds of body weight. All of the animals increased slightly in height at withers and chest circumference. Gain in body weight essentially stopped when the level of phosphorus was lowered. It appeared that the sudden drop in the phosphorus level seriously retarded the growth of group I animals. This was in contrast to the work of Baker (6) who reported that animals of similar size and age continued to make good gains on normal rations. Total gain in body weight for the twelve months period for group I bulls averaged 90 pounds.

Following the change in feed constituents in October, the feed intake of the bulls in group II was calculated to be 69 per cent of the TDN and 41 per cent of the phosphorus recommended by the National Research Council. All animals showed slow gains in weight, height, and chest circumference. The average body weight gain for the group II bulls was 113 pounds during the last eight months of the experimental period. During the entire twelve months period the average gain per animal was 233 pounds. It seemed remarkable that the animals could continue to grow with such a low phosphorus and nutrient intake. Their intake was less than that of group I bulls, yet their growth response was much better. These animals were six months younger than those of group I and were of a different breed, but it is doubtful that this could account for the difference in growth between the two groups. Apparently, group II animals had developed a conditioned response to the lower levels of phosphorus and nutrient intake.

The body weight of bulls in group II was far below that expected of bulls on normal diets. At an average age of 32.5 months, the average body weight was 741 pounds. Morrison (62) states that the

average weight for Ayrshire bulls at 24 months of age is 990 pounds.

The rate of gain for the group III bulls decreased after the phosphorus levels were lowered in October. The average intake of TDN and phosphorus was calculated to be 105 per cent and 63 per cent, respectively, of the NRC recommendations. Average gain in body weight was 278 pounds per animal during the last eight months of the experimental period. The average total gain for the entire twelve months was 440 pounds or an average of 1.2 pounds per day. Apparently, phosphorus fed at 63 per cent of the NRC recommended amounts did not seriously restrict growth, but was below the minimum amount for optimal growth.

Morrison's standards (62) show that the weight of the two Ayrshire bulls in group III was comparable to the average weight of bulls of that breed. The two Holstein bulls were approximately 200 pounds lighter than average Holstein bulls as reported by Baker (6) and Morrison. Morrison does not show standards for Guernsey bulls over 12 months of age. The weights of the two Guernsey bulls in group III were approximately 100 pounds less than the average Guernsey bulls at 12 months of age.

DIGESTION TRIALS:

Summaries of the results of digestion trials VI and VII are given in Table 2. Complete data relative to the trials are given in Appendix Tables XXXI and XXXII. Feed intake was excellent for all animals, with the exception of Bull 99 in group III and Bull 34 in group II. All other animals consumed all the feed offered to them. Bull 99 became very weak and refused small amounts of the offered feed during the last two days of the collection period. Bull 34 would not consume all his feed at any time, but the orts were small each day.

TABLE 2

Average Results of Digestion Trials VI and VII

Body Weight	Description	Dry Matter	Ash	Organic Matter	Ca.	P.	E.E.	C.P.	N.
				TRIAL VI					
638.0	Intake (g.)	48616.7	2724.8	45891.9	220.9	82.7	1129.5	10644.9	750.8
	Outgo: feces (g.)	12268.4	702.9	11565.5	124.6	48.7	285.7	4264.3	75.2
	Urine (g.)				14.6	0.9			278.0
	Per cent digested	74.8		74.8			74.7	59.9	90.0
	Per cent retained				37.0	40.0			53.0
	Balance/day (g.)				8.2	3.3			39.8
	Ret/cwt/day (g.)				1.3	0.5			6.2
				TRIAL VII					
713.0	Intake (g.)	37069.7	800.3	36269.4	150.4	35.4	258.0	13964.5	496.3
	Outgo: feces (g.)	6151.4	528.2	5755.6	45.5	24.9	137.2	2509.0	36.3
	Urine (g.)				2.1	0.5			314.1
	Per cent digested	83.4		84.1			46.8	82.0	92.7
	Per cent retained				68.4	28.3			29.4
	Balance/day (g.)				10.3	1.0			14.6
	Ret/cwt/day (g.)				1.4	0.1			2.0

Digestion coefficients obtained from results of the trials were in agreement with earlier trials involving the same animals on similar rations (70) (31). These figures indicate that digestion coefficients used to calculate TDN intake by animals on the experiment were applicable.

The high calculated percentages of digestion of crude fiber and protein may be explained by the source of the ingredients. The finely ground wood pulp was almost pure cellulose, so that digestion should be more complete than with coarser fibrous materials. The protein was largely from dried beef blood fibrin and high digestibility would be expected.

It should be noted that in trial VII, although phosphorus intake was only 33.7 per cent of NRC recommendations for growing heifers of the same weight, a positive phosphorus retention was shown on all animals. Total digestible nutrient intake was 86 per cent of the NRC recommendations. These animals averaged gaining 1.55 pounds of weight per day while on the trial.

BLOOD ANALYSES:

Appendix Tables XXIX and XXX show the calcium and inorganic phosphorus content of blood serum taken at monthly intervals from each animal. These values reflect the changes in rations in October. As the phosphorus intake was lowered, the blood phosphorus was lowered. Part of this decrease in serum phosphorus could be due to advancing age of the animals, as has been reported by Hansard (33) and Long (52). Plasma levels remained fairly constant throughout the experimental period.

The phosphorus and calcium levels were above the minimum considered necessary for reproduction by Long (52) in almost all cases.

The ability of the group II animals to withstand prolonged shortages of phosphorus is shown by comparing phosphorus levels of groups II and III. Group III animals' phosphorus intake was 50 per cent more than the intake of animals in group II, yet their blood levels fell lower in some instances than group II.

A comparison of the mean calcium and phosphorus levels of the blood serum of the different groups at the same age is given in Figures 1 and 2. The decline in phosphorus with maturity of the bulls is shown in all groups.

SEMEN DATA:

Hall (31) has reported on the earlier sexual development and semen production of animals in the experiment. Semen had been collected from 7 of the 14 bulls.

Appendix Tables XVI through XXVIII contain data relevant to semen collected during the experimental period. Due to improper operation of the photelometer, colorimetric readings were too high and the resulting estimates of spermatozoan concentrations were too low from November 1, 1955, to February 3, 1956. Faulty refrigeration on February 13, and 24, 1956, affected all samples in cold storage on those days.

Bull 3, presumed to be a unilateral cryptorchid, has never shown the reproductive ability of other animals in group I. Collection of semen from Bull 3 has been slow and erratic. The quality of his ejaculates has not been as high as desired. Semen from Bull 21 was of good quality until March 30, 1956. On that date, an artificial vagina lining ruptured, causing severe burns on the penis of the bull. Resulting adhesions have prevented further semen collection from him. Semen

Figure 1. Average Plasma Calcium Levels by Groups

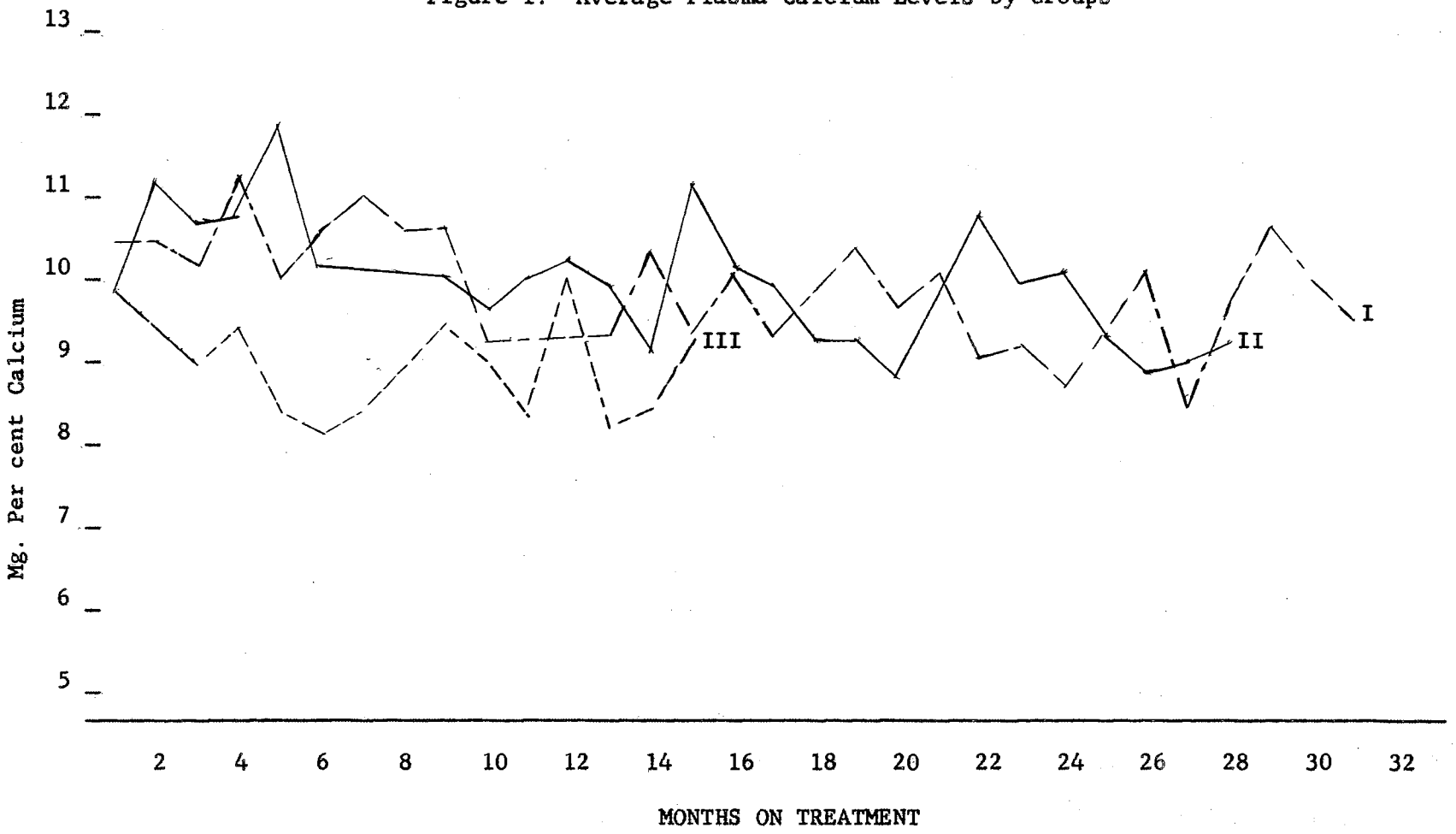
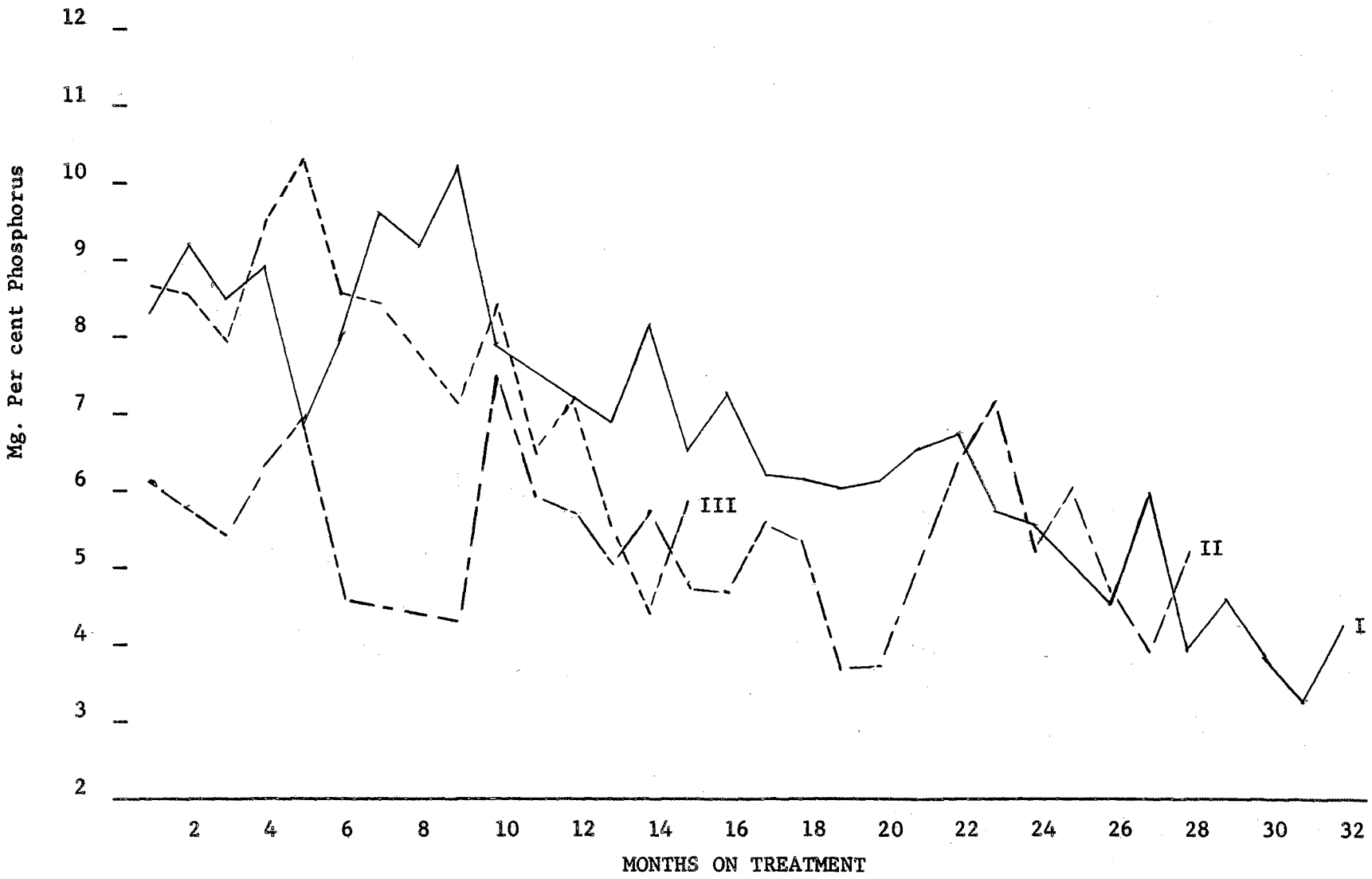


Figure 2. Average Plasma Inorganic Phosphorus Levels by Groups



from Bull 4 and Bull 15 has been of good quality. During the latter weeks of the experiment some difficulty in mounting another animal was shown by Bulls 3, 4, and 15. However, the semen obtained apparently did not change in quality.

Three ejaculates were collected from group I animals by the electro-ejaculate technique on three separate occasions. Considerable debris was found in the ejaculates but the livability of spermatozoa at 5°C. was acceptable. However, the stimuli of the electric shock seemed to place undue stress on the animals muscular systems. Possibly, this may have been partially due to the weak physical condition of the bulls while on the low phosphorus diet.

Semen collection from group II has been acceptable. Bull 36 was 26 months old before semen was collected from him. Since then, his libido has been excellent and quality of his semen average. Bull 34 was slow to mount another animal but ejaculates collected have been better than average. Semen of fair quality has been consistently collected from Bulls 35 and 37.

First collections of semen from animals of group III were from Bulls 23 and 99 at 10 months of age and from 41, 45, and 96 at 11 months of age. While Bull 108 exhibited evidence of sexual maturity, at the end of the experimental period he had not mounted another animal, making semen collection impossible by the artificial technique. Collections from Bulls 45 and 96 have been erratic, but semen of good quality was produced when true ejaculates were obtained. Semen from Bull 41 has had large percentages of abnormal spermatozoa, but it has been acceptable in other respects. Bulls 23 and 99 have consistently produced good quality semen.

No large differences in the production of good quality semen could be observed between the three groups of bulls during the experimental period. However, large differences occurred between animals of the same groups and in successive ejaculates from the same bull.

The expression of libido seems to have been influenced by the low phosphorus rations. Sexual expression as evidenced by general behavior and reluctance to mount other animals was observed in group I following the feeding of rations of low phosphorus content.

Hall (31) reported that the average of group I animals when first collections of semen were made was 12 months. The average age of group II animals was 19 months at the time of first semen collection. Five of the six animals of group III produced semen at an average age of 10.5 months.

Until more information is known concerning laboratory analysis of bovine semen, it is considered that normal semen was obtained from 13 of the 14 experimental animals.

SUMMARY AND CONCLUSIONS

The third segment of a long term experiment to compare the effects of three different levels of phosphorus on the growth and reproduction of young bulls has been completed.

Definite effects of low intake of phosphorus has been shown in groups I and II. Growth was essentially stopped in group I and sexual activity was decreased greatly. Slow growth and delayed sexual maturity were observed in group II bulls. Group III animals showed normal growth and reproduction for young bulls.

Two digestion trials were completed. Digestion coefficients obtained are in agreement with earlier trials (70) (31), indicating that the calculated TDN estimates are acceptable. A developed ability to conserve body stores of phosphorus and thus require very little exogenous phosphorus is indicated in group II animals.

Blood serum inorganic phosphorus levels dropped as the phosphorus content of the feed was lowered and as the animals advanced in age.

The different levels of phosphorus have not materially affected the quality of semen collected from any of the bulls.

LITERATURE CITED

(1) ALMQUIST, J. O. Diluters of Bovine Semen. V. A Comparison of Heated Milk and Egg Yolk and Citrate as Diluters for Semen from Bulls of High and Low Fertility. J. Dairy Sci., 37: 1308. 1954.

(2) ANDERSON, A. K., GAYLEY, H. E., AND PRATT, A. D. Studies of the Chemical Composition of Bovine Blood. J. Dairy Sci., 13: 336. 1930.

(3) ARCHIBALD, J. G. The Composition, Digestibility, and Feeding Value of Hydrolyzed Sawdust. J. Dairy Sci., 9: 257. 1926.

(4) ARRINGTON, L. R., AND DAVIS, G. K. Metabolism of Phosphorus and Molybdenum in Rats Receiving High Calcium Diets. J. Nutr., 55: 185. 1955.

(5) ASDELL, S. A. Nutrition and Treatment of Sterility in Dairy Cattle. (A Review). J. Dairy Sci., 32: 60. 1949.

(6) BAKER, F. N., VANDEMARK, N. L., AND SALISBURY, G. W. Growth of Holstein Bulls and Its Relationship to Sperm Production. J. Animal Sci., 14: 746. 1955.

(7) BAKER, F. N., VANDEMARK, N. L., AND SALISBURY, G. W. The Effect of Frequency of Ejaculation on the Semen Production, Seminal Characteristics, and Libido of Bulls During the First Post Pubertal Year. J. Dairy Sci., 38: 1000. 1955.

(8) BRANTON, C., BRATTON, R. W., AND SALISBURY, G. W. Semen Production and Fertility of Dairy Bulls Fed Rations Containing Protein of Animal Origin. J. Dairy Sci., 32: 292. 1949.

(9) BRANTON, C., BRATTON, R. W., AND SALISBURY, G. W. Total Digestible Nutrients and Protein Levels for Dairy Bulls Used in Artificial Breeding. J. Dairy Sci., 30: 1003. 1947.

(10) BRANTON, C., JAMES, C. B., PATRICK, T. E., AND NEWSOM, M. H. The Relationship Between Certain Semen Quality Tests and Fertility and the Interrelationships of These Tests. J. Dairy Sci., 34: 310. 1951.

(11) BRANTON, C., KELLGREN, H. C., AND PATRICK, T. E. The Importance of Numbers of Spermatozoa in Relation to Semen Quality and Fertility of Dairy Bulls. J. Dairy Sci., 36: 1301. 1953.

(12) BRANTON, C., PATRICK, T. E., NEWSOM, M. H., AND D'ARENSBOURGH, G. Pasture vs. Dry Lot Feeding for Dairy Bulls in Artificial Breeding. J. Dairy Sci., 36: 3. 1953.

(13) BRATTON, R. W., AND FOOTE, R. H. Semen Production and Fertility of Dairy Bulls Ejaculated Either Once or Twice at Intervals of Either Four or Eight Days. J. Dairy Sci., 37: 1439. 1954.

(14) BRATTON, R. W., FOOTE, R. H., MUSGRAVE, S. D., AND VAN DEMARK, N. L. Livability and Fertility of Bovine Spermatozoa in Different Diluents. J. Dairy Sci., 32: 604. 1949.

(15) BRATTON, R. W., FOOTE, R. H., HENDERSON, C. R., MUSGRAVE, S. D., DUNBAR, R. S., JR., DUNN, H. O., AND BEARDSLEY, J. P. The Relative Usefulness of Combinations of Laboratory Tests for Predicting the Fertility of Bovine Semen. J. Dairy Sci., 39: 1542. 1956.

(16) BRIGGS, H. M., AND GALLUP, W. D. Metabolism Stalls for Wethers and Steers. J. Animal Sci., 8: 479. 1949.

(17) COX, R. L. Physical Balance as a Factor in Determining the Efficiency of Feed Utilization by Fattening Lambs. Kans. Agr. Expt. Sta., Tech Bull., 65. 1948.

(18) CRAGLE, R. G., AND MUNTZ, J. H. Mineral Levels of Bovine Semen and Seminal Plasma. J. Dairy Sci., 39: 922. 1956.

(19) DAVENPORT, E. On the Importance of the Physiological Requirements of the Body. Results of an Attempt to Grow Cattle Without Coarse Feed. Ill. Agr. Expt. Sta., Bull., 46. 1897.

(20) DREHER, W. H., AND WEBB, J. H. A Comparison of Homogenized Whole Milk and Egg Yolk - Phosphate as Diluters for Bull Semen. J. Dairy Sci., 36: 673. 1953.

(21) DUNCAN, H. R. High Phosphorus VS. Low Phosphorus - Red Clover Hay for Growing Calves. Am. Soc. Animal Prod. Proc., 33: 109. 1940. (J. Dairy Sci., 24: A328. 1941.)

(22) DUNN, H. O. Further Studies of the Influence of Three Levels of Nutrient Intake on the Growth and Sexual Development of Young Holstein Bulls. Ph.D. Thesis. Cornell Univ. 1953.

(23) DUNN, H. O., BRATTON, R. W., AND HENDERSON, C. R. Fertility of Bovine Spermatozoa in Buffered Whole Egg Extenders Containing Penicillin, Streptomycin, Sulfonamides, and Added Glucose. J. Dairy Sci., 36: 524. 1953.

(24) DZIUK, P. J., GRAHAM, E. F., AND PETERSON, W. E. The Technique of Electroejaculation and Its Use in Dairy Bulls. J. Dairy Sci., 37: 1035. 1954.

(25) ECKLES, C. H., BECKER, R. B., AND PALMER, L. S. A Mineral Deficiency in the Ration of Cattle. Minn. Agr. Expt. Sta. Bull., 229. 1926.

(26) ECKLES, C. H., GULLICKSON, T. W., AND PALMER, L. S. Phosphorus Deficiency in the Rations of Cattle. Minn. Agr. Expt. Sta., Bull., 91. 1932.

(27) ERB, R. E., FLERCHINGER, F. H., EHLERS, M. H., AND GASSNER, F. X. Metabolism of Bull Semen. II. Fructolysis Relationships with Sperm Concentration and Fertility. J. Dairy Sci., 39: 326. 1956.

(28) FISKE, C. H., AND SUBBAROW, Y. The Colorimetric Determination of Phosphorus. J. Biol. Chem., 66: 375. 1925.

(29) FLERCHINGER, F. H., AND ERB, R. E. Metabolism of Bull Semen. I. Inorganic and Total Phosphorus Relationships. J. Dairy Sci., 38: 1028. 1955.

(30) GULLICKSON, T. W. Some Experiences in Feeding Dairy Cattle Rations Devoid of Roughage. J. Dairy Sci., 20: 419. 1937.

(31) HALL, J. G. The Effects of Levels of Phosphorus Intake on Growth and Semen Production in Young Dairy Bulls. M. S. Thesis. Oklahoma A & M College. 1955.

(32) HANSARD, S. L., COMAR, C. L., AND PLUMLEE, M. P. Absorption and Tissue Distribution of Radio-Calcium in Cattle. J. Animal Sci., 11: 524. 1952.

(33) HANSARD, S. L., COMAR, C. L., AND PLUMLEE, M. P. The Effects of Age Upon Calcium Utilization and Maintenance Requirements in the Bovine. J. Animal Sci., 13: 25. 1954.

(34) HAVARD, R. E., AND REAY, G. A. The Influence of Exercise on the Inorganic Phosphates of the Blood. J. Physiol., 61: 35. 1926.

(35) HAWK, H. W., TYLER, W. J., AND CASIDA, L. E. Some Factors Affecting Age at Puberty in Holstein-Friesian Heifers. J. Dairy Sci., 37: 252. 1954.

(36) HAWK, P. B., OSER, B. L., AND SUMMERSON, W. H. Practical Physiological Chemistry. 13th Ed. The Blakiston Co., New York, N. Y. 1954.

(37) HAWKINS, G. E., JR., WISE, G. N., MATRONE, G., AND WAUGH, R. K. Manganese in the Nutrition of Young Dairy Cattle Fed Different Levels of Calcium and Phosphorus. J. Dairy Sci., 38: 5. 1955.

(38) HENDERSON, H. O., AND WEAKLEY, C. E., JR. The Effect of Feeding Different Amounts of Calcium and Phosphorus upon the Growth and Development of Dairy Animals. W. Va. Agr. Expt. Sta. Bull., 231. 1929.

(39) HERMAN, H. A., AND RAGSDALE, A. C. Artificial Insemination of Dairy Cows. Mo. Agr. Expt. Sta. Bull. 407. 1939.

(40) HERMAN, H. A., AND SWANSON, E. W. Variations in Dairy Bull Semen with Respect to Its Use in Artificial Insemination. Mo. Agr. Expt. Sta. Bull., 326. 1941.

(41) HOUSE, W. B., AND HOGAN, A. G. Mineral Nutrition of Guinea Pigs. J. Nutr., 55: 507. 1955.

(42) HUFFMAN, C. F. Hay is Necessary in Rations for Dairy Cattle. Mich. Agr. Expt. Sta. Qtrly. Bull. 1. 1928.

(43) HUFFMAN, C. F., ROBINSON, C. S., DUNCAN, C. W., LAMB, T. W., AND MASON, M. F. A Study of the Phosphorus Requirements for Growth and Reproduction from Three Months to First Calving. J. Dairy Sci., 16: 203. 1933.

(44) HURST, V. Dilution of Bull Semen with Frozen Egg Yolk - Sodium Citrate. J. Dairy Sci., 36: 181. 1953.

(45) KAY, H. D. Plasma Phosphates. II. The Enzyme in Disease, Particularly in Bone Disease. J. Biol. Chem., 89: 249. 1930.

(46) KAMPSCHMIDT, R. F., MAYER, D. T., AND HERMAN, H. A. Lipid and Lipoprotein Constituents of Egg Yolk in the Resistance and Storage of Bull Spermatozoa. J. Dairy Sci., 36: 733. 1953.

(47) KLEIBER, M., SMITH, A. H., RALSTON, N. P., AND BLACK, A. L. Radio Phosphorus as Tracer for Measuring Endogenous Phosphorus in Cow's Feces. J. Nutr., 45: 253. 1951.

(48) LASLEY, J. F. Spermatozoan Motility as a Measure of Semen Quality. J. Animal Sci., 10: 211. 1951.

(49) LEPARD, O. L., SHUART, C. E., AND FOSTER, A. The Effect of Exercise on the Amount and Quality of a Dairy Bull's Semen. J. Dairy Sci., 24: 509. 1941.

(50) LINDSEY, J. B., ARCHIBALD, J. G., AND NELSON, P. R. The Calcium Requirements of Dairy Heifers. J. Agr. Res., 42: 883. 1931.

(51) LOFGREEN, G. P., KLEIBER, M., AND LUICK, J. R. The Metabolic Fecal Phosphorus Excretion of the Young Calf. J. Nutr., 47: 571. 1952.

(52) LONG, R. A., VAN ARSDELL, W. A., MacVICAR, R., AND ROSS, O. B. Blood Composition of Normal Beef Cattle. Okla. Agr. Expt. Sta. Tech. Bull. 43. 1952.

(53) MARDEN, W. G. R. New Advances in the Electro-Ejaculation of the Bull. J. Dairy Sci., 37: 556. 1954.

(54) MAYER, D. T., SQUIERS, C. A., BOGART, R., AND OLOUFA, M. M. The Technique for Characterizing Mammalian Spermatozoa as Dead or Living by Differential Staining. J. Animal Sci., 10: 51. 1951.

(55) MAYNARD, L. A., AND SMITH, S. E. Mineral Metabolism. Ann. Revs. of Biochem., 16: 273. 1947.

(56) McALPINE, R. J. Alkaline Glycerophosphate in the Developing Thyroid, Parathyroid, and Thymus of the Albino Rat. J. Anatomy, 96: 191. 1955.

(57) McELROY, W. D., AND GLASS, B. Phosphorus Metabolism, A Symposium on the Role of Phosphorus in the Metabolism of Plants and Animals. Vol. II. John Hopkins Press. Baltimore, Md. 1952.

(58) MEAD, S. W., AND REGAN, W. M. Deficiencies in Rations Devoid of Roughage for Calves. I. The Effect of the Addition of Cod Live Oil and Alfalfa Ash. J. Dairy Sci., 14: 283. 1931.

(59) MITCHELL, H. H. The Mineral Requirements of Farm Animals. J. Animal Sci., 6: 365. 1947.

(60) MONTGOMERY, R. L. Characteristics of Semen of Young Dairy Bulls Maintained on Two Levels of Phosphorus Intake. M. S. Thesis. Oklahoma A & M College. 1956.

(61) MOORE, L. A., IRVIN, H. M., AND SHAW, J. C. Relationships Between TDN and Energy Values of Feed. J. Dairy Sci., 36: 93. 1953.

(62) MORRISON, F. B. Feeds and Feeding. 22nd Ed. The Morrison Publ. Co., Ithaca, N. Y. 1956.

(63) MUSGRAVE, S. D. The Influence of Three Levels of Nutrient Intake on the Growth and Sexual Developments of Young Holstein Bulls. Ph.D. Thesis, Cornell University. 1951.

(64) NATIONAL RESEARCH COUNCIL. III. Recommended Nutrient Allowances for Dairy Cattle. Washington, D. C. 1950.

(65) OLDS, D. Viability of Spermatozoa in Bovine Genital Tract Fluids. J. Dairy Sci., 39: 923. 1956.

(66) OLDS, D., OLIVER, L., SEATH, D. M., AND CARPENTER, M. C. The Fertility of Bull Semen Extended with Yolk - Citrate Containing Varying Proportions of Egg Yolk. J. Dairy Sci., 34: 1081. 1951.

(67) PALMER, L. S., CUNNINGHAM, W. S., AND ECKLES, C. H. Normal Variations in the Organic Phosphorus of the Blood of Dairy Cattle. J. Dairy Sci., 13: 174. 1941.

(68) PALMER, L. S., GULLICKSON, T. W., BOYD, W. L., FITCH, C. P., AND NELSON, J. W. The Effect of Rations Deficient in Phosphorus and Protein on Ovulation, Estrus, and Reproduction of Dairy Heifers. J. Dairy Sci., 24: 199. 1941.

(69) PHILLIPS, R. W., AND ANDREWS, F. N. The Development of the Testes and Scrotum of the Ram, Bull, and Boar. Mass. Agr. Expt. Sta. Bull. 331. 1936.

(70) POITRAS, P. E. Experimental Rations to Study the Phosphorus Requirements of Young Dairy Bulls for Growth and Reproduction. M. S. Thesis. Oklahoma A & M College. 1955.

(71) PORTER, J. C., SHANKMAN, S., AND MELAMPY, R. M. Chemical Composition of Bovine Spermatozoa. Proc. Soc. Exp. Biol. Med., 77: 53. 1951.

(72) QUICKE, G. V., PHILLIPS, P. H., AND DREHER, W. H. An All Roughage Ration for Bulls. J. Dairy Sci., 33: 869. 1950.

(73) REED, O. E., AND HUFFMAN, C. F. Dairy Cattle Need Phosphorus in Ration. Mich. Agr. Expt. Stat. Qtrly. Bull. 10: 151. 1928.

(74) REED, O. E., AND HUFFMAN, C. F. Heavy Feeding of Concentrates Without Proper Quality of Roughage is Detrimental to the Animal. Mich. Agr. Expt. Sta. Qtrly. Bull. 8: 118. 1926.

(75) REID, J. T., WARD, G. M., AND SALSBURY, R. L. Simple vs. Complex Concentrate Mixtures for Young Breeding Bulls. I. Growth, Blood Composition, and Cost. J. Dairy Sci., 31: 429. 1948.

(76) REID, J. T., WARD, G. M., SALISBURY, R. L., AND SHUART, C. E. The Relationship of Semen Production, Age, Plasma Calcium, and Plasma Phosphorus to the Plasma Phosphatases of Dairy Bulls. J. Dairy Sci., 30: 546. 1947.

(77) RIDDLE, W. H., HUGHES, J. S., AND FITCH, J. R. The Relationship of Phosphorus Deficiency to the Utilization of Feed in Dairy Cattle. Kans. Agr. Expt. Sta. Tech. Bull. 36. 1934.

(78) RUSOFF, L. L., JOHNSTON, J. E., AND BRANTON, C. Blood Studies of Breeding Dairy Bulls. I. Hematocrit, Hemoglobin, Plasma Calcium, Plasma Inorganic Phosphorus, Alkaline Phosphatase Values, Erythrocyte Count, and Leucocyte Count. J. Dairy Sci., 37: 30. 1954.

(79) SALISBURY, G. W., BECK. G. H., ELLIOT, I., AND WILLETT, E. L. Rapid Methods for Estimating the Numbers of Spermatozoa in Bull Semen. J. Dairy Sci., 26: 69. 1943.

(80) SCHULTZE, M. O. Effects of Malnutrition in Early Life on Subsequent Growth and Reproduction of Rats. J. Nutr., 56: 25. 1956.

(81) SMITH, A. H., KLEIBER, M., BLACK, A. L., LUICK, J. R., LARSON, R. F., AND WEIR, W. C. Distribution of Intravenously Injected Radioactive Phosphorus (P^{32}) Among Sheep Tissues. J. Animal Sci., 11: 638. 1952.

(82) SMITH, A. H., KLEIBER, M., BLACK, A. L., EDICK, M., ROBINSON, R. R., AND HEITMAN, H., JR. Distribution of Intravenously Injected Radioactive Phosphorus (P^{32}) Among Swine Tissues. J. Animal Sci., 10: 893. 1951.

(83) SMITH, J. T., MAYER, D. T., AND HERMAN, H. A. A Comparison of the Ability of Certain Egg Yolk Diluents to Maintain Optimum Osmotic Conditions During the Storage of Bull Semen. J. Dairy Sci., 37: 684. 1954.

(84) SMITH, J. T., MAYER, D. T., AND MERILAN, C. P. Effect of Egg Yolk and Its Isolated Constituents upon the Dehydrogenase Activity of Bovine Spermatozoa. J. Dairy Sci., 39: 552. 1956.

(85) SNYDER, J. W., AND RALSTON, N. P. Effect of Forced Exercise on Bull Fertility. J. Dairy Sci., 38: 125. 1955.

(85) STARE, F. J., AND ELVEHJEM, C. A. The Phosphorus Partition in the Blood of Rachitic and Non-Rachitic Calves. J. Biol. Chem., 97: 511. 1932.

(86) STONE, E. J., JOHNSON, J. E., AND MIXNER, J. P. Live Spermatozoa Relationships and Fertility of Dairy Bull Semen. J. Dairy Sci., 33: 442. 1950.

(87) SWANSON, W. W. The Effects of Varying Proportions of Egg Yolk and Sodium Citrate Buffer in Semen Diluters upon Sperm Motility. J. Dairy Sci., 32: 345. 1949.

(88) SWANSON, E. W., AND HERMAN, H. A. The Correlation Between Some Characteristics of Dairy Bull Semen and Conception Rate. Mo. Agr. Expt. Sta. Circ. 313. 1947.

(89) THACKER, D. L., AND ALMQUIST, J. O. Diluters for Bovine Semen. I. Fertility and Motility of Bovine Spermatozoa in Boiled Milk. J. Dairy Sci., 36: 173. 1953.

(90) THACKER, D. L., AND ALMQUIST, J. O. Diluters for Bovine Semen. I. Fertility and Motility of Bovine Spermatozoa in Boiled Milk. J. Dairy Sci., 36: 173. 1953.

(91) TILLMAN, A. D., SIRNY, R. J., AND MacVICAR, R. The Effect of Alfalfa Ash upon the Digestibility and Utilization of Cottonseed Hulls by Sheep. J. Animal Sci., 13: 726. 1954.

(92) TITUS, H. W. The Mutual Influence of the Proportion of the Several Nutrients, in Feeds, on Their Digestibility. I. Crude Fiber - The Digestibility of Rations Containing Varying Amounts of Alfalfa and Paper Pulp. N. Mex. Agr. Expt. Sta. Tech. Bull. 153. 1926.

(93) TURNER, W. A., AND HARTMAN, A. Calcium and Phosphorus Metabolism in Dairy Cows. III. The Right Ration for High Producing Cows and the Effect of Exercise on the Calcium, Phosphorus, and Nitrogen Balance. J. Nutr., 1: 445. 1929.

(94) VAN DEMARK, N. L., BOYD, L. J., AND BAKER, F. N. Potential Services of a Bull Frequently Ejaculated for Four Consecutive Years. J. Dairy Sci., 39: 1071. 1956.

(95) VISEK, W. J.,AND LOOSLI, J. K. Behavior of Radio-Calcium in the Lactating Goat After Oral and Intravenous Administration. J. Dairy Sci., 34: 508. 1951.

(96) VISEK, W. J., MONROE, R. A., SWANSON, E. W., AND COMAR, C. L. Calcium Metabolism in Dairy Cows as Studied with Ca^{45}. J. Dairy Sci., 36: 383. 1953.

(97) VISEK, W. J., MONROE, R. A., SWANSON, E. W., AND COMAR, C. L. Determination of Endogenous Fecal Calcium in Cattle by a Single Isotope Dilution Method. J. Nutr., 50: 23. 1953.

(98) WILLETT, E. L., AND BUCKNER, P. J. The Determination of Number of Spermatozoa in Bull Semen by Measurement of Light Transmission. J. Animal Sci., 10: 219. 1951.

(99) WILLETT, E. L., HENKE, L. A., AND MARUYAMA, C. The Use of Urea in Rations for Cows under Hawaiian Conditions. J. Dairy Sci., 29: 629. 1946.

(100) WILLETT, E. L., AND LARSON, G. L. The Fertility of Bull Semen as Influenced by Dilution Level, Antibiotics, Spermatozoan Numbers, and Interactions of These Factors. J. Dairy Sci., 35: 899. 1952.

(101) WILLIAMS, D. E., MAC LEOD, F. L., AND MORRELL, E. Availability to White Rats of Phosphorus in Lespedeza and Alfalfa Hays. J. Nutr., 19: 251. 1940.

APPENDIX

APPENDIX

TABLES PAGE

Appendix (Continued)

TABLES

TABLE I

Recorded feed consumption of all bulls prior to June 5, 1955

Bull No.	Herd starter consumed	Hay consumed	Milk consumed	Conc. offered	Pulp molasses offered	Beet pulp offered	Orts	TDN consumed	Total protein consumed	Calcium consumed	Phos. consumed
	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
					Group I						
3	331.1	207.9	244.0	7421.2	5179.2	476.0		6384.6	957.1	31455.4	9226.1
4	542.8	392.8	314.0	4489.5	8144.5	616.0		8177.7	1220.4	42517.5	12085.8
11	124.3	49.3	10.0	2186.5	1619.5	182.0	280.4	2433.0	454.7	11732.9	3622.6
15	48.0	34.9	-----	3828.0	5274.0	483.0	778.6	5146.1	771.8	27194.6	7148.2
21	397.9	336.4	393.0	4096.9	8059.5	553.0		7002.9	1075.1	37365.0	10537.0
					Group II						
33	288.1	195.1	356.0	1275.1	710.6	49.0	114.9	1575.2	268.3	6050.8	1959.1
34	292.4	196.3	276.0	2555.8	1516.7	195.5	1317.2	2138.2	385.3	9684.7	3516.2
35	284.5	194.5	231.0	2605.5	1656.2	204.4	1100.1	2260.8	430.9	11002.8	3305.2
36	249.5	193.5	268.0	2529.5	1371.7	203.0	1218.2	1979.3	403.5	9538.9	3368.1
37	291.4	184.9	253.0	2647.8	1981.4	202.5	921.5	2556.3	493.4	12448.3	3810.4
38	294.7	199.2	210.0	1884.8	1201.5	76.5	569.3	1844.8	294.2	8211.5	2331.7
					Group III						
23	419.6	183.6	330.5	478.1	215.0			809.5	204.8	7199.6	2456.0
41	245.0	92.0	385.1	466.9	203.3		0.5	619.1	158.3	5580.2	2117.5
45	316.8	191.6	479.4	490.9	234.5		1.3	762.4	190.6	6547.7	2411.6
96	349.8	209.3	503.5	483.4	218.4		6.6	783.8	196.6	6759.2	2447.1
99	335.6	173.9	402.1	483.7	223.3		13.0	740.5	187.9	6490.3	2308.9
108	50.3	23.9	462.5	469.7	215.0			468.4	121.8	4020.3	1901.8

TABLE II

Growth measurements and feed consumption for Holstein bull No. 3, Group 1
Born February 2, 1953 - Purchased March 14

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	976	70.0	53.0	47.6	100.8	7.0		88.4	11.3	608.5	161.1
	18	996	69.0	53.0	47.6	105.0	7.0		90.8	11.4	621.6	163.1
	25	1015	70.0	52.5	47.6	106.4	7.0		91.5	11.4	625.9	163.8
July	2	989	69.5	53.0	49.0	105.0	7.0		91.6	11.7	629.4	166.3
	9	1024	71.0	54.0	49.0	105.0	7.0		91.6	11.7	629.4	166.3
	16	1053	71.0	52.0	49.0	105.0	7.0		91.6	11.7	629.4	166.3
	23	1102	72.0	53.0	49.0	105.0	7.0		91.6	11.7	629.4	166.3
	30	1062	72.0	53.0	53.2	105.0	7.0		101.9	12.4	652.8	175.9
Aug.	6	1059	72.0	53.0	53.2	109.2	7.0		96.4	12.5	665.9	177.9
	13	1006	71.5	53.0	50.4	109.9	7.0		93.1	12.0	652.5	171.9
	20	1081	71.5	53.0	47.6	105.0	7.0		90.8	11.4	621.6	163.1
	27	1108	72.5	53.0	51.8	112.0	7.0		97.2	12.3	666.8	176.1
Sept.	3	1154	73.0	53.0	53.2	113.4	7.0		98.7	12.6	679.0	179.9
	10	1059	72.0	53.0	55.6	116.4	7.0		101.8	13.1	701.8	186.8
	17	1109	74.0	52.5	56.0	117.0	7.0		102.4	13.2	705.8	188.0
	24	1129	75.5	53.5	56.0	116.9	7.0		102.3	13.2	705.5	187.9
Oct.	1	1133	73.0	53.0	54.6	115.5	7.0		100.7	12.9	693.3	184.1
	8	1170	77.0	53.5	35.0	98.0*		25.0	94.1	5.8	231.2	64.5
	15	1150	75.0	53.0	35.0	98.0		16.1	98.2	6.1	234.9	65.5
	22	1150	75.5	53.5	35.0	98.0			111.7	6.5	241.7	67.8
	29	1179	75.0	54.0	35.0	98.0		1.1	110.8	6.5	241.2	67.7

Table II (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Nov. 5	1180	78.0	53.0	35.0	98.0		2.1	110.0	6.5	240.8	67.5
12	1183	75.5	54.0	35.0	98.0		4.6	107.9	6.4	239.8	67.2
19	1132	76.0	53.0	35.0	98.0		3.3	109.0	6.5	240.3	67.4
26	1170	76.0	54.0	35.0	98.0		2.8	110.1	6.5	240.5	67.4
Dec. 3	1115	74.0	54.0	35.0	98.0		6.6	106.2	6.3	238.9	66.9
10	1164	75.0	54.0	35.0	98.0		7.2	105.7	7.2	191.0	61.0
17	1154	75.0	54.0	35.0	98.0		15.0	99.1	7.0	187.7	60.0
24	1150	75.0	54.0	35.0	98.0		7.7	105.3	7.2	190.8	61.0
31	1178	75.0	54.0	35.0	98.0		9.9	103.4	7.2	189.8	60.7
(1956)											
Jan. 7	1156	74.5	54.5	35.0	98.0		7.6	105.4	6.9	200.2	39.2
14	1184	76.0	54.5	35.0	98.0			111.7	7.1	203.4	40.2
21	1196	76.0	54.0	35.0	98.0			111.7	7.1	203.4	40.2
28	1216	74.5	54.0	35.0	98.0			111.7	7.1	203.4	40.2
Feb. 4	1199	75.0	54.0	35.0	98.0			111.7	7.1	203.4	40.2
11	1208	76.0	55.0	35.0	98.0			111.7	7.1	203.4	40.2
18	1110	74.0	54.0	35.0	98.0			111.7	7.1	203.4	40.2
25	1184	74.5	55.0	35.0	98.0			111.7	7.1	203.4	40.2
Mar. 3	1166	77.0	55.0	35.0	98.0			111.7	7.1	203.4	40.2
10	1168	74.5	55.0	35.0	98.0			111.7	7.1	201.6	41.8
17	1120	74.5	55.0	35.0	98.0			111.7	7.1	201.6	41.8
24	1188	75.0	55.0	35.0	98.0		4.5	108.0	6.8	199.9	41.5
31	1176	75.0	55.0	35.0	98.0		13.2	100.7	6.6	196.7	40.9

Table II (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Apr. 7	1188	76.0	55.5	35.0	98.0		2.6	109.6	6.8	200.6	41.6
14	1144	75.0	55.0	35.0	98.0		4.5	108.0	6.8	199.9	41.5
21	1156	76.0	55.0	35.0	98.0			111.7	6.8	201.6	41.8
28	1184	76.5	55.0	35.0	98.0		24.2	91.4	6.5	192.6	40.2
May 5	1158	76.0	55.0	35.0	98.0		16.9	97.5	6.6	195.3	40.7
12	1164	75.0	55.0	35.0	98.0		38.6	79.3	6.3	187.3	39.3
19	1154	75.0	55.0	35.0	98.0		15.7	98.6	6.6	195.8	40.8
26	1136	75.5	54.5	35.0	98.0		21.2	93.9	6.3	251.2	130.0
June 2	1140	73.0	55.5	35.0	98.0		3.0	109.2	6.6	259.0	131.2
Total				2095.4	5282.5	119.0	253.4	5324.2	442.8	18537.7	4863.3

*Weights hereafter are for wood pulp only.

TABLE III

Growth measurements and feed consumption for Holstein bull No. 4, Group I
Born February 14, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	1463	74.0	55.5	68.6	133.0	7.0		128.8	15.8	814.0	224.2
	18	1482	76.0	55.0	71.4	137.2	7.0		133.2	16.4	838.4	232.6
	25	1495	76.5	55.0	72.8	140.0	7.0	2.0	134.5	16.6	849.2	237.1
July	2	1470	77.0	55.5	74.2	140.0	7.0		136.6	16.9	858.0	240.3
	9	1483	79.0	55.5	58.6	105.0	7.0		105.4	13.4	674.1	188.1
	16	1476	80.0	55.5	67.2	107.0	7.0		111.9	14.9	727.4	208.6
	23	1532	79.0	55.5	67.2	105.0	7.0		110.7	14.9	721.4	207.6
	30	1493	77.0	55.5	67.2	111.0	7.0		114.4	15.0	739.5	210.5
Aug.	6	1518	78.5	55.5	64.0	119.0	7.0		117.3	14.6	746.0	207.1
	13	1451	78.0	55.5	66.6	116.9	7.0		117.8	15.1	754.1	212.0
	20	1532	78.5	56.0	64.4	115.5	7.0		115.4	14.6	737.6	206.3
	27	1537	79.0	56.0	67.2	105.0	7.0		110.7	14.9	721.4	207.6
Sept.	3	1581	79.0	55.0	67.2	105.0	7.0		110.7	14.9	721.4	207.6
	10	1599	79.0	55.5	68.4	120.2	7.0		120.8	15.5	774.1	217.7
	17	1561	80.5	55.5	68.6	120.4	7.0		121.0	15.5	775.8	213.4
	24	1558	81.0	56.0	50.6	120.4	7.0		109.9	12.3	675.4	177.1
Oct.	1	1565	80.0	56.0	68.6	120.4	7.0		121.0	15.5	775.8	213.4
	8	1577	83.0	56.5	35.0	140.0*		72.9	85.8	4.8	242.4	60.7
	15	1599	81.0	56.0	35.0	140.0		62.5	94.5	5.0	247.4	62.4

Table III (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	1588	82.0	55.5	35.0	140.0		61.0	95.7	5.1	248.1	62.6
29	1636	81.0	56.0	35.0	140.0		55.9	100.1	5.2	250.6	63.4
Nov. 5	1643	82.5	56.5	35.0	140.0		59.4	97.1	5.1	248.9	62.9
12	1612	82.5	55.0	35.0	105.0		24.7	115.6	6.5	246.5	64.6
19	1585	82.5	56.5	35.0	105.0		16.0	104.2	6.1	239.9	66.0
26	1615	80.0	57.0	35.0	112.0		12.3	113.2	7.1	247.7	67.3
Dec. 3	1560	81.0	57.0	35.0	112.0		16.5	109.6	7.0	245.7	66.7
10	1520	80.5	55.5	35.0	112.0		10.9	114.4	7.2	200.7	61.8
17	1500	81.5	56.0	35.0	126.0		23.2	115.8	6.9	206.8	61.3
24	1420	81.0	57.0	35.0	112.0		14.1	111.7	7.1	199.1	61.3
31	1522	79.0	57.0	35.0	105.0		17.0	103.3	7.0	191.7	70.0
(1956)											
Jan. 7	1540	80.0	57.0	35.0	98.0		9.2	104.0	6.9	198.9	38.7
14	1584	80.5	57.0	35.0	98.0			111.7	7.1	203.4	40.2
21	1584	80.5	57.0	35.0	98.0			111.7	7.1	203.4	40.2
28	1540	79.0	57.0	35.0	98.0			111.7	7.1	203.4	40.2
Feb. 4	1548	80.5	57.0	35.0	98.0			111.7	7.1	203.4	40.2
11	1580	80.0	57.0	35.0	98.0			111.7	7.1	203.4	40.2
18	1522	79.0	57.0	35.0	98.0			111.7	7.1	203.4	40.2
25	1484	79.0	57.0	35.0	98.0			111.7	7.1	203.4	40.2
Mar. 3	1500	83.0	57.0	35.0	98.0			111.7	7.1	203.4	40.2

Table III (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	10	1520	80.5	57.0	35.0	98.0			111.7	7.1	201.6	41.8
	17	1480	81.0	57.0	35.0	98.0		4.5	108.0	6.8	200.2	41.4
	24	1450	79.5	57.0	35.0	98.0		19.0	95.7	6.5	195.5	39.8
	31	1496	81.0	57.0	35.0	84.0		21.2	82.2	6.5	182.7	38.4
Apr.	7	1470	80.5	57.0	35.0	98.0		14.4	99.2	6.6	197.0	40.6
	14	1484	80.0	57.0	35.0	98.0		22.7	92.7	6.5	194.3	39.8
	21	1384	80.5	57.0	35.0	98.0		10.2	103.2	6.7	198.3	40.9
	28	1420	81.0	58.0	35.0	98.0		43.5	75.2	6.2	187.7	38.1
May	5	1490	81.5	58.0	35.0	98.0		12.1	101.6	6.6	197.7	40.8
	12	1472	80.0	58.0	35.0	98.0		32.5	84.4	6.3	191.2	39.0
	19	1468	80.0	57.0	35.0	98.0		17.6	97.0	6.6	196.0	40.3
	26	1484	82.5	57.5	35.0	98.0		26.0	89.9	6.2	250.8	129.2
June	2	1404	82.0	57.0	35.0	98.0		10.1	103.3	6.5	255.9	130.5
Total					2357.8	5752.0	119.0	691.4	5622.8	485.7	20394.1	5503.1

*Weights hereafter are for wood pulp only.

TABLE IV

Growth measurements and feed consumption for Guernsey bull No. 15, Group I
Born April 15, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	991	67.0	51.5	44.9	91.0	7.0	22.9	72.6	10.2	551.3	150.3
	18	1011	67.0	50.5	46.2	98.0	7.0	39.0	70.0	10.2	572.2	156.7
	25	992	66.0	51.0	44.8	106.4	7.0	56.5	65.9	9.8	581.7	157.5
July	2	976	67.5	51.0	45.6	101.5	7.0	72.0	56.4	9.6	534.8	156.9
	9	981	67.5	51.0	45.5	101.5	7.0	80.2	52.5	9.4	530.2	156.7
	16	994	67.5	51.0	45.5	100.9	7.0	75.5	54.4	9.5	558.9	156.4
	23	974	68.0	51.0	45.5	101.5	7.0	83.1	51.2	9.3	557.0	156.7
	30	939	66.5	51.0	45.5	104.5	7.0	76.8	55.9	9.5	569.5	158.1
Aug.	6	978	66.5	51.5	45.5	105.0	7.0	81.0	54.2	9.5	569.0	158.4
	13	951	66.5	51.5	47.3	105.0	7.0	69.4	60.6	10.1	584.8	162.5
	20	1000	68.0	51.5	45.5	101.5	7.0	67.0	58.7	9.6	565.1	156.7
	27	1010	67.0	51.0	47.6	105.0	7.0	71.7	59.7	10.0	585.4	163.1
Sept.	3	1025	68.0	52.0	47.6	105.0	7.0	74.0	58.7	10.0	584.2	163.1
	10	1050	69.5	51.5	48.8	107.9	7.0	70.1	62.9	10.3	601.9	167.3
	17	1020	67.5	52.0	50.4	102.9	7.0	73.1	56.9	9.6	569.0	168.5
	24	1031	73.0	51.5	50.4	110.5	7.0	64.3	65.4	10.0	597.2	172.2
Oct.	1	1049	68.0	52.0	49.0	110.5	7.0	62.6	68.0	10.6	614.9	169.0
	8	1045	72.0	52.0	35.0	98.0*		64.2	68.8	5.3	209.2	60.4
	15	1027	70.0	51.5	35.0	98.0		58.8	72.4	5.4	212.0	61.0

Table IV (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	1035	69.0	52.0	35.0	98.0		70.2	64.8	5.1	206.2	59.7
29	1045	71.0	52.0	35.0	98.0		70.3	64.7	5.1	206.2	59.7
Nov. 5	1030	69.5	51.5	35.0	98.0		68.0	66.3	5.2	207.3	59.9
12	1032	70.5	52.0	35.0	56.0		21.7	61.9	6.0	194.5	60.7
19	1066	73.0	52.0	35.0	56.0		9.3	70.2	6.2	200.8	62.1
26	1057	72.0	52.0	35.0	56.0		10.8	69.2	6.2	200.0	62.0
Dec. 3	1025	70.0	53.0	35.0	56.0		8.7	70.6	6.2	201.1	62.2
10	1048	71.0	51.0	35.0	70.0		11.5	80.5	7.1	164.0	57.6
17	1062	71.0	51.5	35.0	70.0		13.1	79.5	7.1	163.2	57.4
24	1030	70.5	51.5	35.0	70.0		21.7	76.8	6.9	158.7	56.4
31	1060	71.5	53.0	35.0	56.0		17.5	64.8	6.9	149.0	55.4
(1956)											
Jan. 7	1052	70.5	53.0	35.0	84.0		24.8	83.4	6.6	175.4	35.7
14	1060	70.5	52.5	35.0	70.0		8.6	60.4	6.8	174.9	36.1
21	1056	69.5	52.5	35.0	70.0		10.0	81.5	6.8	174.1	35.9
28	1070	69.0	53.0	35.0	70.0		9.1	82.1	6.8	174.6	36.0
Feb. 4	1064	71.0	52.0	35.0	70.0		15.0	78.2	6.7	171.6	35.4
11	1080	70.5	52.5	35.0	70.0		12.3	80.0	6.8	173.0	35.7
18	1042	70.0	52.5	35.0	70.0		10.0	81.5	6.8	173.7	35.9
25	1054	71.0	53.5	35.0	70.0		13.2	79.4	6.7	172.5	35.6
Mar. 3	1066	73.0	54.0	35.0	70.0		11.7	80.4	6.8	173.3	35.7
10	1074	70.0	53.5	35.0	70.0		9.8	81.7	6.8	172.4	37.6

Table IV (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar. 17	1054	71.0	53.5	35.0	70.0		9.0	82.2	6.6	172.9	37.7
24	1064	70.0	53.5	35.0	70.0		29.0	68.8	6.2	162.7	35.4
31	1058	71.0	53.5	35.0	56.0		28.8	57.2	6.1	150.8	33.9
Apr. 7	1086	71.5	53.0	35.0	56.0		22.0	62.1	6.3	154.3	34.7
14	1074	71.0	54.0	35.0	56.0		18.6	64.0	6.3	156.0	35.1
21	1080	71.0	53.5	35.0	56.0		22.3	61.5	6.3	154.1	34.6
28	1062	71.5	53.5	35.0	70.0		44.6	88.2	5.9	154.9	33.5
May 5	1070	71.5	53.0	35.0	56.0		27.5	58.1	6.1	151.5	34.0
12	1070	71.0	53.5	35.0	56.0		56.4	48.7	5.6	136.9	30.7
19	1060	71.0	53.5	35.0	56.0		16.7	65.3	6.4	157.0	35.9
26	1082	71.5	53.5	35.0	56.0		30.4	45.9	5.9	207.5	123.3
June 2	1072	73.0	53.0	35.0	56.0		2.3	74.9	6.4	221.8	126.5
Total				2020.6	4166.6	119.0	2017.1	3500.0	385.8	15915.2	4459.5

*Weights hereafter are for wood pulp only.

TABLE V

Growth measurements and feed consumption for Holstein bull No. 21, Group I
Born February 26, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	1223	73.5	54.0	58.8	120.4	7.0		125.3	13.8	771.2	196.0
	18	1236	72.0	54.0	60.2	121.8	7.0		127.1	14.0	733.3	203.9
	25	1261	75.0	54.5	60.2	123.2	7.0		128.1	14.1	737.5	204.6
July	2	1256	76.5	54.0	60.2	122.5	7.0	8.3	122.8	13.7	732.8	203.0
	9	1261	75.0	54.0	53.2	108.2	7.0	5.3	110.2	12.3	651.3	176.6
	16	1296	75.5	54.0	53.2	102.2	7.0	1.8	108.2	12.3	634.2	174.3
	23	1350	79.0	54.0	53.2	102.1	7.0	8.0	104.5	12.0	632.0	173.3
	30	1277	76.5	55.0	53.2	102.2	7.0	6.7	105.4	12.1	632.7	173.6
Aug.	6	1352	80.0	54.0	59.5	105.0	7.0	2.4	114.0	13.4	677.7	189.8
	13	1280	78.0	55.0	59.5	109.2	7.0		118.2	13.6	691.2	192.2
	20	1350	77.0	55.0	56.0	103.6	7.0		112.1	12.9	654.6	184.2
	27	1364	79.5	55.0	58.8	108.5	7.0		117.3	13.5	685.2	190.3
Sept.	3	1376	78.0	54.5	62.2	109.9	7.0		120.5	14.1	708.3	198.6
	10	1397	81.0	54.5	60.2	109.9	7.0		119.2	13.8	697.2	198.2
	17	1386	77.5	55.0	60.2	109.9	7.0		119.2	13.8	697.2	198.2
	24	1451	82.0	55.0	60.2	109.9	7.0		119.2	13.8	697.2	198.2
Oct.	1	1402	78.0	55.0	60.2	96.7	7.0	2.4	117.8	13.4	656.4	191.9
	8	1420	83.5	54.5	35.0	126.0*		54.0	95.6	4.6	248.7	63.0
	15	1496	81.0	55.0	35.0	126.0		44.5	102.6	4.9	251.7	64.3
	22	1377	80.5	55.5	35.0	126.0		45.1	102.2	4.9	251.5	64.2

Table V (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 29	1420	81.0	55.0	35.0	126.0		31.8	111.9	5.4	255.7	66.2
Nov. 5	1417	81.0	55.0	35.0	126.0		32.6	111.3	5.4	255.5	66.1
12	1400	80.0	56.0	35.0	84.0		19.1	86.0	5.8	223.5	63.4
19	1415	81.5	55.0	35.0	84.0		10.9	92.0	6.1	226.1	64.6
26	1451	81.5	56.0	35.0	98.0		6.7	106.8	6.3	239.6	66.8
Dec. 3	1432	80.5	56.0	35.0	98.0		7.7	106.1	6.2	239.3	66.7
10	1446	82.5	56.0	35.0	98.0		9.4	104.8	7.1	191.0	60.6
17	1444	82.0	56.0	35.0	98.0		14.3	101.2	6.9	189.5	59.9
24	1418	82.0	56.0	35.0	112.0		32.9	99.4	6.2	183.6	58.7
31	1438	80.0	56.5	35.0	98.0		16.3	99.8	6.8	188.8	59.6
(1956)											
Jan. 7	1420	81.0	56.0	35.0	105.0		22.4	98.8	6.3	186.9	37.6
14	1424	80.5	56.0	35.0	112.0		11.7	114.9	6.7	211.7	40.0
21	1434	79.5	56.0	35.0	98.0			111.7	7.1	203.4	40.2
28	1428	78.5	56.5	35.0	112.0		7.1	118.3	6.9	213.1	40.7
Feb. 4	1428	79.5	56.5	35.0	112.0			123.5	7.1	215.4	41.7
11	1444	80.0	56.5	35.0	112.0			123.5	7.1	215.4	41.7
18	1452	78.0	56.5	35.0	112.0			123.5	7.1	215.4	41.7
25	1436	79.0	57.0	35.0	112.0			123.5	7.1	215.4	41.7
Mar. 3	1428	82.0	56.5	35.0	112.0			123.5	7.1	215.4	41.7
10	1426	80.0	56.0	35.0	112.0			123.5	7.1	214.3	43.3
17	1396	80.0	57.0	35.0	112.0		7.0	118.4	6.7	214.0	42.6

Table V (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar. 24	1412	80.0	57.0	35.0	112.0		37.8	95.8	6.2	196.0	39.7
31	1388	79.5	56.5	35.0	98.0		49.9	75.1	6.0	181.2	37.1
Apr. 7	1418	81.0	57.5	35.0	98.0		24.7	93.6	6.4	191.5	39.4
14	1360	80.0	56.5	35.0	98.0		48.6	76.1	6.0	181.7	37.2
21	1384	80.5	56.5	35.0	84.0		21.2	84.4	6.5	180.8	38.2
28				35.0	98.0		42.2	80.8	6.8	184.4	37.8
May 5	1398	81.0	56.0	35.0	98.0		9.1	105.1	6.7	197.9	40.9
12	1376	80.0	57.0	35.0	98.0		47.8	76.6	6.0	182.1	37.3
19	1386	80.5	57.0	35.0	98.0		6.2	107.2	6.7	199.1	41.2
26	1442	81.5	57.0	35.0	98.0		113.0	28.8	4.7	213.0	120.6
June 2	1426	82.0	57.0	35.0	98.0			111.7	6.6	259.1	131.4
Total				2214.0	5554.2	119.0	808.9	5547.1	448.1	19121.7	5124.7

*Weights hereafter are for wood pulp only.

TABLE VI

Growth measurements and feed consumption for Ayrshire bull No. 34, Group II
Born September 15, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	487	54.0	43.0	28.0	28.0	7.0	21.5	32.0	5.6	223.8	57.5
	18	480	54.0	42.5	38.6	33.6	7.0	32.4	36.8	7.4	280.3	75.2
	25	490	54.0	42.5	39.2	41.3	7.0	31.3	43.5	7.7	307.6	79.1
July	2	488	55.0	43.0	39.2	37.8	7.0	26.7	43.9	7.9	300.8	78.5
	9	500	55.5	43.0	39.2	37.8	7.0	37.5	37.0	7.6	292.0	77.0
	16	490	56.0	43.0	39.2	37.8	7.0	37.3	37.1	7.6	292.1	77.0
	23	506	56.0	43.0	39.2	37.8	7.0	37.8	36.8	7.6	291.8	76.9
	30	511	55.0	43.5	39.8	44.4	7.0	53.5	32.0	7.4	302.7	78.1
Aug.	6	491	56.0	43.5	39.9	49.7	7.0	58.2	32.9	7.4	316.0	78.5
	13	500	57.0	43.5	39.9	43.7	7.0	49.2	34.3	7.5	304.6	77.7
	20	533	56.5	43.5	39.9	44.1	7.0	50.5	33.8	7.5	304.6	77.7
	27	540	57.0	43.0	38.5	48.3	7.0	51.5	35.2	7.3	310.5	76.7
Sept.	3	571	57.0	43.5	39.9	49.7	7.0	51.5	37.2	7.5	321.1	79.5
	10	556	57.0	43.5	40.6	52.7	7.0	56.7	36.6	7.7	320.2	80.8
	17	546	59.5	43.5	40.6	51.8	7.0	58.1	35.0	7.6	319.1	80.3
	24	600	60.0	44.0	39.9	50.4	7.0	43.9	42.5	7.8	329.1	80.9
Oct.	1	569	58.5	44.0	40.6	57.4	7.0	55.5	40.7	7.8	344.9	82.7
	8	565	61.0	44.0	35.0	28.0*		27.6	28.1	6.6	160.0	55.9
	15	565	59.5	44.0	35.0	28.0		20.1	32.8	6.7	165.8	57.0

Table VI (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	572	61.5	44.5	35.0	28.0		17.7	34.4	6.8	167.6	57.4
29	564	61.0	44.5	35.0	28.0		16.8	35.0	6.8	168.3	57.5
Nov. 5	588	62.0	44.5	35.0	28.0		19.2	33.4	6.8	166.5	57.2
12	600	60.0	44.0	35.0	28.0		12.3	37.8	6.9	171.8	58.2
19	602	61.0	44.5	35.0	28.0		12.4	37.8	6.9	171.7	58.2
26	637	61.5	45.0	35.0	28.0		10.7	38.8	6.9	172.4	58.5
Dec. 3	621	61.0	45.0	35.0	28.0		9.3	39.7	7.0	132.5	52.8
10	617	62.5	45.5	35.0	28.0		9.6	39.5	7.0	132.3	52.8
17	629	62.0	45.0	35.0	28.0		6.6	41.4	7.1	134.6	53.2
24	618	62.0	45.0	35.0	28.0		7.4	40.9	7.0	134.0	52.1
31	670	64.0	46.0	35.0	28.0		6.4	41.6	7.8	134.8	53.3
(1956)											
Jan. 7	618	63.0	45.5	35.0	28.0		8.1	40.5	7.8	152.9	31.3
14	636	63.0	45.5	35.0	28.0		13.5	37.1	7.5	148.7	30.5
21	668	68.5	47.0	35.0	28.0		12.2	37.9	7.5	149.7	30.7
28	605	62.0	45.5	35.0	28.0		10.3	39.1	7.5	151.2	31.0
Feb. 4	659	64.0	45.0	35.0	28.0		11.6	38.3	7.5	150.2	30.8
11	651	63.5	45.0	35.0	28.0		12.5	37.7	7.5	149.5	30.6
18	664	63.5	47.0	35.0	28.0		5.0	42.5	7.7	155.2	31.8
25	686	64.5	47.0	35.0	28.0		16.0	35.5	7.5	146.8	30.1
Mar. 3	673	63.5	46.0	35.0	28.0		7.6	40.8	7.6	153.2	31.4
10	677	64.0	45.0	35.0	28.0		8.3	40.3	7.5	152.7	27.8

Table VI (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	17	686	63.5	47.0	35.0	28.0			45.6	6.5	159.1	29.1
	24	in metabolism stall			35.0	28.0		11.8	37.2	4.3	159.1	29.1
	31	690	65.0	45.5	35.0	28.0		11.3	37.5	4.4	159.1	29.1
Apr.	7	715	65.0	46.5	35.0	28.0		7.9	40.6	6.3	153.0	27.8
	14	684	64.0	47.0	35.0	28.0			45.6	6.5	159.1	29.1
	21	700	64.5	47.0	35.0	28.0		3.9	43.1	6.4	156.1	28.5
	28	700	65.0	45.0	35.0	28.0		7.8	40.6	6.4	153.1	27.9
May	5	650	64.0	46.5	35.0	28.0		7.2	41.0	6.4	153.5	28.0
	12	700	65.5	47.0	35.0	28.0		6.5	41.5	6.4	154.1	28.1
	19	722	67.5	47.0	35.0	28.0		8.0	40.5	6.3	153.6	27.8
	26	711	66.0	47.5	35.0	28.0		5.1	42.4	7.2	155.2	28.3
June	2	715	67.0	47.0	35.0	28.0		1.9	44.4	7.3	157.6	28.8
Total					1887.2	1726.3	119.0	1105.7	1998.2	367.2	10549.2	2685.8

* Weights hereafter are for wood pulp only.

TABLE VII

Growth measurements and feed consumption for Ayrshire bull No. 35, Group II
Born September 12, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	528	56.0	43.0	32.2	35.0	7.0	9.5	50.0	7.0	277.8	69.2
	18	521	56.0	44.0	39.2	42.8	7.0	22.7	53.5	8.2	329.2	82.5
	25	563	58.0	44.0	39.9	46.2	7.0	25.0	55.3	8.5	342.2	83.6
July	2	546	57.5	44.0	39.9	49.0	7.0	34.9	5157	8.5	347.7	85.1
	19	570	59.0	44.0	40.2	49.0	7.0	25.1	57.5	8.6	352.1	86.6
	16	517	59.0	44.5	39.9	49.0	7.0	45.2	45.9	8.4	344.5	84.4
	23	565	58.0	44.5	39.9	49.0	7.0	30.6	54.2	8.5	349.1	85.4
	30	563	58.0	45.0	40.5	51.4	7.0	31.9	55.4	8.6	358.6	86.3
Aug.	6	587	59.0	45.0	40.6	57.4	7.0	30.2	61.2	8.8	378.3	89.5
	13	578	60.0	44.5	40.6	55.8	7.0	42.1	53.2	8.6	369.6	88.1
	20	621	60.5	44.5	40.6	54.6	7.0	41.5	52.7	8.6	366.1	87.8
	27	630	58.0	45.0	40.6	60.2	7.0	45.4	54.6	8.7	382.2	89.5
Sept.	3	644	60.0	45.0	41.3	60.9	7.0	46.7	55.0	8.9	387.1	90.8
	10	683	63.5	44.5	41.3	62.3	7.0	44.0	57.5	8.9	392.3	91.5
	17	674	62.0	44.5	42.0	67.2	7.0	45.1	61.1	9.1	410.1	94.3
	24	673	62.5	44.5	40.3	65.8	7.0	40.8	61.3	8.8	399.6	91.3
Oct.	1	671	61.5	44.5	41.3	66.5	7.0	46.3	59.4	9.0	404.5	92.8
	8	700	64.0	45.0	35.0	28.0*		19.8	35.8	6.9	175.1	58.9
	15	687	63.5	45.0	35.0	28.0		8.5	42.2	7.0	178.7	59.7

Table VII (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	673	65.5	45.0	35.0	28.0		6.6	43.3	7.0	179.3	59.8
29	685	65.0	44.5	35.0	28.0		3.4	45.1	7.0	180.2	60.0
Nov. 5	654	66.5	45.0	35.0	28.0		8.3	42.3	7.0	178.7	59.7
12	705	64.5	45.5	35.0	28.0		10.4	41.1	7.0	178.1	59.5
19	683	64.0	45.5	35.0	28.0		4.1	44.7	7.0	180.0	59.9
26	675	64.5	45.0	35.0	28.0		3.8	44.9	7.0	180.1	60.0
Dec. 3	682	65.5	45.5	35.0	28.0		3.3	45.1	7.2	132.7	54.1
10	697	66.0	46.0	35.0	28.0		4.1	44.7	7.2	132.4	54.0
17	685	64.0	46.0	35.0	28.0		4.4	44.5	7.2	132.3	54.0
24	715	65.0	47.0	35.0	28.0		7.9	42.5	7.1	131.2	53.8
31	696	64.5	46.5	35.0	28.0		4.6	44.4	7.7	141.6	32.3
(1956)											
Jan. 7	686	66.0	46.5	35.0	28.0		5.1	44.2	7.7	141.4	32.3
14	691	63.5	46.5	35.0	28.0		12.1	40.2	7.7	139.2	31.8
21	684	63.5	45.0	35.0	28.0		11.3	40.6	7.7	339.5	31.9
28	700	64.5	45.5	35.0	28.0		17.4	37.2	7.6	337.6	31.5
Feb. 4	700	67.0	47.0	35.0	28.0		14.0	39.1	7.7	338.6	31.7
11	697	66.0	47.0	35.0	28.0		15.7	38.1	7.6	339.1	31.6
18	698	66.0	47.5	35.0	28.0		5.6	43.8	7.7	141.3	32.2
25	709	67.0	47.0	35.0	28.0		6.7	43.2	7.7	140.9	32.2
Mar. 3	727	66.5	47.0	35.0	28.0		9.8	41.4	7.7	140.0	32.2
10	728	68.0	47.5	35.0	28.0		7.4	42.8	6.4	117.1	28.6

Table VII (Continued)

Date period ended (1956)	Body weight (lb.)	Heart girth (in.)	Height at withers (in.)	Concentrate offered (lb.)	Pulp molasses offered (lb.)	Beet pulp offered (lb.)	Orts (lb.)	Est. TDN consumed (lb.)	Total protein consumed (lb.)	Calcium consumed (g.)	Phosphorus consumed (g.)
Mar. 17	702	66.5	46.0	35.0	28.0		10.9	40.8	5.7	119.4	29.1
24	in metabolism stall			35.0	28.0			47.1	6.5	119.4	29.1
31	756	69.0	46.5	35.0	28.0			47.1	6.5	119.4	29.1
Apr. 7	718	67.5	47.5	35.0	28.0		13.0	39.6	6.4	115.4	28.2
14	710	67.5	47.5	35.0	28.0		11.1	40.7	6.4	115.9	28.4
21	747	67.0	47.5	35.0	28.0		9.2	41.8	6.4	116.5	28.5
28	745	67.0	48.5	35.0	28.0		3.6	45.0	6.5	118.3	28.9
May 5	686	66.0	48.0	35.0	28.0		7.9	42.5	6.4	116.9	28.6
12	744	67.0	48.0	35.0	28.0		9.8	41.4	6.4	116.3	28.5
19	750	69.0	48.0	35.0	28.0		9.5	41.6	6.4	116.4	28.5
26	747	68.5	48.0	35.0	28.0		6.1	43.5	7.2	196.9	123.1
June 2	725	69.0	49.0	35.0	28.0		4.1	44.7	7.3	197.5	123.2
Total				1905.3	1902.1	119.0	886.5	2426.5	391.6	12034.4	3053.6

*Weights hereafter are for wood pulp only.

TABLE VIII

Growth measurements and feed consumption for Ayrshire bull No. 36, Group II
Born September 19, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	456	52.0	41.0	35.0	29.4	7.0	30.3	31.0	6.7	259.9	68.8
	18	451	53.0	42.0	38.5	31.5	7.0	27.1	37.7	7.5	299.3	75.6
	25	450	53.0	42.0	38.5	31.5	7.0	32.0	34.0	7.4	282.1	75.0
July	2	412	54.0	42.0	39.2	37.8	7.0	33.9	37.8	7.6	303.3	78.0
	9	440	54.0	41.5	39.2	37.8	7.0	35.6	36.5	7.5	302.4	78.1
	16	450	54.5	41.0	39.2	37.8	7.0	43.3	30.7	7.4	298.4	76.9
	23	485	55.5	41.0	39.2	37.8	7.0	33.9	37.8	7.6	303.3	78.0
	30	494	55.0	42.0	39.8	41.3	7.0	38.1	37.7	7.5	314.6	79.8
Aug.	6	501	55.0	41.5	39.9	48.3	7.0	36.1	44.6	7.9	337.6	82.8
	13	457	55.0	41.5	39.9	44.1	7.0	49.6	31.2	7.5	317.7	79.6
	20	517	56.0	42.5	39.2	39.2	7.0	32.9	39.6	7.6	363.2	78.7
	27	523	55.5	42.0	39.9	46.9	7.0	60.7	25.0	7.3	320.6	79.3
Sept.	3	516	55.0	42.0	39.9	46.9	7.0	49.6	33.4	7.3	325.4	80.7
	10	498	55.0	41.5	39.9	46.9	7.0	55.6	28.8	7.1	323.3	80.9
	17	519	56.0	42.0	39.9	44.1	7.0	55.5	30.6	7.2	317.2	79.5
	24	521	58.5	42.5	39.9	46.9	7.0	41.5	39.5	7.5	330.6	81.7
Oct.	1	545	57.0	42.0	39.9	42.9	7.0	53.3	27.5	7.1	311.9	78.7
	8	530	60.0	43.0	35.0	28.0*		27.4	26.9	6.4	167.0	56.8
	15	535	59.0	42.0	35.0	28.0		18.5	33.6	6.7	171.7	57.9

Table VIII (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	560	58.5	43.0	35.0	28.0		15.8	35.6	6.7	173.1	58.3
29	530	60.5	42.0	35.0	28.0		9.1	40.7	6.9	176.6	59.1
Nov. 5	576	60.0	43.5	35.0	28.0		12.2	38.3	6.8	174.9	58.7
12	565	58.5	43.0	35.0	28.0		12.7	38.0	6.8	174.7	58.6
19	581	59.0	43.5	35.0	28.0		10.2	39.8	6.9	176.0	58.9
26	582	60.5	43.0	35.0	28.0		8.5	41.1	6.9	176.9	59.2
Dec. 3	603	62.5	43.5	35.0	28.0		8.8	40.8	7.0	129.1	53.2
10	595	62.5	43.5	35.0	28.0		8.1	41.4	7.0	129.5	53.3
17	597	62.0	44.0	35.0	28.0		7.2	42.1	7.0	129.9	53.4
24	618	62.0	44.5	35.0	28.0		11.2	39.1	6.9	127.9	52.9
31	650	62.5	45.0	35.0	28.0		10.2	39.8	7.5	137.7	31.3
(1956)											
Jan. 7	611	62.5	44.5	35.0	28.0		8.3	41.3	7.5	138.7	31.6
14	614	62.5	44.5	35.0	28.0		13.9	37.1	7.3	135.8	30.9
21	657	63.0	44.5	35.0	28.0		15.1	36.2	7.3	135.1	30.7
28	611	61.5	46.0	35.0	28.0		15.5	35.8	7.3	134.9	30.7
Feb. 4	648	63.0	44.5	35.0	28.0		15.6	35.8	7.3	134.9	30.7
11	660	62.0	44.0	35.0	28.0		13.0	37.7	7.4	136.2	31.0
18	660	62.0	45.0	35.0	28.0		10.1	39.9	7.5	137.7	31.4
25	645	63.0	46.0	35.0	28.0		9.5	40.4	7.5	138.0	31.4
Mar. 3	672	63.0	45.5	35.0	28.0		8.6	41.1	7.5	138.5	31.5
10	656	63.0	45.0	35.0	28.0		7.2	42.1	7.6	115.6	28.3

Table VIII (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	17	668	64.0	45.0	35.0	28.0			53.4	7.8	119.4	29.1
	24	in metabolism stall			35.0	28.0			53.4	7.8	119.4	29.1
	31	662	64.0	45.5	35.0	28.0			53.4	7.8	119.4	29.1
Apr.	7	695	64.0	45.0	35.0	28.0		12.8	37.9	7.4	112.7	27.5
	14	677	63.5	45.5	35.0	28.0		8.8	40.9	7.5	114.8	28.0
	21	700	64.0	45.0	35.0	28.0		4.1	44.5	7.7	117.3	28.6
	28	717	64.5	45.0	35.0	28.0		2.8	45.4	7.7	117.9	28.8
May	5	664	63.0	45.0	35.0	28.0		6.6	42.6	7.6	116.0	28.3
	12	726	64.5	46.0	35.0	28.0		7.1	42.2	7.6	115.7	28.2
	19	743	66.0	46.0	35.0	28.0		6.3	42.8	7.6	116.1	28.3
	26	741	65.0	45.5	35.0	28.0		6.0	43.0	7.1	195.7	122.9
June	2	745	67.0	46.0	35.0	28.0		8.1	41.4	7.1	194.6	122.7
Total					1892.0	1671.1	119.00	1048.3	2008.9	380.1	10260.2	2882.5

*Weights hereafter are for wood pulp only.

TABLE IX

Growth measurements and feed consumption for Ayrshire bull No. 37, Group II
Born September 23, 1953

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	600	58.0	44.0	40.6	44.8	7.0	26.4	50.6	8.2	335.6	82.8
	18	572	59.0	44.0	40.6	49.0	7.0	25.9	54.2	8.3	348.9	83.7
	25	616	60.0	43.5	39.9	53.2	7.0	33.3	51.2	8.1	355.0	83.6
July	2	605	60.5	45.0	40.6	57.4	7.0	34.4	54.1	8.3	370.5	86.0
	9	633	61.0	44.5	40.6	57.4	7.0	43.2	47.3	8.1	366.1	84.6
	16	626	61.0	44.5	40.6	57.4	7.0	48.0	43.7	7.7	363.7	83.9
	23	593	62.0	44.0	40.6	57.4	7.0	53.1	39.8	7.8	361.1	83.1
	30	580	61.5	44.5	40.6	56.2	7.0	55.6	36.9	7.6	356.2	82.3
Aug.	6	593	62.5	45.0	40.6	58.8	7.0	37.7	52.7	7.6	373.2	86.0
	13	650	63.0	44.5	40.6	56.4	7.0	38.8	50.6	8.2	368.3	85.2
	20	669	62.5	45.0	41.3	63.7	7.0	45.5	60.0	8.3	387.6	87.7
	27	675	62.0	44.5	41.3	66.5	7.0	50.2	49.5	8.2	390.7	87.8
Sept.	3	625	62.0	45.0	41.3	66.5	7.0	54.5	46.2	8.1	388.5	87.1
	10	652	64.0	45.0	40.7	61.0	7.0	51.4	44.2	8.0	375.4	85.4
	17	665	63.0	45.0	41.3	63.7	7.0	53.0	45.2	8.1	383.9	86.5
	24	690	65.5	45.0	41.3	65.1	7.0	42.2	54.6	8.4	393.5	88.7
Oct.	1	736	64.0	45.0	42.0	68.6	7.0	47.4	53.8	8.5	404.8	90.3
	8	695	68.0	45.5	35.0	28.0*		28.6	31.4	6.5	171.3	56.7
	15	687	65.0	46.0	35.0	28.0		13.2	40.5	6.8	176.2	58.6

Table IX (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	680	65.0	46.0	35.0	28.0		5.2	45.2	7.0	179.3	59.6
29	678	67.5	46.5	35.0	28.0		6.6	44.4	6.9	178.8	59.4
Nov. 5	700	67.0	47.0	35.0	28.0		8.8	43.1	6.9	177.9	59.1
12	697	67.0	46.5	35.0	28.0		5.2	45.2	7.0	179.3	59.6
19	740	66.0	46.5	35.0	28.0		2.9	46.6	7.0	180.2	59.8
26	723	65.0	47.0	35.0	28.0		5.3	45.2	7.0	179.3	59.6
Dec. 3	752	67.0	46.5	35.0	28.0		2.7	46.7	7.2	132.7	54.0
10	773	67.5	46.0	35.0	28.0		4.1	45.9	7.1	132.1	53.8
17	755	69.0	47.0	35.0	28.0		2.5	46.8	7.2	132.7	54.0
24	726	67.0	46.5	35.0	28.0		6.1	44.7	7.1	131.4	53.5
31	787	68.5	49.0	35.0	28.0		2.9	46.6	7.6	141.9	32.2
(1956)											
Jan. 7	759	68.0	47.5	35.0	28.0		4.4	45.7	7.6	139.0	32.1
14	787	67.5	47.5	35.0	28.0		7.8	43.7	7.5	140.0	31.6
21	779	70.0	48.0	35.0	28.0		12.1	41.1	7.4	138.4	31.1
28	776	67.0	46.0	35.0	28.0		10.3	42.2	7.5	139.0	31.3
Feb. 4	785	67.5	47.5	35.0	28.0		10.9	41.9	7.5	138.8	31.2
11	788	68.0	47.0	35.0	28.0		8.0	44.1	7.5	140.3	31.7
18	839	68.5	47.5	35.0	28.0		2.8	46.6	7.6	141.9	32.3
25	820	70.5	48.0	35.0	28.0		2.1	47.0	7.6	142.2	32.3
Mar. 3	868	71.0	47.0	35.0	28.0		1.5	47.4	7.6	142.4	32.4
10	856	69.5	47.0	35.0	28.0		1.4	48.3	6.4	118.9	28.9

Table IX (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	17	796	69.5	47.5	35.0	28.0			48.3	6.4	119.4	29.1
	24	in metabolism stall			35.0	28.0			48.3	6.4	119.4	29.1
	31	806	69.0	47.5	35.0	28.0			48.3	6.4	119.4	29.1
Apr.	7	823	70.0	48.0	35.0	28.0		3.4	46.3	6.3	118.1	28.7
	14	767	68.0	48.0	35.0	28.0			48.3	6.4	119.4	29.1
	21	806	69.0	48.0	35.0	28.0		1.3	47.5	6.4	118.9	28.9
	28	850	70.5	48.0	35.0	28.0		0.9	47.8	6.4	119.1	29.0
May	5	801	67.0	48.0	35.0	28.0		1.2	47.6	6.4	119.0	28.9
	12	852	69.0	48.0	35.0	28.0		0.7	47.9	6.4	119.2	29.0
	19	870	70.0	48.5	35.0	28.0		3.0	46.5	6.3	118.4	28.7
	26	812	69.5	48.5	35.0	28.0		0.3	48.1	6.4	198.6	123.1
June	2	818	69.5	49.0	35.0	28.0			48.3	6.5	198.7	123.4
Total					1919.5	1983.1	119.0	906.8	2428.1	379.7	11383.6	3025.6

*Weights hereafter are for wood pulp only.

TABLE X

Growth measurements and feed consumption for Ayrshire bull No. 23, Group III
Born September 15, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Oats	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	324	46.0	38.0	37.1	23.1			44.5	7.2	257.2	139.0
	18	327	46.0	39.0	37.8	26.6			47.7	7.6	271.6	143.0
	25	348	47.0	39.0	38.5	29.4			50.2	7.5	283.9	146.8
July	2	335	47.0	38.0	37.8	26.6			47.7	7.6	271.6	143.0
	9	374	49.0	39.0	37.8	26.6			47.7	7.6	271.6	143.0
	16	394	50.0	39.5	37.8	26.6			47.7	7.6	271.6	143.0
	23	412	49.5	40.0	37.8	26.6			47.7	7.6	271.6	143.0
	30	419	51.0	40.5	38.4	32.0	6.0		56.5	8.2	315.7	151.8
Aug.	6	430	50.5	41.0	39.2	37.8	7.0		62.1	8.5	337.8	158.0
	13	440	51.5	40.5	39.2	35.8	7.0	0.3	60.4	8.5	335.2	155.8
	20	448	52.5	41.5	39.2	29.4	7.0	0.3	55.7	8.3	335.2	152.8
	27	470	53.0	41.0	39.2	37.8	7.0		62.1	8.5	337.8	158.0
Sept.	3	481	53.5	41.5	39.2	40.6	7.0		64.2	8.6	337.8	159.3
	10	501	54.0	41.5	39.8	41.2	7.0		65.1	8.7	347.0	161.7
	17	516	56.0	42.0	39.8	44.1	7.0		67.2	8.7	347.0	163.1
	24	530	56.5	41.5	39.9	48.3	7.0		70.5	8.9	347.8	165.4
Oct.	1	541	56.0	42.0	39.9	48.3	7.0		70.5	8.9	347.8	165.4
	8	550	59.0	43.5	39.9	42.0			60.6	7.9	338.1	98.1
	15	567	59.0	42.5	39.9	42.0			60.6	7.9	338.1	98.1

Table X (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct.	22	565	60.0	42.5	39.9	42.0			60.6	7.9	338.1	98.1
	29	605	60.5	43.5	39.9	42.0			60.6	7.9	338.1	98.1
Nov.	5	591	59.5	43.5	39.9	42.0		0.8	60.0	7.9	334.7	97.1
	12	674	60.5	43.0	39.9	42.0			60.6	7.9	338.1	98.1
	19	646	62.0	43.0	39.9	42.0			60.6	7.9	338.1	98.1
	26	671	61.5	44.0	39.9	42.0			60.6	7.9	166.1	50.7
Dec.	3	670	62.0	43.0	39.9	42.0			60.6	7.9	166.1	50.7
	10	678	63.0	43.5	39.9	42.0			60.6	7.9	166.1	50.7
	17	699	62.0	44.5	39.9	42.0			60.6	7.9	166.1	50.7
	24	686	63.5	44.5	39.9	42.0			60.6	7.9	166.1	50.7
	31	711	64.5	45.5	39.9	42.0			60.6	7.9	166.1	50.7
(1956)												
Jan.	7	720	63.0	44.5	39.9	42.0			60.6	8.4	165.2	66.6
	14	688	64.0	44.5	39.9	42.0			60.6	8.4	165.2	66.6
	21	in metabolism stall			39.9	42.0			60.6	8.4	165.2	66.6
	28	710	63.5	43.0	39.9	42.0			60.6	8.4	165.2	66.6
Feb.	4	738	64.5	45.5	39.9	42.0			60.6	8.4	165.2	66.6
	11	736	64.0	45.0	39.9	42.0			60.6	8.4	165.2	66.6
	18	737	65.0	45.0	39.9	42.0			60.6	8.4	165.2	66.6
	25	773	65.5	46.0	39.9	42.0			60.6	8.4	165.2	66.6
Mar.	3	779	65.5	44.5	39.9	42.0			60.6	8.4	165.2	66.6
	10	779	66.0	47.0	39.9	42.0			60.6	8.4	165.2	66.6

Table X (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar. 17	780	67.5	47.0	39.9	42.0			60.6	8.4	165.2	66.6
24	782	67.0	46.0	39.9	42.0			60.6	8.0	169.4	65.2
31	770	66.5	46.0	39.9	42.0			60.6	8.0	169.4	65.2
Apr. 7	817	69.0	47.0	39.9	42.0		11.3	52.3	6.9	146.0	56.2
14	777	67.5	47.0	39.9	42.0			60.6	8.0	169.4	65.2
21	779	67.0	46.5	39.9	42.0			60.6	8.0	169.4	65.2
28	795	67.5	47.0	39.9	42.0			60.6	8.0	169.4	65.2
May 5	761	66.5	47.5	39.9	42.0			60.6	8.0	169.4	65.2
12	830	68.5	47.0	39.9	42.0			60.6	8.0	169.4	65.2
19	840	69.0	48.0	39.9	42.0			60.6	8.0	169.4	65.2
26	853	70.0	48.0	39.9	42.0			60.6	8.0	169.4	65.2
June 2	857	69.0	47.5	39.9	42.0		0.7	60.1	7.9	168.0	64.7
Total				2054.9	2050.8	69.0	13.4	3079.1	420.4	12305.4	5022.3

TABLE XI

Growth measurements and feed consumption for Holstein bull No. 41, Group III
Born October 25, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	300	43.0	37.5	36.4	21.0			40.0	7.0	240.6	135.5
	18	300	44.0	36.5	37.8	26.6			44.9	7.4	263.4	143.1
	25	311	46.0	37.5	37.8	28.0			45.9	7.4	267.3	143.7
July	2	304	45.0	38.0	37.1	23.8			42.5	7.2	252.0	139.3
	9	333	47.0	38.0	37.8	23.8			42.9	7.3	255.5	141.7
	16	348	48.0	39.0	37.1	23.8			42.5	7.2	252.0	139.3
	23	380	48.0	39.0	37.1	23.8			42.5	7.2	252.0	139.3
	30	382	48.5	39.5	37.7	28.6	6.0		50.4	7.4	268.5	143.7
Aug.	6	397	50.0	39.5	37.8	39.9	7.0		59.1	7.7	329.0	154.2
	13	395	50.5	39.5	37.8	33.3	7.0		54.5	7.6	310.5	151.1
	20	420	50.5	41.0	37.8	31.5	7.0	0.5	52.9	7.5	305.4	150.2
	27	454	51.5	41.0	37.9	34.3	7.0		55.3	7.6	313.8	151.8
Sept.	3	472	52.0	41.0	39.2	37.8	7.0		58.6	7.9	330.0	158.0
	10	481	52.5	41.0	39.2	39.9	7.0		60.0	7.9	336.0	159.0
	17	494	52.5	41.5	39.9	41.3	7.0		61.5	8.1	343.4	162.1
	24	509	55.0	41.0	39.9	42.7	7.0		62.5	8.1	347.4	162.8
Oct.	1	533	55.5	42.0	39.9	45.5	7.0	2.0	63.1	8.2	355.2	164.1
	8	550	59.0	43.5	37.8	42.0			55.7	7.6	317.3	91.1
	15	551	57.0	42.5	37.8	42.0			55.7	7.6	326.4	93.0

Table XI (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	555	60.0	42.5	37.8	42.0			55.7	7.6	326.4	93.0
29	585	60.0	42.5	37.8	42.0			55.7	7.6	326.4	93.0
Nov. 5	566	58.5	43.5	37.8	42.0			55.7	7.6	326.4	93.0
12	591	58.0	43.0	37.8	42.0			55.7	7.6	326.4	93.0
19	584	60.0	44.0	37.8	42.0			55.7	7.6	326.4	93.0
26	613	60.0	44.0	37.8	42.0			55.7	8.3	163.5	48.5
Dec. 3	605	59.5	44.5	37.8	42.0			55.7	8.3	163.5	48.5
10	636	61.5	44.5	37.8	42.0			55.7	8.3	163.5	48.5
17	626	60.0	45.0	37.8	42.0			55.7	8.3	163.5	48.5
24	614	60.5	45.0	37.8	42.0			55.7	8.3	163.5	48.5
31	650	61.5	46.0	37.8	42.0			55.7	8.3	163.5	48.5
(1956)											
Jan. 7	652	62.0	45.5	37.8	42.0			55.7	8.0	162.6	63.5
14	644	61.0	45.0	37.8	42.0			55.7	8.0	162.6	63.5
21	680	61.5	43.5	37.8	42.0			55.7	8.0	162.6	63.5
28	619	62.5	45.5	37.8	42.0		2.1	54.2	7.8	158.4	61.8
Feb. 4	675	63.0	46.0	37.8	42.0			55.7	8.0	162.6	63.5
11	688	63.0	45.0	37.8	42.0			55.7	8.0	162.6	63.5
18	686	64.5	47.0	37.8	42.0			55.7	8.0	162.6	63.5
25	696	63.5	47.0	37.8	42.0			55.7	8.0	162.6	63.5
Mar. 3	710	64.5	47.0	37.8	42.0			55.7	8.0	162.6	63.5
10	733	64.0	47.0	37.8	42.0			55.7	8.0	162.6	63.5

Table XI (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN cpnsumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	17	740	65.5	46.0	37.8	42.0			55.7	8.0	162.6	63.5
	24	753	64.5	47.0	37.8	42.0			55.7	7.6	166.6	62.2
	31	755	63.5	47.0	37.8	42.0			55.7	7.6	166.6	62.2
Apr.	7	820	67.0	48.0	37.8	42.0			55.7	7.6	166.6	62.2
	14	786	65.5	48.0	37.8	42.0			55.7	7.6	166.6	62.2
	21	788	66.0	48.0	37.8	42.0			55.7	7.6	166.6	62.2
	28	798	66.0	47.5	37.8	42.0			55.7	7.6	166.6	62.2
May	5	778	67.0	47.5	37.8	42.0			55.7	7.6	166.6	62.2
	12	784	66.0	48.0	37.8	42.0			55.7	7.6	166.6	62.2
	19	835	67.0	48.5	37.8	42.0			55.7	7.6	166.6	62.2
	26	815	67.0	48.5	37.8	42.0			55.7	7.6	166.6	62.2
June	2	847	67.5	48.0	37.8	42.0			55.7	7.6	166.6	62.2
Total					1971.2	2015.6	69.0	4.6	2827.1	403.1	11895.7	4860.0

TABLE XII

Growth measurements and feed consumption for Guernsey bull No. 45, Group III
Born September 18, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	336	48.0	41.0	39.2	25.2			47.8	7.6	265.4	147.2
	18	333	48.0	41.0	37.8	26.6			47.8	7.4	263.4	143.1
	25	351	48.5	42.0	38.5	29.4			50.4	7.5	274.7	146.8
July	2	340	49.0	41.0	37.8	26.6			47.8	7.4	263.4	143.1
	9	365	50.0	42.5	37.8	26.6			47.8	7.4	263.4	143.1
	16	396	51.5	42.0	37.8	26.6			47.8	7.4	263.4	143.1
	23	417	51.0	42.0	37.8	26.6			47.8	7.4	263.4	143.1
	30	423	52.0	41.5	38.4	34.3	6.0		58.4	8.2	312.2	149.2
Aug.	6	436	52.5	43.0	37.8	39.2	7.0		61.0	8.3	327.0	147.2
	13	413	52.0	42.0	39.0	37.4	7.0		61.9	6.2	328.0	152.8
	20	444	53.5	43.5	38.5	32.0	7.0		57.5	8.2	310.3	148.5
	27	476	54.0	43.0	39.2	36.4	7.0		61.3	8.5	326.1	153.0
Sept.	3	475	55.0	43.5	39.9	41.3	7.0		65.4	8.7	343.4	159.0
	10	479	54.5	43.0	40.0	41.3	7.0		65.5	8.7	343.9	159.4
	17	490	56.0	43.5	39.9	41.3	7.0		65.4	8.7	343.4	159.0
	24	489	57.0	44.0	39.9	42.7	7.0		66.5	8.7	347.5	158.5
Oct.	1	515	58.0	42.0	39.9	42.7	7.0		66.5	8.7	347.5	158.5
	8	530	59.0	43.5	37.8	42.0			59.2	7.6	326.4	93.0
	15	545	58.0	44.5	37.8	42.0			59.2	7.6	326.4	93.0

Table XII (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	536	59.5	45.0	37.8	42.0			59.2	7.6	326.4	93.0
29	573	60.0	45.0	37.8	42.0		1.8	57.9	7.5	321.3	91.0
Nov. 5	575	61.0	45.0	37.8	42.0			59.2	7.6	326.4	93.0
12	597	60.0	44.5	37.8	42.0			59.2	7.6	326.4	93.0
19	588	62.0	45.5	37.8	42.0			59.2	7.6	326.4	93.0
26	609	61.0	46.0	37.8	42.0			59.2	8.3	163.5	48.5
Dec. 3	606	61.0	45.0	37.8	42.0			59.2	8.3	163.5	48.5
10	612	63.5	46.0	37.8	42.0			59.2	8.3	163.5	48.5
17	641	62.0	46.0	37.8	42.0			59.2	8.3	163.5	48.5
24	638	62.0	46.0	37.8	42.0			59.2	8.3	163.5	48.5
31	645	63.0	47.0	37.8	42.0			59.2	8.3	163.5	48.5
(1956)											
Jan. 7	640	62.0	46.0	37.8	42.0			59.2	8.0	162.6	63.5
14	604	62.5	45.5	37.8	42.0		14.5	48.4	6.6	103.4	51.7
21	652	63.5	46.0	37.8	42.0			59.2	8.0	162.6	63.5
28	601	63.5	43.5	37.8	42.0			59.2	8.0	162.6	63.5
Feb. 4	671	64.5	46.5	37.8	42.0			59.2	8.0	162.6	63.5
11	684	64.0	46.5	37.8	42.0			59.2	8.0	162.6	63.5
18	679	64.0	47.0	37.8	42.0			59.2	8.0	162.6	63.5
25	697	65.0	47.0	37.8	42.0			59.2	8.0	162.6	63.5
Mar. 3	708	65.0	47.0	37.8	42.0			59.2	8.0	162.6	63.5
10	708	65.0	47.5	37.8	42.0			59.2	8.0	162.6	63.5

Table XII (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Oats	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	17	718	66.0	47.0	37.8	42.0			59.2	8.0	162.6	63.5
	24	737	66.0	48.5	37.8	42.0			59.2	7.6	166.6	62.2
	31	718	65.5	47.5	37.8	42.0			59.2	7.6	166.6	62.2
Apr.	7	770	67.0	48.0	37.8	42.0			59.2	7.6	166.6	62.2
	14	716	66.0	48.0	37.8	42.0			59.2	7.6	166.6	62.2
	21	756	67.0	48.0	37.8	42.0			59.2	7.6	166.6	62.2
	28	755	67.0	48.0	37.8	42.0			59.2	7.6	166.6	62.2
May	5	727	65.0	47.5	37.8	42.0			59.2	7.6	166.6	62.2
	12	786	67.5	48.5	37.8	42.0			59.2	7.6	166.6	62.2
	19	807	68.0	48.5	37.8	42.0			59.2	7.6	166.6	62.2
	26	776	67.5	48.5	37.8	42.0			59.2	7.6	166.6	62.2
June	2	786	68.0	48.5	37.8	42.0			59.2	7.6	166.6	62.2
Total					1982.2	2046.2	69.0	16.3	3026.5	408.1	12009.1	4865.5

TABLE XIII

Growth measurements and feed consumption for Guernsey bull No. 96, Group III
Born September 13, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	336	47.0	38.5	37.8	23.8			38.6	7.3	255.5	141.7
	18	312	48.0	39.0	37.8	26.6			40.3	7.4	263.4	143.1
	25	324	49.0	39.0	37.8	28.0			41.2	7.4	267.3	143.7
July	2	318	49.0	39.0	37.8	24.5			39.0	7.3	257.5	142.0
	9	347	49.0	39.0	37.8	24.4			39.0	7.3	257.2	142.0
	16	359	50.5	39.5	37.8	24.8			39.2	7.3	258.2	142.1
	23	382	51.0	39.0	37.8	25.2			39.5	7.3	258.4	142.4
	30	385	51.0	40.0	38.4	28.8	6.0		45.9	7.6	296.7	150.3
Aug.	6	426	52.0	40.0	38.5	34.3	7.0		49.9	7.7	316.8	153.9
	13	417	50.5	40.5	39.1	33.5	7.0		49.9	7.7	317.5	155.6
	20	448	53.5	41.0	38.5	33.6	7.0		49.6	7.9	314.7	153.6
	27	450	54.0	40.5	39.2	36.4	7.0		51.7	7.9	326.2	157.3
Sept.	3	438	53.5	41.0	39.2	37.8	7.0		52.6	7.9	330.1	158.0
	10	457	54.0	41.0	39.2	36.6	7.0		51.8	7.9	326.7	157.4
	17	470	56.0	41.5	39.2	39.2	7.0		53.5	7.9	334.0	158.7
	24	493	56.5	42.0	39.2	40.6	7.0		54.4	8.0	338.0	159.3
Oct.	1	512	58.0	42.0	39.2	42.7	7.0	2.7	54.0	8.0	343.9	160.4
	8	510	58.0	42.0	37.8	42.0			50.0	7.6	326.4	93.0
	15	516	57.0	42.5	37.8	42.0			50.0	7.6	326.4	93.0

Table XIII (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	502	59.5	42.5	37.8	42.0			50.0	7.6	326.4	93.0
29	518	59.0	42.0	37.8	42.0			50.0	7.6	326.4	93.0
Nov. 5	540	60.5	42.0	37.8	42.0			50.0	7.6	326.4	93.0
12	551	60.0	43.0	37.8	42.0			50.0	7.6	326.4	93.0
19	552	60.5	43.0	37.8	42.0			50.0	7.6	326.4	93.0
26	576	60.0	42.0	37.8	42.0			50.0	8.3	163.5	48.5
Dec. 3	585	61.5	43.5	37.8	42.0			50.0	8.3	163.5	48.5
10	580	62.0	43.0	37.8	42.0			50.0	8.3	163.5	48.5
17	600	61.5	43.5	37.8	42.0			50.0	8.3	163.5	48.5
24	609	62.0	43.5	37.8	42.0			50.0	8.3	163.5	48.5
31	600	63.0	44.0	37.8	42.0			50.0	8.3	163.5	48.5
(1956)											
Jan. 7	604	63.5	42.5	37.8	42.0		1.2	49.2	8.0	156.6	62.1
14	616	61.5	43.0	37.8	42.0			50.0	8.0	162.6	63.5
21	636	63.0	43.0	37.8	42.0		18.3	38.5	6.2	127.6	48.5
28	606	62.0	43.0	37.8	42.0			50.0	8.0	162.6	63.5
Feb. 4	627	64.5	43.0	37.8	42.0			50.0	8.0	162.6	63.5
11	637	63.0	44.0	37.8	42.0			50.0	8.0	162.6	63.5
18	616	64.0	44.5	37.8	42.0			50.0	8.0	162.6	63.5
25	652	64.5	44.0	37.8	42.0			50.0	8.0	162.6	63.5
Mar. 3	675	63.5	44.5	37.8	42.0			50.0	8.0	162.6	63.5
10	654	64.5	45.0	37.8	42.0			50.0	8.0	162.6	63.5

Table XIII (Continued)

Date period ended (1956)		Body weight (lb.)	Heart girth (in.)	Height at withers (in.)	Concentrate offered (lb.)	Pulp molasses offered (lb.)	Beet pulp offered (lb.)	Orts (lb.)	Est. TDN consumed (lb.)	Total protein consumed (lb.)	Calcium consumed (g.)	Phosphorus consumed (g.)
Mar.	17	674	65.0	45.0	37.8	42.0			50.0	8.0	162.6	63.5
	24	651	65.0	45.0	37.8	42.0			50.0	7.6	166.6	62.2
	31	654	64.5	44.0	37.8	42.0			50.0	7.6	166.6	62.2
Apr.	7	718	66.5	45.5	37.8	42.0			50.0	7.6	166.6	62.2
	14	670	65.5	45.5	37.8	42.0			50.0	7.6	166.6	62.2
	21	700	67.0	47.5	37.8	42.0			50.0	7.6	166.6	62.2
	28	695	67.0	46.0	37.8	42.0			50.0	7.6	166.6	62.2
May	5	645	64.5	45.0	37.8	42.0			50.0	7.6	166.6	62.2
	12	714	66.5	45.0	37.8	42.0			50.0	7.6	166.6	62.2
	19	747	67.0	45.5	37.8	42.0			50.0	7.6	166.6	62.2
	26	730	68.5	46.0	37.8	42.0			50.0	7.6	166.6	62.2
June	2	746	68.0	45.5	37.8	42.0			50.0	7.6	166.6	62.2
Total					1977.3	2010.8	69.0	22.2	2527.8	402.6	11908.1	4869.8

TABLE XIV

Growth measurements and feed consumption for Ayrshire bull No. 99, Group III
Born October 2, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	327	47.0	37.5	37.8	23.1			43.7	7.3	253.5	141.4
	18	329	47.0	39.0	37.8	26.6			46.2	7.4	263.4	143.1
	25	346	48.0	40.0	38.5	29.4			48.6	7.5	274.7	146.8
July	2	337	49.0	40.0	37.8	26.6			46.2	7.4	263.4	143.1
	9	365	49.5	40.0	37.8	26.6			46.2	7.4	263.4	143.1
	16	400	50.0	40.5	37.8	26.6			46.2	7.4	263.4	143.1
	23	433	52.0	40.5	37.8	26.6			46.2	7.4	263.4	143.1
	30	427	52.0	41.0	39.0	33.8	6.0		56.5	7.8	313.8	154.7
Aug.	6	432	52.0	41.0	39.2	39.2	7.0		61.2	7.9	334.0	158.7
	13	436	53.0	42.0	39.2	31.9	7.0		56.0	7.8	313.5	155.2
	20	449	53.0	42.0	38.6	34.8	7.0		60.8	7.7	318.7	154.5
	27	467	53.5	42.5	39.2	37.8	7.0		66.2	7.9	330.1	158.0
Sept.	3	498	54.5	42.8	39.2	41.3	7.0		62.7	8.0	339.9	159.7
	10	502	53.0	42.5	39.8	43.6	7.0		64.8	8.1	349.4	162.9
	17	503	56.5	43.0	39.9	44.1	7.0		65.3	8.2	351.3	163.4
	24	526	57.5	42.5	39.9	44.1	7.0		65.3	8.2	351.3	163.4
Oct.	1	525	57.0	43.5	39.9	48.3	7.0	1.5	67.2	8.1	363.1	165.4
	8	565	59.0	43.5	37.8	42.0			57.2	7.6	326.4	93.0
	15	603	60.5	43.5	37.8	42.0			57.2	7.6	326.4	93.0

Table XIV (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct. 22	626	61.5	44.0	37.8	42.0			57.2	7.6	326.4	93.0
29	586	61.5	43.5	37.8	42.0			57.2	7.6	326.4	93.0
Nov. 5	600	62.0	44.0	37.8	42.0			57.2	7.6	326.4	93.0
12	616	61.0	44.5	37.8	42.0			57.2	7.6	326.4	93.0
19	610	63.0	44.0	37.8	42.0			57.2	7.6	326.4	93.0
26	644	61.0	45.0	37.8	42.0			57.2	8.3	163.5	48.5
Dec. 3	649	62.5	45.0	37.8	42.0			57.2	8.3	163.5	48.5
10	648	63.5	44.0	37.8	42.0			57.2	8.3	163.5	48.5
17	666	63.5	45.5	37.8	42.0			57.2	8.3	163.5	48.5
24	638	63.5	44.5	37.8	42.0			57.2	8.3	163.5	48.5
31	632	64.0	46.5	37.8	42.0			57.2	8.3	163.5	48.5
(1956)											
Jan. 7	676	64.0	46.0	37.8	42.0			57.2	8.0	162.6	63.5
14	614	64.0	46.0	37.8	42.0		28.5	36.8	4.7	122.1	41.2
21	650	64.5	46.0	37.8	42.0		21.3	41.9	5.6	132.3	46.8
28	655	63.0	46.0	37.8	42.0			57.2	8.0	162.6	63.5
Feb. 4	668	64.5	47.0	37.8	42.0		.9	56.6	7.9	160.9	62.8
11	658	64.0	47.5	37.8	42.0		.8	56.7	7.9	161.0	62.9
18	668	64.0	47.0	37.8	42.0			57.2	8.0	162.6	63.5
25	651	64.5	47.0	37.8	42.0			57.2	8.0	162.6	63.5
Mar. 3	662	64.5	47.5	37.8	42.0			57.2	8.0	162.6	63.5

Table XIV (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar.	10	683	64.5	47.5	37.8	42.0			57.2	8.0	162.6	63.5
	17	689	66.5	47.5	37.8	42.0			57.2	8.0	162.6	63.5
	24	713	65.0	47.5	37.8	42.0			57.2	7.6	166.6	62.2
	31	700	64.5	48.0	37.8	42.0			57.2	7.6	166.6	62.2
Apr.	7	759	67.5	48.0	37.8	42.0			57.2	7.6	166.6	62.2
	14	718	66.0	48.5	37.8	42.0			57.2	7.6	166.6	62.2
	21	741	65.5	48.0	37.8	42.0			57.2	7.6	166.6	62.2
	28	759	66.5	47.5	37.8	42.0			57.2	7.6	166.6	62.2
May	5	747	66.0	48.0	37.8	42.0			57.2	7.6	166.6	62.2
	12	788	66.5	48.5	37.8	42.0			57.2	7.6	166.6	62.2
	19	800	67.0	48.5	37.8	42.0			57.2	7.6	166.6	62.2
	26	762	67.0	48.0	37.8	42.0		2.8	55.2	7.3	160.6	60.0
June	2	796	67.5	48.0	37.8	42.0		2.2	55.6	7.4	162.9	60.8
Total					1982.2	2054.4	69.0	58.0	2904.9	399.7	12013.5	4880.4

TABLE XV

Growth measurements and feed consumption for Holstein bull No. 108, Group III
Born December 20, 1954

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
June	11	321	45.5	39.0	37.8	26.6			43.8	7.4	263.4	143.1
	18	335	46.0	39.0	37.8	26.6			43.8	7.4	263.4	143.1
	25	346	49.0	40.0	38.5	29.4			46.2	7.6	274.7	146.8
July	2	334	48.0	40.0	37.8	26.6			43.8	7.4	263.4	143.1
	9	366	48.5	40.0	37.8	26.6			43.8	7.4	263.4	143.1
	16	396	50.0	41.0	37.8	26.6			43.8	7.4	263.4	143.1
	23	413	50.5	41.0	37.8	26.6			43.8	7.4	263.4	143.1
	30	418	50.5	41.5	38.4	32.0	6.0		51.9	8.2	281.5	151.8
Aug.	6	427	51.5	42.0	39.2	37.8	7.0		57.1	8.5	330.1	158.0
	13	433	52.5	41.5	39.2	35.8	7.0	0.5	55.3	8.4	323.5	157.0
	20	433	52.0	42.0	39.2	28.0	7.0	7.0	45.7	7.6	288.8	153.3
	27	456	53.0	42.0	39.2	33.8	7.0	1.7	53.2	8.3	315.5	156.1
Sept.	3	481	53.0	42.5	39.2	37.9	7.0	1.3	56.3	8.4	342.2	155.5
	10	477	54.0	42.0	40.0	41.0	7.0		59.8	8.7	343.1	162.2
	17	496	53.5	42.5	52.9	41.3	7.0		68.8	11.1	408.3	208.1
	24	517	56.5	44.5	39.9	44.1	7.0		61.8	8.9	351.3	163.4
Oct.	1	534	58.0	42.0	39.9	46.9	7.0	1.5	62.7	8.7	359.2	161.9
	8	552	57.5	43.0	37.8	42.0			54.2	7.6	326.4	93.0
	15	549	58.0	44.0	37.8	42.0			54.2	7.6	326.4	93.0

Table XV (Continued)

Date period ended		Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1955)		(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Oct.	22	562	59.0	44.5	37.8	42.0			54.2	7.6	326.4	93.0
	29	584	59.5	44.5	37.8	42.0			54.2	7.6	326.4	93.0
Nov.	5	597	59.0	44.5	37.8	42.0		1.1	53.5	7.5	321.9	91.7
	12	645	60.5	44.5	37.8	42.0			54.2	7.6	326.4	93.0
	19	600	61.0	44.0	37.8	42.0			54.2	7.6	326.4	93.0
	26	626	60.5	44.0	37.8	42.0			54.2	8.3	163.5	48.5
Dec.	3	639	62.0	45.0	37.8	42.0			54.2	8.3	163.5	48.5
	10	630	62.0	45.5	37.8	42.0			54.2	8.3	163.5	48.5
	17	643	61.5	46.0	37.8	42.0			54.2	8.3	163.5	48.5
	24	633	63.0	45.5	37.8	42.0			54.2	8.3	163.5	48.5
	31	639	62.0	47.0	37.8	42.0			54.2	8.3	163.5	48.5
(1956)												
Jan.	7	659	62.0	46.0	37.8	42.0			54.2	8.0	162.6	63.5
	14	660	60.5	47.0	37.8	42.0			54.2	8.0	162.6	63.5
	21	676	63.0	43.5	37.8	42.0			54.2	8.0	162.6	63.5
	28	641	63.5	47.0	37.8	42.0			54.2	8.0	162.6	63.5
Feb.	4	670	63.5	46.0	37.8	42.0			54.2	8.0	162.6	63.5
	11	673	64.5	46.5	37.8	42.0			54.2	8.0	162.6	63.5
	18	676	64.0	47.0	37.8	42.0			54.2	8.0	162.6	63.5
	25	712	65.5	48.0	37.8	42.0			54.2	8.0	162.6	63.5
Mar.	3	680	64.5	48.0	37.8	42.0			54.2	8.0	162.6	63.5
	10	725	65.0	47.5	37.8	42.0			54.2	8.0	162.6	63.5

Table XV (Continued)

Date period ended	Body weight	Heart girth	Height at withers	Concentrate offered	Pulp molasses offered	Beet pulp offered	Orts	Est. TDN consumed	Total protein consumed	Calcium consumed	Phosphorus consumed
(1956)	(lb.)	(in.)	(in.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(g.)	(g.)
Mar. 17	732	66.0	48.0	37.8	42.0			54.2	8.0	162.6	63.5
24	754	66.5	48.0	37.8	42.0			54.2	7.6	166.6	62.2
31	721	65.5	48.5	37.8	42.0			54.2	7.6	166.6	62.2
Apr. 7	814	67.5	48.5	37.8	42.0			54.2	7.6	166.6	62.2
14	764	66.0	49.0	37.8	42.0			54.2	7.6	166.6	62.2
21	802	67.0	49.0	37.8	42.0			54.2	7.6	166.6	62.2
28	801	67.0	49.0	37.8	42.0			54.2	7.6	166.6	62.2
May 5	735	66.5	48.5	37.8	42.0			54.2	7.6	166.6	62.2
12	787	67.0	48.5	37.8	42.0			54.2	7.6	166.6	62.2
19	818	67.0	50.0	37.8	42.0			54.2	7.6	166.6	62.2
26	811	68.5	49.0	37.8	42.0			54.2	7.6	166.6	62.2
June 2	829	68.5	49.0	37.8	42.0			54.2	7.6	166.6	62.2
Total				1995.4	2037.6	69.0	13.1	2777.9	413.3	12081.1	4956.1

TABLE XVI

Semen data for bull No. 3 (Group I)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
June									
1	4.9	3	40	----	19.2	6.4	117.0	13	229.3
9	3.8	3	70	----	7.5	6.5	91.0	15	243.1
16	6.4	3	60	----	30.0	6.4	90.0	13	344.7
23	3.1	4	70	----	34.2	6.6	106.0	15	229.4
30	4.2	2	50	----	36.0	6.5	96.0	20	201.1
July									
6	5.3	4	40	----	30.0	6.2	87.0	22	185.3
15	4.5	4	80	----	30.6	6.3	104.0	13	372.9
21	7.2	3	40	----	30.0	6.5	84.0	7	243.0
28	4.1	4	50	----	28.8	6.2	108.0	16	221.3
August									
5	2.4	3	60	----	4.5	6.7	93.9	16	135.2
11	5.0	2	80	----	7.5	6.7	105.7	16	422.8
18	2.8	3	40	----	30.0	6.6	127.0	12	142.2
25	4.8	4	50	----	18.0	6.5	127.0	15	304.8
September									
3	7.1	4	60	----	14.7	6.7	73.8	16	314.4
9	4.0	3	30	----	10.5	6.9	78.8	10	252.2
20	3.4	4	80	----	9.0	6.5	63.0	15	171.4
30	3.5	3	50	20.0	12.6	6.7	15.2	13	26.6
October									
1		No Ejaculate							
11	5.7	4	50	30.0	21.0	6.6	85.8	11	244.5
18	4.5	4	60	----	10.5	6.8	47.9	14	129.3
25	2.2	Seminal Fluid Only							
November									
1	2.8	3	60	5.0	6.1	7.3	7.9	9	18.0
8	4.2	3	40	----	16.8	6.8	14.0	16	23.5
15	6.3	Seminal Fluid Only							
22	2.8	3	30	10.0	9.1	7.0	11.8	16	9.9
29	4.8	3	50	5.0	18.6	6.9	16.4	16	39.4
December									
6	3.0	2	40	10.0	11.8	6.7	13.7	10	16.4
13	3.2	3	50	10.0	13.5	6.9	16.8	17	26.2
22	3.7	3	50	5.0	13.8	6.5	15.6	19	28.9
29		No Ejaculate							
(1956)									
January									
2	9.5	1	40	10.0	----	8.0	----	--	
10	3.8	3	30	1.0	5.4	6.5	12.9	18	14.7
18		No Ejaculate							
24	5.8	3	40	10.0	14.7	6.7	52.5	30	121.8
25*	8.7	Seminal Fluid Only							

Table XVI (Continued)

Date (1956)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live Sperm/ejac ($x10^7$)
February									
3	5.7	2	25	----	19.8	6.9	72.6	21	103.5
10	5.2	4	60	10.0	15.0	6.8	90.6	20	282.7
17	4.4	4	40	3.0	8.1	6.6	10.8	23	19.0
24	2.4	3	40	7.0	13.6	6.5	12.2	--	11.7
March									
2	3.7	2	20	30.0	19.8	6.8	42.4	10	31.4
9	2.8	3	30	10.0	10.8	6.9	63.0	20	52.9
16		No Ejaculate							
23	3.0	2	5	10.0	----	7.3	30.6	7	4.6
30	5.6	2	30	30.0	24.3	6.8	95.8	14	160.9
April									
6	2.5	2	30	10.0	16.5	6.6	94.0	18	70.5
13	3.4	Seminal Fluid Only							
20	2.8	3	20	20.0	21.0	6.3	70.3	15	39.4
27	2.0	2	20	10.0	21.0	6.3	80.2	10	48.1
May									
4	3.0	4	70	10.0	18.0	6.2	115.3	13	242.1
11	3.9	2	30	10.0	12.3	6.8	87.4	11	102.3
18		No Ejaculate							
25		No Ejaculate							
June									
1	2.0	3	40	20.0	----	7.2	71.5	13	57.2

*Collected by Electro-ejaculate method

TABLE XVII

Semen data for bull No. 4 (Group I)

Date (1955)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
June									
1	4.5	2	50	10.0	13.8	7.0	60.0	8	135.0
9	8.0	4	60	----	13.2	6.4	101.0	12	484.8
16	8.4	4	60	----	17.7	6.2	134.0	11	675.4
23	6.0	4	80	----	8.1	6.4	96.0	12	475.2
30	6.5	4	50	----	18.3	6.4	125.0	14	406.2
July									
6	10.5	3	80	----	9.6	6.1	118.0	16	991.2
15	5.1	3	30	----	9.6	7.1	90.0	8	137.7
21	8.3	2	10	----	15.0	6.8	82.0	3	68.1
28	8.8	3	20	----	29.0	6.5	36.0	5	63.4
August									
5	5.9	2	30	----	8.1	6.9	15.2	--	26.9
11	7.5	2	10	----	13.5	6.6	21.9	--	16.4
18	9.1	3	40	----	4.8	6.6	28.5	4	103.7
25	7.1	3	30	----	9.0	6.6	23.7	11	50.5
September									
3	8.7	4	30	----	9.6	6.8	30.6	7	79.9
9	11.2	4	50	----	25.8	6.7	28.3	8	158.5
20	3.5	4	50	----	4.5	6.7	83.7	12	146.5
30	7.5	4	50	20.0	----	6.7	37.3	16	139.9
October									
1		No Ejaculate							
11	8.8	3	55	5.0	14.7	7.1	41.1	9	180.8
18	8.6	4	20	55.0	26.4	6.6	105.7	14	181.8
25	4.7	4	50	20.0	8.7	6.4	132.2	15	310.7
November									
1	4.2	3	50	10.0	9.6	6.4	6.5	24	13.7
8	5.3	3	40	10.0	9.1	7.3	21.0	15	44.5
15	2.3	2	40	10.0	9.1	7.7	6.2	7	5.7
22	6.6	4	50	10.0	18.0	6.3	15.2	19	50.2
29	3.4	4	60	1.0	4.8	6.8	16.4	12	33.5
December									
6	5.0	3	80	10.0	----	6.4	16.8	19	67.2
13	9.5	3	40	5.0	13.9	6.8	14.0	17	53.2
22	3.4	1	10	1.0	21.9	7.6	5.5	9	1.9
29	5.6	4	60	10.0	14.7	6.6	16.8	13	56.4
(1956)									
January									
3	4.6	3	10	15.0	----	8.0	----	3	----
10	3.7	2	20	4.0	6.3	6.6	10.3	14	7.6
18	4.8	3	40	10.0	19.4	6.9	16.8	16	32.3
24	3.6	3	40	20.0	----	6.9	60.2	22	86.7
25*	12.3	4	30	10.0	----	7.3	36.2	11	133.6

Table XVII (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	4.5	3	30	----	19.8	6.9	127.1	16	171.6
10	3.7	4	50	10.0	12.9	6.7	151.8	16	280.8
17	9.0	3	20	20.0	21.0	7.4	52.7	9	94.9
24	4.2	3	30	2.0	13.5	6.6	24.2	8	30.5
March									
2	3.2	4	50	20.0	17.7	6.9	110.3	18	176.5
9	3.6	4	60	2.0	6.3	6.7	115.3	16	249.0
16	6.5	3	30	1.0	9.0	6.9	134.1	13	261.5
23	6.5	4	50	10.0	21.0	6.6	138.0	19	448.5
30	2.7	4	40	10.0	13.9	6.8	110.3	17	119.1
April									
6	3.3	2	30	15.0	8.1	7.1	112.8	9	111.7
13	3.2	3	40	10.0	15.3	6.2	----	11	-----
20	4.2	4	50	20.0	24.0	6.6	130.5	13	274.1
27	3.0	1	20	10.0	10.5	6.3	151.8	12	91.1
May									
4	2.2	2	30	10.0	15.0	6.8	73.8	11	48.7
11	3.4	4	50	2.0	7.5	6.6	142.2	16	241.7
18	4.8	3	40	10.0	12.0	6.7	97.6	9	187.4
25	5.1	4	40	30.0	25.2	6.8	97.6	14	199.1
June									
1	7.4	3	40	10.0	6.0	6.6	142.2	12	193.4

*Collected by Electro-ejaculate method

TABLE XVIII

Semen data for bull No. 15 (Group I)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml (x10^7)	Storage time (days)	Live sperm/ejac (x10^7)
June									
1	6.7	4	90	----	25.8	5.9	1130.0	16	621.1
9	8.2	3	60	----	27.9	6.5	127.0	16	624.8
23	5.7	4	80	----	13.5	6.4	119.0	14	542.6
30	6.2	4	60	----	40.2	6.3	117.0	12	435.2
July									
6	6.8	4	80	----	35.4	6.2	121.0	21	658.2
15	7.0	4	80	----	12.6	6.5	1070	15	599.2
21	6.1	3	80	----	17.4	6.3	121.0	13	590.5
28	7.1	4	60	----	25.5	6.2	132.0	19	562.3
August									
5	10.6	4	90	----	22.5	6.5	134.0	16	1278.4
11	6.5	3	70	----	9.0	6.5	134.0	19	609.7
18	7.4	4	70	----	30.0	6.7	120.8	22	625.7
25	7.6	4	50	----	11.8	6.5	151.8	18	576.8
September									
3	7.0	4	50	----	12.3	6.7	115.0	12	402.5
9	8.2	4	60	----	19.8	6.5	127.0	20	624.8
20	6.0	4	60	----	15.0	6.2	94.0	16	338.4
30	9.3	4	70	20.0	8.1	6.5	67.0	21	436.2
October									
1		No Ejaculate							
11	11.5	4	70	20.0	13.5	6.4	101.5	18	817.1
18	5.2	2	10	20.0	23.4	6.7	94.0	16	48.9
25	6.1	4	60	20.0	10.0	6.5	107.9	21	394.9
November									
1	6.2	4	60	5.0	10.5	6.4	9.9	22	36.3
8	4.4	4	50	5.0	16.8	7.2	19.3	---	42.7
15	9.6	4	40	10.0	13.5	6.6	15.2	19	58.4
22	5.4	4	70	20.0	22.5	6.8	16.4	25	62.0
29	4.4	3	30	2.0	18.6	7.0	16.4	18	21.6
December									
6	6.8	3	50	10.0	12.3	6.4	9.9	9	33.7
13	8.3	4	50	15.0	23.3	6.6	16.8	22	69.7
22	8.2	4	80	1.0	14.8	6.6	17.2	19	112.8
29	7.2	4	60	10.0	4.8	6.4	16.8	13	84.7
(1956)									
January									
3	4.9	4	50	20.0	8.1	6.8	16.0	22	47.0
10	5.6	4	60	2.0	22.5	6.6	16.4	19	64.3
18	7.5	4	70	10.0	18.9	6.9	16.8	19	88.2
24	5.1	3	40	40.0	30.0	6.7	50.9	31	103.8
25*	9.6	3	50	10.0	----	7.7	4.6	16	22.1

Table XVIII (Continued)

Date (1956)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	10.0	2	25	----	9.3	7.0	127.0	22	317.5
10	6.5	4	50	20.0	11.1	6.8	127.0	26	412.8
17	6.8	4	60	2.0	9.0	6.7	127.0	22	657.9
24	6.0	3	70	1.0	4.8	6.5	11.4	14	47.9
March									
2	5.5	4	60	20.0	12.0	6.8	15.2	13	50.2
9	6.1	4	40	30.0	21.9	6.6	120.9	20	295.0
16	6.4	3	60	5.0	6.9	6.6	115.3	21	442.8
23	9.1	4	60	10.0	10.5	6.5	118.0	24	644.3
30	4.9	4	40	20.0	10.5	6.6	127.0	23	248.9
April									
6	6.2	3	40	20.0	24.0	6.7	115.3	17	285.9
13	7.0	3	40	10.0	25.2	6.3	-----	25	-----
20	7.1	4	70	2.0	3.9	6.6	94.0	12	467.2
27	3.8	3	70	7.0	8.1	6.2	157.3	16	418.4
May									
4	3.0	4	60	10.0	12.3	6.3	142.2	21	256.0
11	3.0	4	50	10.0	18.3	6.5	120.9	20	181.4
18		No Ejaculate							
25	5.5	3	30	30.0	29.1	6.8	123.9	11	204.4
June									
1	6.5	2	40	20.0	----	6.7	115.3	21	299.8

*Collected by Electro-ejaculate method

TABLE XIX

Semen data for bull No. 21 (Group I)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
June									
1	6.6	4	90	----	11.1	5.9	122.0	17	724.7
9	7.1	4	70	----	27.6	6.3	121.0	11	601.4
16	4.5	4	80	----	27.0	6.4	114.0	13	410.4
23	6.5	4	80	----	43.5	6.5	114.0	17	592.8
30	6.3	4	60	----	19.2	6.4	115.0	14	434.7
July									
6	8.7	4	80	----	27.0	6.2	117.0	17	814.3
15	6.2	4	80	----	30.9	6.3	108.0	13	535.7
21	6.8	4	90	----	18.3	6.2	119.0	9	728.3
28	6.2	4	80	----	38.7	6.3	134.0	16	664.6
August									
5	6.5	4	50	----	27.0	6.6	127.1	16	413.1
11	7.0	4	80	----	11.7	6.4	151.8	13	850.1
18	7.1	4	60	----	15.0	6.4	151.8	11	646.7
25	6.0	4	90	----	15.6	6.3	140.0	18	504.0
September									
3	8.5	4	90	----	20.0	6.5	142.2	14	1087.8
9	6.3	4	90	----	1.0	6.4	151.8	13	860.7
20	5.5	4	60	----	1.8	6.2	142.2	17	469.3
30	6.4	3	60	20.0	----	6.4	38.5	15	147.8
October									
1		No Ejaculate							
11	7.4	4	50	30.0	21.0	7.0	59.3	11	210.5
18	6.4	2	30	30.0	10.8	---	110.3	11	211.8
25	5.6	4	70	10.0	12.3	6.5	97.6	14	382.6
November									
1	6.4	4	60	5.0	9.0	7.0	19.3	16	74.1
8	2.2	3	60	15.0	19.8	6.8	20.6	14	27.2
15	6.0	4	50	20.0	9.0	6.5	16.0	19	48.0
22	6.6	4	60	10.0	15.0	6.5	17.6	20	69.7
29	4.0	4	60	5.0	15.0	6.9	17.2	16	41.3
December									
6	6.8	4	70	10.0	8.1	6.3	16.8	15	80.0
13	7.5	4	50	10.0	10.7	6.6	16.8	21	63.0
22	5.4	4	60	3.0	11.7	6.8	16.8	12	54.4
29	5.3*	4	70	10.0	----	6.4	15.6	13	57.9
(1956)									
January									
2	2.7	Seminal Fluid Only							
10	4.5	2	40	1.0	8.7	6.3	16.8	19	30.2
18	3.8	4	70	10.0	16.2	6.8	16.0	15	24.3
24	1.6	3	40	10.0	9.0	7.0	28.5	30	18.2
25**	4.5	3	20	30.0	27.0	7.5	23.7	14	21.3

Table XIX (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	8.7	4	65	----	15.3	6.9	67.1	16	379.5
10	6.2	4	50	10.0	15.0	6.7	115.3	16	357.4
17	3.9	3	30	5.0	6.6	7.1	101.5	11	118.6
24	4.1	3	70	1.0	10.8	6.4	55.8	13	160.1
March									
2	9.0	4	60	10.0	11.7	6.6	115.3	19	622.6
9	5.7	3	60	10.0	9.9	6.4	103.6	17	354.3
16	6.2	2	30	1.0	6.2	6.7	110.3	13	205.2
23	4.0	2	40	10.0	9.9	7.6	36.7	9	58.7

*Second Ejaculate

**Collected by Electro-ejaculate method

TABLE XX

Semen data for bull No. 34 (Group II)

Date (1955)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($\times 10^7$)	Storage time (days)	Live sperm/ejac ($\times 10^7$)
June									
1	5.2	3	50	----	12.9	6.5	76.0	15	197.6
9	3.0	4	60	----	18.9	6.3	81.0	19	145.8
16	1.1	3	60	----	18.6	6.7	33.0	15	21.8
23	3.2	4	80	----	16.8	6.6	65.0	14	166.4
30	1.8	3	50	----	15.6	6.6	57.0	17	51.3
July									
6	2.6	4	60	----	18.3	6.0	94.0	23	146.6
15	10.5	2	2	----	17.4	7.0	37.0	0	7.8
21	3.9	3	40	----	10.8	6.5	91.0	12	142.0
28	1.8	4	70	----	14.7	6.8	28.0	14	35.3
August									
5		No Ejaculate							
11		No Ejaculate							
18	2.8	4	50	----	5.4	6.7	39.8	7	55.7
25	4.4	4	80	----	10.5	6.6	69.2	13	243.6
September									
3	6.7	4	50	----	11.1	6.7	105.7	7	354.1
9	7.0	4	80	----	11.7	6.6	105.7	14	592.0
20	3.3	-	--	----	24.8				
30	2.0	3	40	30.0	18.9	6.7	13.7	14	11.0
October									
1		No Ejaculate							
11		No Ejaculate							
18	5.0	3	20	20.0	15.0	6.8	54.1	16	54.1
25	4.5	4	50	30.0	10.8	6.7	92.3	17	207.7
November									
1	3.8	3	50	10.0	9.6	6.8	87.4	15	166.1
8	4.1	4	40	30.0	23.9	7.2	17.6	23	28.9
15	1.8	3	50	20.0	16.8	7.1	----	15	-----
22	3.4	4	50	5.0	11.7	6.7	11.4	20	19.4
29	3.8	2	20	1.0	----	7.2	.1	17	.1
December									
6	2.0	Seminal Fluid Only							
13	3.2	3	40	20.0	18.6	6.6	15.2	16	19.5
22	3.6	4	70	1.0	16.2	6.9	7.5	19	18.9
26	2.0	Seminal Fluid Only							
(1956)									
January									
3	5.3	4	60	2.0	8.7	6.8	14.4	21	45.8
10	4.8	4	60	10.0	----	6.6	15.2	16	43.8
18	6.4	4	60	10.0	12.6	7.0	15.6	17	60.0
24	7.1	4	70	3.0	12.6	6.6	50.9	30	253.0

Table XX (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	3.9	3	60	----	9.0	6.8	90.6	20	212.0
10	2.8	4	60	20.0	11.4	6.8	85.9	18	144.3
17	7.1	3	50	15.0	12.6	6.7	97.6	23	346.5
24	6.0	3	40	2.0	13.6	6.8	7.9	15	19.0
March									
2	5.4	4	50	20.0	19.2	6.7	105.7	18	285.4
9	6.0	2	20	10.0	6.6	---	101.5	22	121.8
16		On Metabolism Trial							
23		On Metabolism Trial							
30		On Metabolism Trial							
April									
6	3.3	3	40	15.0	21.0	6.5	142.2	22	188.0
13		No Ejaculate							
20	2.0	4	50	10.0	12.3	6.9	-----	12	-----
27	2.7	4	80	5.0	16.1	6.3	151.8	18	328.0
May									
4	5.0	3	50	10.0	16.9	6.3	138.0	20	345.0
11	2.2	4	70	1.0	4.8	6.5	103.6	20	159.5
18	3.2	4	90	1.0	11.8	6.5	142.2	20	409.5
25	3.0	4	60	5.0	9.0	6.7	110.3	24	198.5
June									
1	2.4	3	40	10.0	21.0	6.6	94.1	22	90.3

TABLE XXI

Semen data for bull No. 35 (Group II)

(1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
June									
1	4.2	4	80	----	21.9	6.2	122.0	16	409.9
9	3.4	3	60	----	10.2	6.6	96.0	13	195.8
16	3.9	4	40	----	8.4	6.4	130.0	15	202.8
23	3.8	4	80	----	28.8	6.4	124.0	14	377.0
30	3.9	4	50	----	17.1	6.5	108.0	13	210.6
July									
6	4.4	2	40	----	15.3	6.2	110.0	16	193.6
15	7.2	3	70	----	36.6	6.3	152.0	8	766.1
21	4.2	3	40	----	14.4	6.4	134.0	11	225.1
28	4.0	3	40	----	22.5	6.6	87.0	10	139.2
August									
5	3.7	3	20	----	12.0	6.6	93.1	15	68.9
11	3.5	4	60	----	18.0	6.7	93.1	9	195.5
18	4.2	4	60	----	22.5	6.5	160.4	16	404.2
25	4.0	4	50	----	21.9	6.5	125.4	18	250.8
September									
3	3.0	4	80	----	2.7	6.5	120.9	14	290.2
9	3.6	3	60	----	16.6	6.5	132.2	12	285.6
20	3.7	Seminal Fluid Only							
30	3.0	4	70	10.0	12.3	6.6	63.1	--	132.5
October									
1		No Ejaculate							
11	3.4	4	60	10.0	24.3	6.7	67.1	15	136.9
18	3.9	4	30	20.0	28.8	6.8	49.4	--	57.8
25	5.5	4	60	20.0	11.4	6.7	120.9	12	399.0
November									
1*	2.6	4	50	20.0	21.0	7.0	83.0	14	107.9
8	2.6		20	----	27.0	7.4	16.4	19	8.5
15	3.5	2	30	30.0	32.7	6.7	15.2	13	61.6
22	2.6	3	40	5.0	4.5	6.6	17.2	15	17.9
29*	6.3	1	2	1.0	----	7.3	4.3	3	.5
December									
6	5.0	3	40	20.0	12.9	6.5	17.6	19	35.2
13	3.7	3	40	30.0	11.4	6.7	15.6	12	23.1
22	3.3	3	50	1.0	10.8	6.9	13.3	11	21.9
29	3.6	3	40	1.0	9.0	6.8	6.9	16	9.9
(1956)									
January									
3	6.2	4	60	5.0	13.6	6.9	16.0	15	59.5
10	4.6	2	20	1.0	----	7.5	----	--	----
18	3.5	4	50	10.0	14.8	6.8	11.4	14	26.2
24	2.9	4	40	5.0	13.2	6.9	50.9	27	59.0

Table XXI (Continued)

Date (1956)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	2.0	2	25	----	7.5	6.9	54.1	--	27.1
10	4.5	4	70	10.0	6.6	6.8	127.1	21	400.4
17*	5.2	4	60	2.0	----	6.8	78.8	17	245.9
24	3.5	3	50	1.0	9.0	6.8	115.3	18	201.8
March									
2	2.6	3	20	10.0	13.5	6.8	127.1	10	66.1
9	5.8	3	30	30.0	27.0	6.7	97.6	18	169.8
16		On Metabolism Trial							
23		On Metabolism Trial							
30		On Metabolism Trial							
April									
6	2.5	1	15	3.0	4.5	6.7	142.2	19	53.3
13	2.5	4	60	10.0	9.0	6.8	-----	19	----
20	1.8	3	30	20.0	18.0	6.9	-----	12	----
27	2.2	3	60	10.0	----	6.3	188.3	18	224806
May									
4	2.8	2	40	20.0	27.0	7.1	97.6	10	109.3
11	2.3	4	60	2.0	6.0	6.6	90.6	14	125.0
18	3.0	3	40	5.0	6.6	6.6	127.1	12	152.5
25*	3.9	2	30	50.0	36.0	6.9	78.8	23	92.2
June									
1	2.1	2	40	10.0	9.3	7.2	50.9	13	140.9

*Second Ejaculate

TABLE XXII

Semen data for bull No. 36 (Group II)

Date (1955)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
November									
15	2.3	2	40	30.0	15.9	6.7	16.0	19	114.7
22	2.4	3	50	10.0	10.2	6.6	14.4	16	17.3
29	4.7	3	50	1.0	14.2	7.0	----	14	----
December									
6	5.5	2	40	20.0	20.1	6.6	14.4	29	31.7
13	5.0	3	40	10.0	18.7	6.7	12.9	13	25.8
22	5.8	2	30	1.0	13.8	6.9	15,2	11	26.4
29	2.8	2	20	1.0	16.8	6.7	14.0	6	7.8
(1956)									
January									
3	3.4	3	40	3.0	15.3	6.9	12.5	14	17.0
10	6.7	3	30	1.0	10.8	6.5	15.2	13	30.6
18	5.0	4	60	20.0	13.5	6.7	16.0	15	48.0
24	3.6	3	30	10.0	----	6.7	46.5	23	50.2
February									
3	3.3	3	40	----	13.5	6.7	67.1	19	88.6
10	5.5	4	60	10.0	16.5	6.7	115.3	18	380.5
17	5.3	3	40	20.0	9.9	6.8	50.9	19	107.9
24	4.0	2	30	5.0	5.4	6.7	105.7	20	126.8
March									
2	2.7	4	40	25.0	24.0	6.7	101.5	14	109.6
9	3.2	3	15	10.0	9.0	6.6	35.0	13	16.8
16		On Metabolism Trial							
23		On Metabolism Trial							
30		On Metabolism Trial							
April									
6	5.1	3	50	10.0	12.3	6.6	90.6	16	231.0
13	3.5	2	50	20.0	26.1	6.5	----	20	-----
20	3.3	3	60	10.0	21.0	6.8	----	12	-----
27	3.0	3	40	3.0	13.5	6.4	42.4	12	50.9
May									
4	3.4	3	50	20.0	30.0	6.5	87.4	18	148.6
11	3.1	3	40	5.0	10.5	6.8	67.1	7	83.2
18	4.1	3	70	15.0	24.3	6.6	55.8	13	160.1
25	2.8	3	50	15.0	15.0	6.5	120.8	20	169.1
June									
1	4.7	3	50	20.0	18.0	6.5	134.6	21	189.8

TABLE XXIII

Semen data for bull No. 37 (Group II)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
June									
1	3.2	3	60	----	16.2	6.6	87.0	12	167.0
9	3.6	2	50	----	22.8	6.8	63.0	12	113.4
16	3.9	4	50	----	28.5	6.6	88.0	15	171.6
23	3.7	4	70	----	27.9	6.7	67.0	8	173.5
30	6.2	4	40	----	17.7	6.5	91.0	14	225.7
July									
6	3.5	4	50	----	16.2	6.6	63.0	8	110.3
15	6.8	4	50	----	40.8	6.6	124.0	11	421.6
21	4.7	4	50	----	18.9	6.6	91.0	13	213.9
28	5.5	4	60	----	----	6.6	115.3	12	380.5
August									
5	5.2	3	50	----	36.6	---	97.6	16	253.8
11	3.5	4	50	----	11.4	---	93.1	9	163.0
18	5.3	4	30	----	9.0	6.6	149.2	13	237.2
25	5.5	3	70	----	6.6	6.6	109.1	23	420.0
September									
3	4.5	4	40	----	27.0	6.7	90.6	11	163.1
9	4.0	4	60	----	9.1	6.6	89.8	10	215.5
20	6.3	4	80	----	4.8	6.8	127.1	16	640.6
30	7.0	4	60	20.0	20.1	6.8	26.6	15	111.7
October									
1		No Ejaculate							
11	7.2	4	60	20.0	13.5	6.7	90.6	14	391.4
18	6.1	4	25	10.0	8.1	6.6	110.3	20	168.2
25	4.1	4	60	10.0	7.2	6.7	112.8	13	277.5
November									
1	6.2	4	60	5.0	----	6.8	76.3	14	283.8
8	2.8	4	15	5.0	21.9	7.0	21.5	13	9.0
15	5.0	3	40	20.0	11.4	6.7	16.0	17	32.0
22	3.4	3	50	5.0	14.8	6.8	12.9	17	21.9
29	5.8	4	30	2.0	15.9	7.2	----	21	-----
December									
6	6.1	3	60	20.0	----	7.1	14.8	15	54.2
13	1.7	3	50	20.0	15.9	6.7	12.9	14	11.0
22	3.8	3	50	1.0	28.8	6.9	12.2	15	23.2
29	2.8	2	20	1.0	16.8	---	14.0	5	7.8
(1956)									
January									
2	5.4	4	40	4.0	12.6	7.0	12.9	17	27.9
10	5.7	4	50	1.0	9.2	6.9	3.6	10	10.3
18	2.7	3	50	20.0	11.7	6.8	14.4	14	19.4
24	4.3	2	20	30.0	10.8	6.8	43.7	27	37.6

Table XXIII (Continued)

Date (1956)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
February									
3	3.8	3	40	----	9.3	6.8	89.0	19	135.3
10	4.8	3	50	20.0	14.4	6.6	66.0	15	158.4
17	4.6	4	50	10.0	8.1	6.7	115.3	22	265.2
24	6.2	3	60	1.0	9.9	6.6	99.5	25	370.1
March									
2	5.6	3	50	10.0	12.6	6.8	65.0	12	182.0
9	4.9	4	40	15.0	18.0	6.8	50.9	18	99.8
16		On Metabolism Trial							
23		On Metabolism Trial							
30		On Metabolism Trial							
April									
6	5.4	2	30	4.0	5.4	6.9	120.9	16	195.9
13	4.8	3	50	10.0	----	6.6	----	14	-----
20	2.5	3	50	5.0	9.0	6.8	----	12	-----
27	2.5	3	30	33.0	10.5	6.5	178.7	9	134.0
May									
4	4.5	4	50	10.0	5.4	7.1	105.7	9	237.8
11	3.5	3	40	10.0	9.0	6.8	13.7	11	19.2
18	1.8	2	40	10.0	11.1	6.4	57.5	11	41.4
25	4.8	3	50	10.0	10.5	7.0	84.4	8	202.6
June									
1	3.0	3	20	20.0	15.9	6.9	84.4	12	50.8

TABLE XXIV

Semen data for bull No. 23 (Group III)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
August									
2	.7	4	80	----	9.0	6.5	38.5	8	21.6
11	2.5	4	70	----	12.0	6.6	60.7	7	106.2
18	0.5	3	50	----	28.0	6.4	----	10	-----
25	3.0	3	60	----	24.6	6.7	76.3	4	137.3
September									
3	2.1	4	50	----	6.6	6.8	80.8	7	84.8
9	3.1	4	40	----	4.5	6.8	71.5	9	88.7
20	5.0	4	60	----	6.9	6.4	105.7	11	317.1
30		No Ejaculate							
October									
1	2.0	4	60	15.0	12.3	6.6	104.6	12	125.5
11	4.7	4	50	30.0	----	6.7	58.5	7	137.5
18	---	4	40	5.0	12.6	6.8	81.6	14	-----
25	1.7	3	30	20.0	----	---	91.4	13	46.6
November									
1	3.2	3	60	10.0	9.1	7.2	84.4	12	162.0
8	---	4	60	10.0	11.4	7.4	17.2	18	-----
15	3.0	4	60	10.0	9.3	6.8	15.6	15	28.1
22	4.8	4	40	5.0	14.7	6.8	12.9	13	24.8
29	3.5	4	60	5.0	4.5	7.4	16.8	13	35.3
December									
6	4.5	3	50	10.0	4.2	6.4	17.2	19	38.7
13	4.3	3	50	2.0	4.2	6.7	16.4	10	35.3
22	4.5	2	50	3.0	24.6	6.9	12.5	12	28.1
29	4.6	4	60	10.0	18.0	6.8	16.0	13	44.2
(1956)									
January									
2	2.3	3	50	20.0	12.0	6.4	17.2	12	19.8
10		No Ejaculate							
18		No Ejaculate							
24	3.5	3	40	10.0	----	6.8	52.5	31	73.5
February									
3	2.3	2	20	----	10.5	7.2	41.1	11	18.9
10	4.0	4	70	10.0	6.6	6.8	120.9	15	338.5
17	2.9	3	50	2.0	9.0	6.9	97.6	15	141.5
24	3.3	3	60	1.0	9.0	7.0	99.5	16	197.0
March									
2	3.8	4	60	10.0	16.2	6.9	115.3	20	262.9
9	1.6	3	10	15.0	16.6	7.0	94.0	10	15.0
16	2.0	2	40	2.0	19.8	6.8	105.7	15	84.6
23	10.0	4	60	10.0	12.0	6.8	110.3	17	661.8
30	2.6	3	40	5.0	6.0	6.7	120.9	13	125.7

Table XXIV (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
April									
6	3.0	3	80	4.0	12.9	6.7	127.1	13	305.0
13	4.0	4	70	10.0	14.4	6.8	-----	12	-----
20	2.7	3	40	5.0	4.5	6.5	112.8	19	121.8
27	4.2	4	80	10.0	14.4	6.0	178.7	19	600.4
May									
4	4.0	4	80	10.0	9.9	6.4	127.1	20	406.7
11	2.3	4	80	1.0	2.7	6.6	130.5	13	240.1
18	4.0	4	80	2.0	8.4	6.8	87.4	10	279.7
25	3.2	4	50	5.0	5.7	6.9	67.1	8	107.4
June									
1	7.5	3	50	10.0	12.3	6.6	124.1	22	198.6

TABLE XXV

Semen data for bull No. 96 (Group III)

Date (1955)	Vol (ml)	Motility (rate)	Motility (%)	Abnormals (Fresh)	Abnormals (Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
August									
18	2.3	4	80	----	15.9	6.6	120.9	14	222.5
25	1.6	4	70	----	9.6	6.7	52.1	10	58.4
September									
3		No Ejaculate							
9	1.6	2	30	----	2.7	6.6	120.9	9	58.0
20	3.0	1	5	----	28.0	8.2	5.7	2	.9
30		No Ejaculate							
October									
1	2.4	4	70	----	12.0	6.8	38.5	11	64.7
11	2.3	-	--	5.0	----	8.0	3.9	--	----
18	2.6	Seminal Fluid Only							
25	.9	Seminal Fluid Only							
November									
1		No Ejaculate							
8	1.4	4	20	2.0	4.5	7.2	----	17	----
15	2.3	1	1	----	----	7.8	----	--	----
22	2.9	4	60	5.0	----	7.4	5.9	15	10.3
29	2.6	-	--	----	----	7.2	2.1	--	----
December									
6		No Ejaculate							
13	2.4	4	40	10.0	9.6	6.5	16.8	9	16.1
22		No Ejaculate							
29		No Ejaculate							
January (1956)									
2	2.8	4	70	10.0	10.8	6.5	17.6	16	34.5
10		No Ejaculate							
18		No Ejaculate							
24		No Ejaculate							
February									
3	2.5	2	35	----	16.5	6.8	127.1	25	111.2
10	2.8	4	80	10.0	9.0	6.7	84.4	25	189.1
17	3.0	3	20	20.0	15.9	7.6	6.5	3	3.9
24	3.5	Seminal Fluid Only							
March									
2	3.3	Seminal Fluid Only							
9	2.1	3	40	5.0	6.0	6.8	78.8	15	26.2
16		On Metabolism Trial							
23	3.5	Seminal Fluid Only							
30	2.3	4	60	10.0	12.0	6.9	90.6	18	125.0
April									
6	3.1	3	30	2.0	15.9	7.1	81.6	12	75.9
13	3.0	Seminal Fluid Only							
20	3.4	4	40	20.0	18.0	6.8	101.5	13	138.0
27	2.1	3	50	1.0	13.5	6.4	66.0	12	69.3

Table XXV (Continued

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
May									
4	5.0	3	50	10.0	24.0	6.3	134.1	21	335.3
11	4.1	3	50	10.0	10.5	6.7	76.3	5	156.4
18	4.0	1	15	2.0	5.1	6.7	17.6	5	10.6
25	3.4	3	40	5.0	2.7	6.8	115.3	15	156.8
June									
1	2.1	3	50	10.0	12.9	6.6	101.5	21	106.6

TABLE XXVI

Semen data for bull No. 99 (Group III)

(1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
August									
1	.8	2	10	----	31.2	6.7	.1	2	.01
11		No Ejaculate							
18		No Ejaculate							
25		No Ejaculate							
September									
3		No Ejaculate							
9		No Ejaculate							
20	2.6	4	50	----	6.3	6.7	38.5	10	50.1
30		No Ejaculate							
October									
1	7.9	3	40	10.0	9.0	6.7	43.7	12	138.1
11	2.6	4	50	20.0	23.4	6.7	59.3	10	77.1
18	4.0	3	30	20.0	21.3	---	----	2	----
25	3.2	4	50	20.0	15.3	6.9	78.8	10	126.1
November									
1	3.3	4	60	15.0	21.0	6.6	95.8	10	189.7
8	2.1	4	50	30.0	30.0	---	16.8	16	17.6
15	2.0	4	70	10.0	15.9	6.7	15.8	29	22.1
22	3.6	4	50	5.0	16.8	6.8	14.4	15	25.9
29	3.4	3	20	2.0	----	6.9	16.4	12	11.2
December									
6	6.5	3	70	10.0	8.1	6.5	14.8	9	67.3
13	3.9	3	60	10.0	10.7	6.6	16.8	13	39.3
22	2.3	2	60	5.0	10.7	6.6	17.6	17	24.3
29	2.4	4	60	20.0	7.8	6.6	18.4	13	26.5
(1956)									
January									
2	2.2	4	50	10.0	8.7	6.5	16.4	19	18.0
10		No Ejaculate							
18		No Ejaculate							
24	2.8	3	40	20.0	----	6.8	49.4	31	55.3
February									
3	2.2	2	30	----	9.6	6.9	163.5	22	107.9
10	2.2	4	60	10.0	18.9	6.9	142.2	16	187.7
17	3.7	4	60	10.0	9.9	6.8	120.9	19	268.4
24	2.4	2	20	2.0	33.0	7.0	94.0	23	45.1
March									
2	3.3	4	70	10.0	9.9	6.5	118.0	24	272.6
9	1.4	4	70	2.0	5.1	6.7	115.3	9	113.0
16	2.9	2	50	20.0	15.0	6.8	127.1	21	184.3
23	3.3	3	40	10.0	9.6	6.8	115.3	12	152.2
30	2.4	4	60	5.0	9.0	6.4	118.0	22	169.9

Table XXVI (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
April									
6	3.1	2	40	20.0	25.2	7.0	76.3	12	94.6
13	3.5	4	70	10.0	----	6.5	----	18	----
20	2.4	4	50	10.0	10.7	6.9	120.9	19	145.1
27	1.9	3	60	15.0	16.4	6.1	163.5	18	186.4
May									
4	3.7	4	70	10.0	11.7	6.3	130.5	21	338.0
11	2.1	4	70	1.0	12.0	6.4	151.8	25	223.1
18	4.0	4	70	2.0	4.5	6.5	105.7	16	296.0
25	4.1	4	50	5.0	3.9	6.5	134.1	26	274.9
June									
1	5.0	3	40	10.0	15.6	6.4	127.1	23	254.2

TABLE XXVII

Semen data for bull No. 45 (Group III)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml (x10^7)	Storage time (days)	Live sperm/ejac (x10^7)
August									
18	1.2	4	60	----	24.0	6.4	14.4	14	10.4
25	1.3	4	50	----	10.8	6.5	25.6	14	16.6
September									
3		No Ejaculate							
9	1.9	3	40	----	31.2	6.6	115.3	11	87.6
20	3.3	3	40	----	9.3	7.0	55.8	10	73.7
30		No Ejaculate							
October									
1	3.4	3	30	----	11.7	7.5	6.5	13	6.6
11		No Ejaculate							
18	---	4	10	5.0	6.9	7.3	30.6	7	----
25	2.3	Seminal Fluid Only							
November									
1	2.8	3	40	20.0	13.5	7.3	21.5	8	24.1
8	2.7	4	30	10.0	----	7.2	19.3	18	15.6
15	3.3	3	50	10.0	10.8	6.5	15.2	18	25.1
22	5.6	3	40	10.0	3.3	7.0	15.2	13	34.0
29	3.8	2	30	4.0	9.0	7.1	----	12	----
December									
6	4.5	3	40	20.0	14.7	6.6	16.0	16	28.8
13	3.5	Seminal Fluid Only							
22	2.4	2	40	10.0	10.5	6.7	16.8	23	16.1
29		No Ejaculate							
(1956)									
January									
2	2.4	4	60	20.0	29.4	6.7	16.8	16	24.2
10		No Ejaculate							
18		No Ejaculate							
24	5.0	4	30	20.0	8.4	7.7	43.7	31	65.6
February									
2		No Ejaculate							
10	2.2	4	60	10.0	9.6	6.8	110.3	14	145.6
17	5.8	4	40	5.0	15.3	6.6	94.0	22	218.1
24	3.5	3	60	1.0	11.7	6.8	101.5	21	213.2
March									
2	3.7	3	30	20.0	18.6	6.1	59.3	12	65.8
9	2.5	3	50	5.0	6.0	6.6	110.3	16	137.9
16	3.0	3	50	1.0	15.0	---	120.8	20	181.2
23	5.4	3	30	20.0	24.0	6.7	115.3	12	186.8
30		Seminal Fluid Only							
April									
6	4.5	3	60	4.0	4.5	6.6	127.1	15	343.2
13	3.0	4	50	20.0	8.1	6.5	----	14	----

Table XXVII (Continued)

Date (1956)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
April									
20	4.4	4	50	10.0	25.1	6.8	----	20	----
27	3.0	3	40	7.0	9.9	6.4	115.3	18	138.4
May									
4	2.1	3	50	20.0	21.0	6.6	69.2	9	72.7
11	2.6	1	40	20.0	21.0	7.8	11.8	4	12.3
18	3.8	2	60	40.0	31.2	6.5	120.8	25	275.4
25	1.6	4	50	10.0	10.8	6.8	110.3	10	88.2
June									
1	7.5	3	50	10.0	12.3	6.6	124.1	22	465.4

TABLE XXVIII

Semen data for bull No. 41 (Group III)

Date (1955)	Vol (ml)	Motility (rate)	(%)	Abnormals (Fresh)	(Stain)	pH	Sperm per ml ($x10^7$)	Storage time (days)	Live sperm/ejac ($x10^7$)
November									
8	---	4	5	1.0	24.9	7.2	----	14	----
15	3.0	2	40	20.0	10.4	7.1	8.6	12	10.3
22	4.0	2	20	5.0	----	7.0	8.6	7	6.9
29	2.7	3	20	1.0	9.0	6.9	11.1	11	6.0
December									
6	2.5	2	40	20.0	11.7	6.6	14.2	17	14.2
13	2.5	Seminal Fluid Only							
22	4.9	1	15	11.0	23.1	6.8	11.8	15	8.7
29	2.2	3	40	20.0	10.3	6.8	16.0	13	14.1
(1956)									
January									
2	2.4	3	40	30.0	19.8	6.5	16.0	12	15.4
10		No Ejaculate							
18		No Ejaculate							
24	3.7	3	30	30.0	25.2	6.8	49.5	25	54.9
February									
3	3.7	2	15	----	13.5	7.8	32.8	13	18.2
10	3.8	3	40	20.0	12.0	7.3	33.3	14	50.6
17	2.5	2	20	20.0	15.0	7.2	75.0	9	37.5
24	4.9	2	15	3.0	18.9	6.9	89.0	14	65.4
March									
2	2.8	3	40	20.0	24.0	6.6	94.0	14	105.3
9	3.7	3	20	30.0	21.6	7.0	57.5	15	42.6
16	4.0	2	20	10.0	28.8	6.8	73.8	13	59.0
23	4.0	3	30	20.0	18.0	6.7	99.5	11	119.4
30	3.2	4	40	30.0	30.9	7.0	89.0	12	113.9
April									
6	3.2	3	60	36.0	36.0	6.7	73.8	12	141.7
13*	3.1	2	40	20.0	13.5	6.5	----	19	----
20	2.2	3	40	20.0	24.9	6.6	----	12	----
27	2.5	2	30	3.0	29.7	6.2	142.2	14	106.7
May									
4	5.5	3	40	30.0	29.7	6.4	101.5	12	223.3
11	3.6	3	40	10.0	14.1	6.6	134.1	19	193.1
18	6.8	2	40	15.0	9.9	6.7	115.3	11	313.6
25	2.5	2	50	30.0	24.9	6.8	94.0	13	11.8
June									
1	3.3	2	30	20.0	24.3	6.8	62.9	12	62.3

*Second Ejaculate

TABLE XXIX

Blood plasma calcium values of all bulls
Mg./100 ml.

Group I

Date	No. 3	No. 4	No. 15	No. 21
6/ 1/55	10.70	9.80	9.90	9.70
7/19/55	11.80	8.20	8.60	7.20
8/23/55	8.80	9.20	9.10	9.30
9/14/55	8.80	8.40	8.80	8.50
11/11/55	9.60	10.60	9.90	9.70
12/16/55	10.00	8.30	7.80	7.50
1/13/56	8.80	9.40	10.00	10.20
2/16/56	10.40	9.90	10.90	10.60
3/17/56	9.90	9.50	10.40	9.60
4/14/56	9.70	9.40	9.20	9.20
5/12/56	8.90	9.50	8.10	8.30

Group II

Date	No. 34	No. 35	No. 36	No. 37
6/ 1/55	10.00	10.00	10.00	9.60
7/19/55	8.60	9.20	9.20	9.90
8/23/56	10.70	9.70	9.00	9.50
9/14/55	9.80	10.10	7.80	7.40
11/11/55	10.30	9.60	11.80	11.00
12/16/55	10.10	8.80	11.00	9.60
1/13/56	10.30	10.10	9.90	9.70
2/16/56	9.60	9.10	9.30	8.90
4/[illegible]3/56	8.20	7.40	10.30	9.30
4/14/56	8.90	8.40	10.00	8.10
5/12/56	8.70	9.00	9.30	9.20

Table XXIX (Continued)

Group III

Date	No. 23	No. 41	No. 45	No. 96	No. 99	No. 108
6/ 1/55	9.90	9.30	9.10	9.30	9.20	9.60
7/19/55	7.10	7.80	9.20	9.60	9.40	7.40
8/23/55	8.40	8.10	8.50	8.80	7.20	7.70
9/14/55	8.00	7.40	9.40	8.00	8.70	8.80
11/11/55	9.40	8.40	8.00	10.30	9.70	10.50
12/16/55	9.80	8.70	7.60	10.60	8.80	8.60
1/26/56	8.50	8.40	7.50	8.70	8.30	8.60
2/16/56	10.00	10.40	9.40	10.00	9.90	10.20
3/17/56	9.20	7.10	7.40	9.00	7.30	9.30
4/14/56	8.80	8.40	7.80	7.60	8.90	8.60
5/12/56	8.80	8.90	9.30	9.40	8.90	9.60

TABLE XXX

Blood plasma inorganic phosphorus of all bulls
Mg./100 ml.

Group I

Date	No. 3	No. 4	No. 15	No. 21
6/ 1/55	6.75	6.25	6.15	6.75
7/19/55	6.70	6.35	6.50	7.25
8/23/55	6.00	6.95	4.30	5.65
9/14/55	6.58	5.90	4.08	5.45
11/11/55	4.60	4.95	3.60	4.75
12/16/55	7.12	5.20	5.42	6.00
1/13/56	4.32	3.75	3.45	3.90
2/16/56	4.75	5.25	4.10	3.75
3/17/56	5.00	3.88	3.45	2.75
4/14/56	4.10	3.38	2.60	2.75
5/12/56	4.98	4.68	3.78	3.50

Group II

Date	No. 34	No. 35	No. 36	No. 37
6/ 1/55	5.25	6.85	4.50	5.60
7/19/55	5.15	7.45	4.30	4.40
8/23/55	3.98	4.15	3.12	3.40
9/14/55	3.40	4.50	3.90	3.15
11/11/55	7.65	6.85	5.40	5.35
12/16/55	6.12	8.15	6.18	7.90
1/13/56	4.62	6.55	4.62	5.00
2/16/56	4.80	7.90	5.50	5.70
4/13/56	4.98	4.60	5.00	3.90
4/14/56	3.55	5.20	3.02	3.75
5/12/56	5.92	5.40	4.82	4.38

Table XXX (Continued)

Group XIII

Date	No. 23	No. 41	No. 45	No. 96	No. 99	No. 108
6/ 1/55	9.60	9.40	9.35	9.85	10.35	8.10
7/19/55	10.60	11.75	9.35	10.25	10.80	8.90
8/23/55	9.15	8.65	8.25	8.40	8.85	7.88
9/14/55	8.70	8.50	8.38	7.38	9.68	8.15
11/11/55	5.38	7.50	7.82	7.02	7.78	7.35
12/16/55	8.20	7.75	8.42	7.60	8.92	9.45
1/26/56	6.02	7.45	5.70	6.25	6.85	Lost
2/16/56	6.98	6.60	6.40	7.75	7.10	8.65
3/17/56	5.90	5.25	4.70	6.75	5.35	5.32
4/14/56	3.70	4.88	4.00	4.60	4.82	4.20
5/12/56	5.12	5.80	5.65	5.35	6.40	6.20

TABLE XXXI

Results of Digestion Trial VI, Group III, January 13 - 22, 1956

Calf No.	Body Weight	Description	Dry Matter	Ash	Organic Matter	Ca.	P	E.E.	C.F.	N.
23	688.0	Intake (g.)	51550.9	2868.9	48682.0	230.8	89.1	1225.1	11031.4	817.2
		Outgo: feces (g.)	10636.6	722.2	9914.4	129.8	58.5	318.0	3064.4	80.8
		Urine (g.)				8.9	0.9			323.6
		Per cent digested	79.4		79.6		74.0	72.2		90.1
		Per cent retained				39.9	33.3			50.5
		Balance/day (g.)				9.2	2.0			41.3
		Ret/cwt/day (g.)				1.3	0.4			6.0
41	644.0	Intake (g.)	50098.1	2807.3	47290.8	227.3	85.9	1161.6	10921.5	778.3
		Outgo: feces (g.)	12524.1	681.3	11842.8	117.2	46.1	314.4	4558.8	75.7
		Urine (g.)				13.0	1.0			184.1
		Per cent digested	75.1		75.0			72.9	58.3	90.3
		Per cent retained				42.7	45.1			66.6
		Balance/day (g.)				9.7	3.9			51.8
		Ret/cwt/day (g.)				1.4	0.6			8.1
45	604.0	Intake: (g.)	50098.1	2807.3	47290.8	227.3	85.9	1161.6	10921.5	778.3
		Outgo: feces (g.)	10261.0	674.2	9586.8	134.4	44.9	290.4	30941.6	69.3
		Urine (g.)				12.0	0.9			199.4
		Per cent digested	79.5		79.7			75.0	72.1	91.1
		Per cent retained				35.6	46.7			65.5
		Balance/day (g.)				8.1	4.0			51.0
		Ret/cwt/day (g.)				1.3	0.6			8.4

Table XXXI (Continued)

Calf No.	Body Weight	Description	Matter	Ash	Organic Matter	Ca.	P.	E.E.	C.F.	N.
96	616.0	Intake: (g.)	50098.1	2807.3	47290.8	227.3	85.9	1161.6	10921.5	778.3
		Outgo: feces (g.)	16381.6	730.6	15651.0	129.4	43.9	213.0	7127.7	70.5
		Urine (g.)				13.3	1.2			382.5
		Per cent digested	67.3		66.9			81.7	34.7	90.9
		Per cent retained				37.2	47.4			41.8
		Balance/day (g.)				8.5	4.1			32.5
		Ret/cwt/day (g.)				1.4	0.6			5.3
99	614.0	Intake (g.)	41209.4	2312.2	38897.2	189.1	66.9	968.7	9262.0	613.0
		Outgo: feces (g.)	10338.9	702.0	9636.9	119.9	52.2	255.4	2800.8	77.9
		Urine (g.)				13.0	0.1			313.9
		Per cent digested	74.9		75.2			73.6	69.8	87.3
		Per cent retained				29.7	20.2			36.1
		Balance/day (g.)				5.6	1.3			22.1
		Ret/cwt/day (g.)				0.9	0.2			3.6
108	660.0	Intake (g.)	50098.1	2807.3	47290.8	227.3	85.9	1161.6	10921.5	778.3
		Outgo: feces (g.)	13467.9	707.1	12760.8	116.6	46.5	323.2	4984.5	76.7
		Urine (g.)				27.1	0.7			264.2
		Per cent digested	73.1		73.0			72.2	54.4	90.1
		Per cent retained				36.8	45.1			56.2
		Balance/day (g.)				8.4	3.9			43.7
		Ret/cwt/day (g.)				1.3	0.6			6.6

TABLE XXXII

Results of Digestion Trial VII, Group II, March 22 - 31, 1956

Calf No.	Body Weight	Description	Dry Matter	Ash	Organic Matter	Ca.	P.	E.E.	C.F.	N.
34	686.0	Intake (g.)	33522.6	643.2	32879.4	128.6	26.8	217.2	13731.1	390.6
		Outgo: feces (g.)	6506.5	407.3	6099.2	43.0	24.4	114.9	2856.4	35.3
		Urine (g.)				2.8	0.5			351.0
		Per cent digested	80.6		81.4			47.2	79.2	91.0
		Per cent retained				64.4	6.8			1.1
		Balance/day (g.)				8.3	.1			0.4
		Ret/cwt/day (g.)				1.2	.0			0.1
35	702	Intake (g.)	38252.1	852.7	37399.4	157.7	38.2	271.6	14042.3	531.5
		Outgo: feces (g.)	6352.3	323.3	6029.0	40.7	19.2	127.0	2982.4	33.3
		Urine (g.)				1.8	0.5			328.5
		Per cent digested	83.4		83.9			53.2	78.8	93.7
		Per cent retained				73.1	48.2			31.9
		Balance/day (g.)				11.5	1.8			17.0
		Ret/cwt/day (g.)				1.6	0.2			2.4

Table XXXII (Continued)

Calf No.	Body Weight	Description	Dry Matter	Ash	Organic Matter	Ca.	P.	E.E.	C.F.	N.
36	668.0	Intake (g.)	38252.1	852.7	37399.4	157.7	38.2	271.6	14042.3	531.5
		Outgo: feces (g.)	6153.6	464.6	5689.0	50.5	29.7	152.0	2117.5	41.6
		Urine (g.)				2.1	0.4			267.8
		Per cent digested	83.9		84.8			44.0	84.9	92.2
		Per cent retained				66.6	21.1			41.8
		Balance/day (g.)				10.5	0.8			22.2
		Ret/cwt/day (g.)				1.6	0.1			3.3
37	796.0	Intake (g.)	38252.1	852.7	37399.4	157.7	38.2	271.6	14042.3	531.5
		Outgo: feces (g.)	5593.3	388.2	5205.1	47.7	26.3	154.9	2079.6	34.8
		Urine (g.)				1.5	0.6			309.0
		Per cent digested	85.4		86.1			42.9	85.3	93.4
		Per cent retained				31.3	29.7			35.3
		Balance/day (g.)				4.9	1.1			18.8
		Ret/cwt/day (g.)				0.6	0.1			2.4

TABLE XXXIII

Chemical Analyses of Rations and Orts

Description of Sample	Moisture	Ash	Ca.	Phos.	Ether Extract	Crude Fiber	Protein
	%	%	%	%	%	%	%
Ration I, Spring, 1955	9.82	6.47	1.23	.50	3.02	7.18	17.75
I, Fall, 1955	6.18	4.56	.28	.24	4.63	8.02	29.48
I, Dec. 28, 1955	5.88	4.81	.27	.33	4.98	7.82	19.00
I, Mar. 17, 1956	8.41	4.55	.66	.30	4.50	8.05	17.94
Ration II, Spring, 1955	9.91	5.03	.99	.36	2.93	6.13	17.69
II, Fall, 1955	9.12	4.36	.69	.32	2.46	6.65	28.32
II, Dec. 28, 1955	6.52	5.56	.75	.19	2.36	6.41	19.38
II, Mar. 5, 1956	8.58	3.80	.60	.16	1.31	6.64	15.76
Ration III, Spring, 1955	10.18	6.51	1.10	.76	3.26	7.86	2.89
Wood Pulp, Spring, 1955	3.46	0.37	.19	.02	.00	72.30	.31
Molasses, Spring, 1955	30.89	7.21	1.02	.16	4.27	.03	3.56
Pulp-Molasses, June 6, 1956	6.32	6.28	.61	.04	.67	33.07	1.79
Orts: # 3, Nov. 18, 1955	3.21	.71	.11	.03	.60	79.46	3.17
# 3, May 4, 1956	4.34	.67	.10	.02	.54	71.70	1.61
# 4, Nov. 18, 1956	2.88	.75	.14	.04	.56	63.09	3.23
# 4, May 4, 1956	4.48	.69	.09	.24	.47	71.78	1.91
# 15, Nov. 18, 1956	2.72	.57	.14	.03	.47	67.13	2.47
# 15, May 4, 1956	5.73	1.76	.24	.06	.59	61.15	5.26
# 21, Nov. 18, 1956	2.57	0.19	.08	.02	.76	70.95	4.33
# 21, May 4, 1956	4.92	0.76	.10	.02	.56	69.00	1.92
# 34, Nov. 18, 1956	2.46	.90	.17	.04	.63	66.51	2.28
# 34, May 4, 1956	7.35	3.34	.17	.10	.59	42.68	11.25
# 35, Nov. 18, 1956	2.65	.69	.09	.02	.76	68.85	1.16
# 36, Nov. 18, 1956	2.58	0.95	.14	.03	.65	67.97	3.47
# 37, Nov. 18, 1956	2.73	0.90	.11	.04	.82	66.12	2.34

TABLE XXXIV

Analyses of Components of Digestion Trials VI and VII

Description	HOH	Ash	Ca.	Phos.	Ether Extract	Crude Fiber	Prot.
	%	%	%	%	%	%	%
Ration I	5.88	4.81	.27	.33	4.98	7.82	19.00
Ration II	8.58	3.80	.60	.16	1.31	6.64	15.76
Pulp-Molasses	6.32	6.28	.61	.04	0.67	33.07	1.79
Wood Pulp	3.46	0.37	.19	.02	0.00	72.30	0.31
Orts: No. 34	7.74	4.43	.62	.24	1.15	6.58	18.62
99	8.00	5.57	.43	.21	2.17	18.67	11.62
Feces: No. 23	76.65	6.79	1.22	.55	2.99	28.81	4.75
34	82.40	6.26	.66	.38	1.92	43.90	3.39
35	80.10	5.09	.64	.30	2.00	46.95	3.28
36	81.40	7.55	.82	.48	2.47	34.41	4.23
37	82.00	6.94	.85	.47	2.77	37.18	3.89
41	77.90	5.44	.94	.37	2.51	36.40	3.78
45	76.40	6.57	1.31	.44	2.83	29.72	4.22
96	76.25	4.46	.79	.27	1.30	43.51	2.69
99	76.70	6.79	1.16	.58	2.47	27.09	4.71
108	78.30	5.25	.87	.35	2.40	37.01	3.56
			Mg/100 ml	Mg/100 ml			Mg/ml
Urine: No. 23			4.80	.48			10.79
34			3.71	.71			29.25
35			2.34	.71			27.38
36			2.83	.55			22.31
37			1.97	.77			25.75
41			6.24	.44			6.67
45			8.00	.60			8.31
96			7.88	.81			15.93
99			8.64	.60			13.08
108			18.08	.46			11.01

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