THE INFLUENCE OF THE WINTER PLANE OF NUTRITION ON THE GROWTH RATE AND SUBSEQUENT PARTURIENT BEHAVIOR OF BEEF HEIFERS

by

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ABSTRACT

Four groups of weanling Hereford heifers were placed on four different winter planes of nutrition for a period of two years according to the following pattern:

Group I - Low plane of nutrition

Group II - Medium-low plane of nutrition

Group III - Medium-high plane of nutrition

Group IV - High plane of nutrition

During the summer seasons the heifers were kept on pasture providing the same feeding level for all animals. The one year old heifers were bred during the months of June and July. All animals were weighed weekly and feed consumption was recorded weekly.

To illustrate the growth rate of the heifers, K-values were calculated for all animals by the method of least squares and their growth curves were constructed. At the end of the second winter period all parturition data were carefully recorded and the rate of growth of the calves studied.

From the results obtained in this experiment the following conclusions can be drawn:

(1) The first post-weaning winter period is very important in regard to the feeding level of young growing heifers. The medium-low plane of nutrition (Group II) showed the best results from the economic point of view.

(2) Young heifers can be bred as yearlings if the previous winter-feeding level allows them to grow continuously and to reach at least 700 pounds body weight before the breeding period starts.

(3) The gestation period did not result in a decreased growth rate of the bred heifers.

(4) The physical difficulties of parturition in two year old heifers do not appear to be insurmountable if the winter plane of nutrition is adequate.

(5) The lactation period means a heavy drain on the young female hence a high level of nutrition must be provided in terms of sufficient amount of pasture dry matter during the grazing season.

(6) Average birth weight of calves was 62.9 pounds, being higher for bull calves than heifer calves.

(7) Pasture dry matter requirements for beef cattle may be calculated from the following equation:

$$DM = 0.17\ w^{.7}$$

(w is animal weight given in pounds)

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INTRODUCTION

A great number of feeding and breeding experiments with the domestic animals are continuously being conducted throughout the world. Livestock production is a dynamic process and research and progress in all branches of science are, each year, adding to its efficiency on farms and ranches. Efficiency is the key to production potential and through continuous research we are able to visualize new horizons, limited by present knowledge. It is the combination of hard work by farmers and the application of research efforts that help to solve so many of the problems of livestock production.

World literature in the past fifty years has accumulated a vast amount of information in the field of animal husbandry; many valuable results have been obtained in animal breeding and feeding methods, in milk, beef, wool or egg production, which can be applicable in general. But the great majority of experimental data and results are of the highest value in the environment where the experiments have been conducted. Climate, feed crops, feeds and feeding practices, breeds and breeding methods are the main factors responsible for the great variation of experimental results.

The present experiment upon which the subject of this thesis is based makes no claim for originality of concept;

many reports have already been made on the influence of the breeding age on the subsequent history of early and late bred females and many papers have been published dealing with the influence of different planes of nutrition on animal growth.

LITERATURE REVIEW

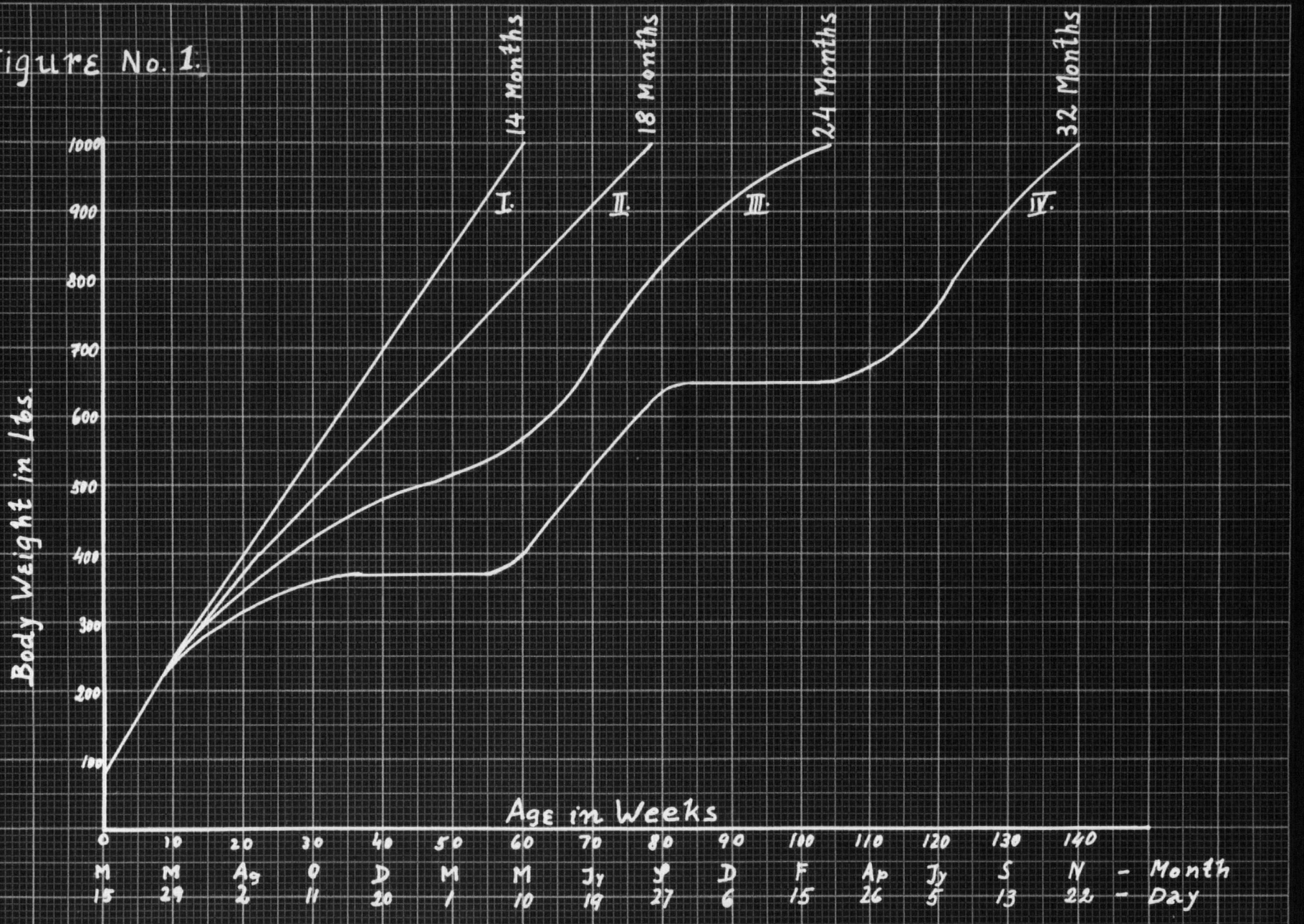
1. The Influence of Various Planes of Nutrition on Animal Growth:

The comparison of sales records from recent studies in the United States with records thirty years earlier indicates that there has been a decided trend toward the marketing of cattle at younger ages. Sales of two year-olds were comparatively few in number, since most producers are selling yearlings. Practically none of the stockmen interviewed in the study reported carrying aged steers - three or four years old, as was common in the 1920's (American Cattle Producer, Business Magazine, September 1953).

Several reasons can be given for this change: the elimination of oxen for draft purposes, the consumer's demand for higher quality beef, the use of the higher growth potential of young animals may be cited. However, the greatest influence was exerted by the results of numerous feeding trials based on the progress in animal physiology, biochemistry, biology, genetics, economics, etc. Many examples can be found in the literature indicating the various growth rates that can be expected when animals are fed on different planes of nutrition. (Guilbert, 1950; Moulton, 1953; Lush, 1930; Haecker, 1922; Amschler, 1953;).

The cost of feed is the principle factor in most cases that determines the level of animal feeding. A brief calcul-

Figure No. 1.

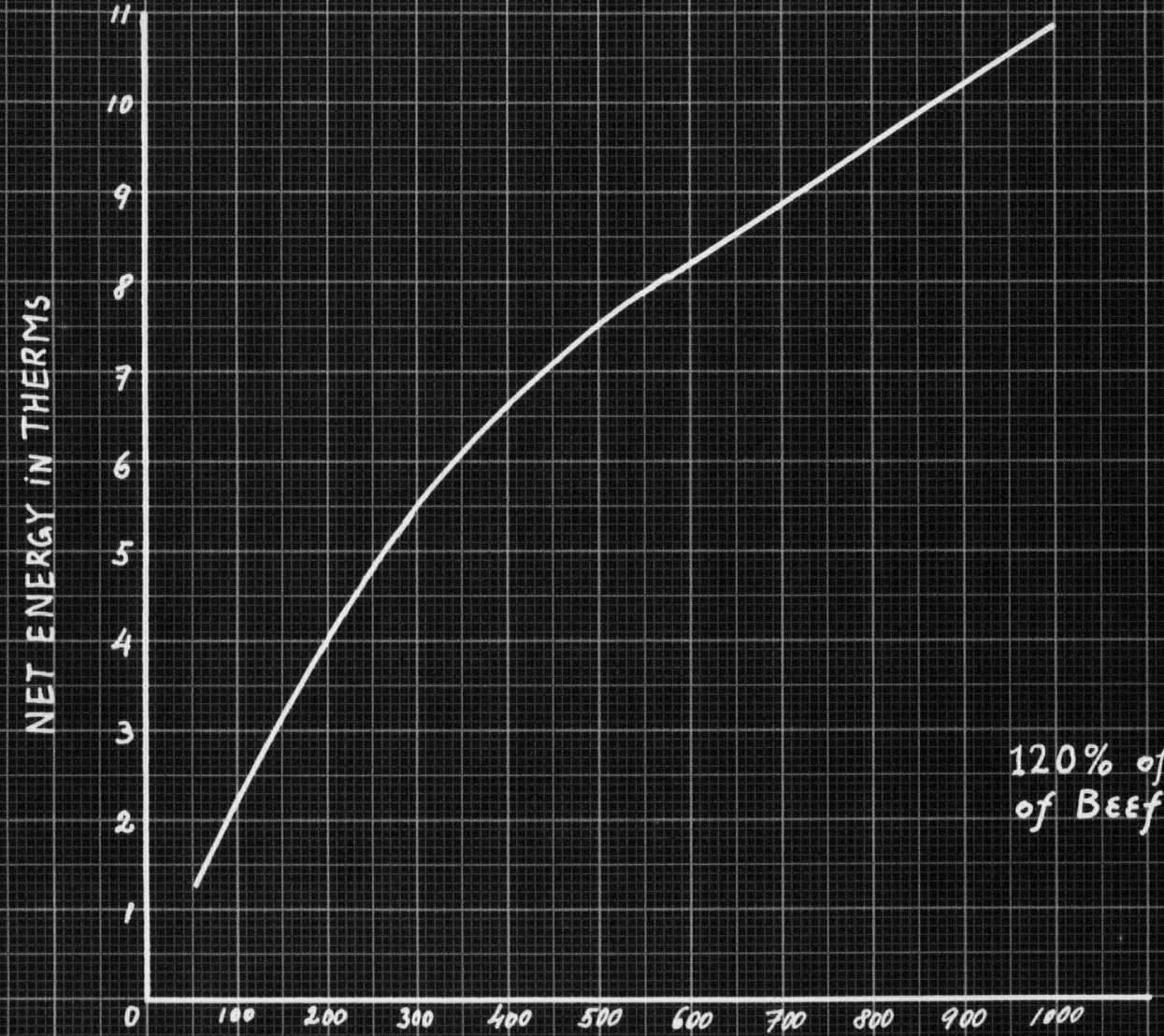


Typical Growth of Beef Cattle under Varying Environments.

ation of the total net energy cost of animal growth under different environmental conditions could be a helpful guide in facilitating the efforts of ranchers.

The maintenance cost expressed in net calories was calculated by using Brody's data for daily maintenance requirements of steers and by adding twenty per cent for the animal's activity as it is shown on Figure No. 2. Figure No. 1 represents the growth patterns of four hypothetical animals raised by different feeding practices. Curve 1 expresses maximum animal growth resulting from supplemental feeding of calves during the summer and from the highest level of nutrition during the winter period. The animal reaches a body weight of a thousand pounds when fourteen months old. The second animal is placed on a slightly lower feeding standard during the weanling winter but receives supplemental feed during the yearling summer on pasture. A thousand pounds of body weight is reached at eighteen months of age. The animal represented by curve 3 is fed only a small amount of concentrate during the winter period as a supplement to good quality hay. It reaches the same weight as the previous animals when it is 24 months old. Animal number four is raised without any supplemental feed during the winter periods, receiving only a limited amount of poor quality hay. This animal requires thirty-two months to reach the same weight.

The total amount of net calories required for the



120% of Resting Metab. of Beef Steers (Brody).

Daily Maintenance Requirement (N.E.)

Figure No. 2.

maintenance of these four animals was calculated by the method of summation of squares indicated on Figure No. 3. The total maintenance cost in net Therms obtained from such a calculation is given below:

Animal I.	3,309.6	therms.
Animal II.	4,212.4	"
Animal III.	5,612.6	"
Animal IV.	7,294.9	"

In order to arrive at more accurate figures for maintenance cost of these four animals a correction has to be made on the basis of numerous experimental results and detailed studies found in the literature.

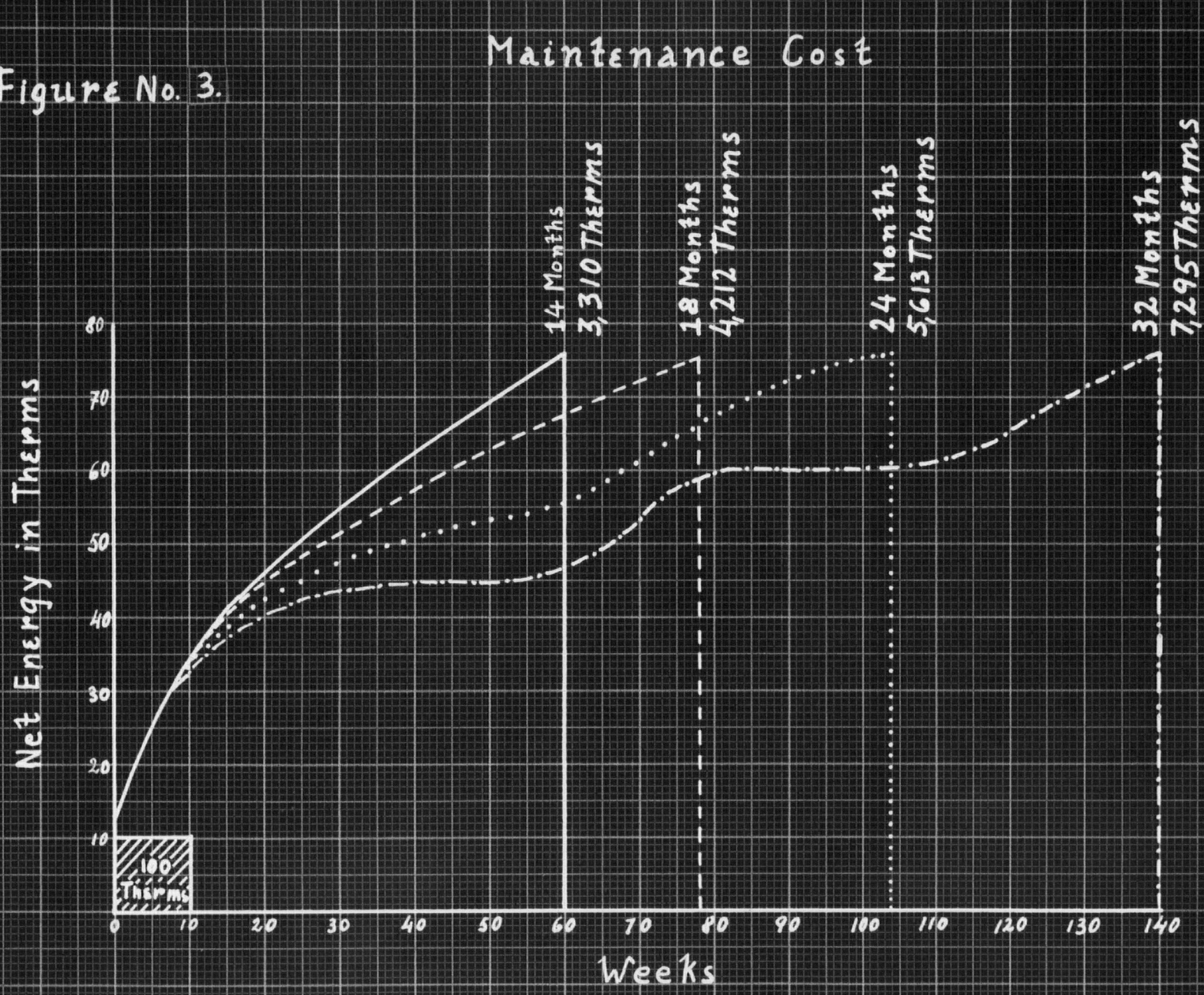
Waters (25) pointed out, that, if the ration of one animal was suddenly reduced under the normal maintenance requirements there would be a process of readjustment. If the reduction was not too severe, after a short period of time a stationary live weight would be obtained and following that there would be an increase in weight.

The Missouri Experiment (20) showed a lower maintenance requirement for animals on a low plane of nutrition.

Armsby (2) concludes that at least a part of a lower maintenance cost at the low plane of nutrition may come from "voluntary restriction of motion on the part of the animals on a low nutrition plane."

Kellner (15) has reported data showing that fat steers have a higher maintenance requirement than those in medium condition.

Figure No. 3.


Maintenance Cost
Net Energy in Therms
80
70
60
50
40
30
20
10
100 Therms
14 Months
3,310 Therms
18 Months
4,212 Therms
24 Months
5,613 Therms
32 Months
7,295 Therms
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Weeks

Results from the various experiments are given in Table No. 1.

TABLE 1

DAILY MAINTENANCE REQUIREMENTS PER 1000 POUNDS BODY WEIGHT

Missouri Experiment (Moulton)	Winter period	high plane ...	5770 Cal.
		med. plane ...	4444 Cal.
		low plane ...	4164 Cal.
	Summer period	high plane ...	5777 Cal.
		med. plane ...	4869 Cal.
		low plane ...	4408 Cal.
Armsby			5995 Cal.
Kellner			5742 Cal.
Eckles			6173 Cal.

Many feeding experiments have proved a close relationship between the amount of net energy intake and maintenance requirements: high energy intake corresponds to a high maintenance cost and a low maintenance requirement is in accordance with the low plane of nutrition (Guilbert and Loosli, (1951), Hogan, Salmon and Fox, (1952).

To harmonize our calculations with the results of numerous experiments and detailed studies it seems to be reasonable to increase the maintenance cost of animal No.1., fed on the high level of nutrition, and to decrease that of animal IV, fed on a low plane of nutrition, both about 15%.

Corrected data used for further calculations are as follows:

Animal I. 3,806 Therms.

Animal II. 4,612.4 "

Animal III. 5,612.6 "

Animal IV. 6,200.5 "

The total body weight made by all four animals is equal: 925 pounds and the requirements of net energy for this growth vary very slightly. The data of net energy stored in one pound of gain at a different age and body weight - used for the calculation - are given in Table I, Appendix V.

The results obtained in the calculations are summarized in the following Table No. 2. (for detailed tables see Appendix V, Table 2).

TABLE 2

NET ENERGY REQUIREMENTS FOR MAINTENANCE AND GROWTH

Animal	Age of Animals at 1000 Lbs. Body Wt. in Months	Total Maintenance cost in net energy Therms	Requirements for Growth in net energy Therms.	Total Net Energy cost in Therms.
1 (high plane)	14	3,806.	1,862.5	5,668.5
2 (medium high pl.)	18	4,612.4	1,770.0	6,382.4
3 (Med-low plane)	24	5,612.6	1,750.0	7,362.6
4 (low plane)	32	6,200.5	1,897.5	8,098.0

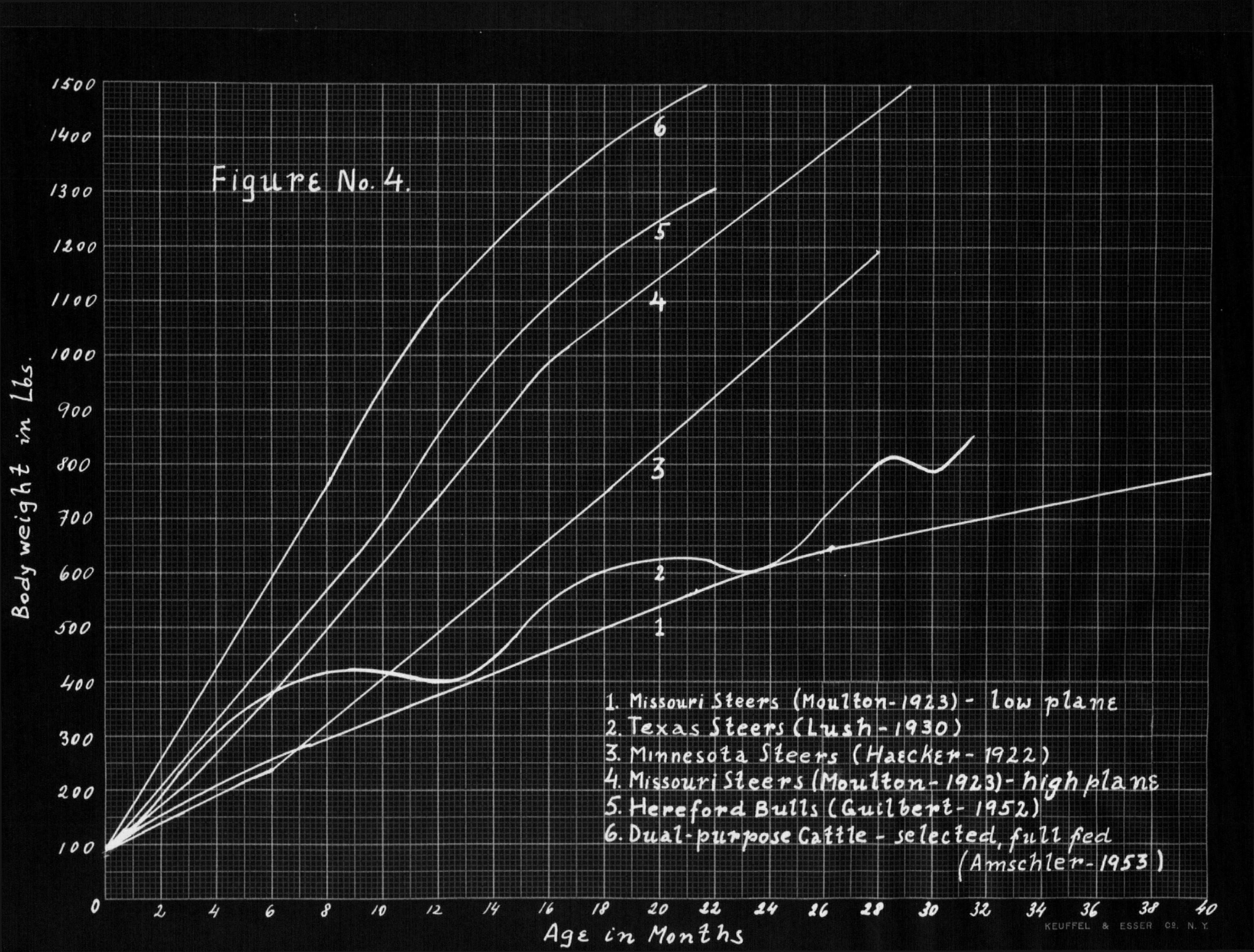


Figure No. 4.
Body weight in Lbs.
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Age in Months
1
2
3
4
5
6
1. Missouri Steers (Moulton-1923) - low plane
2. Texas Steers (Lush-1930)
3. Minnesota Steers (Haecker-1922)
4. Missouri Steers (Moulton-1923) - high plane
5. Hereford Bulls (Guilbert-1952)
6. Dual-purpose Cattle - selected, full fed
(Amschler-1953)
KEUFFEL & ESSER CO. N. Y.

From Table No. 2 it may be shown that maintenance costs make up 67.1% of the cost of producing animal No. I, 72.3% for animal No. 2, 76.2% for animal No. 3 and 76.6% for animal No. 4. It is evident that maintenance is the largest single cost in animal production. That is one of the main reasons why breeders of beef cattle are seeking so intensively new feeding methods and practices in order to restrict, as much as possible, the period of time which is required to fatten and finish an animal. The difference in total net energy cost of animal 1 and 4 is as high as 2 and one half million calories (2,429,500 cal.), which means that animal 4 will consume - expressed in pounds of feed - 5,400 pounds of hay or 2,858 pounds of concentrate or 10.12* tons of green forage more than animal 1 - in order to reach equal body weight.

Table No. 3 in Appendix V shows the production cost of those four animals as follows:

Animal No. 1	$95.50
No. 2	91.24
No. 3	85.34
No. 4	82.40

Although the production cost of animal 4 is expressed by the lowest figure, the final results favour the high level feeding method of animal No. 1. Here are some facts which

* Using the following caloric values of feed: one pound of hay - 450 calories, concentrate 850 calories, grass 120 calories.

have to be considered: the price of grain finished cattle is always higher than that of cattle finished on grass only; the shorter feeding period of animal No. 1 avoids the accumulation of unnecessary overhead costs; twice as much beef can be produced in the same period of time; fast gains and high carcass grades always go together; beef prices can be predicted with more certainty for the following spring than for a period of two or three years.

Curve No. 4 on Figure I can be considered as representative of the growth of animals intended for the breeding herd on the great majority of ranches. Actually the situation in many cases is still worse: the small amount of poor quality hay fed is not often sufficient even to maintain an equal body weight during the winter period and the animal loses weight. There is no doubt that young heifers, under such conditions, cannot be bred as yearlings when their body weight does not reach 500 pounds.

To demonstrate some of the "normal" growth patterns of beef cattle, the actual data, obtained in various feeding experiments, were plotted and the growth curves constructed on Figure No. 4. How different planes of nutrition influence the growth and body weight of animals becomes evident if we compare various body weights that the animals reached at the same age - for instance - when one year old.

1. Missouri Steers (low plane) . . . 375 Lbs in 12 months
2. Texas Steers . . . . . 405 " " " "
3. Minnesota Steers . . . . . 740 " " " "
4. California Hereford Bulls . . . . 860 " " " "
5. Austrian Dual Purpose Cattle . . 1100 " " " "

Growth curve No. I represents the poor growth of steers obtained in Group III of the Missouri experiment (20). The steers were fed on such a ration that the average daily gain during the first two years was 0.69 pounds. Curve No. 4 expresses the growth of steers on a high plane of nutrition in the same experiment. The typical growth pattern of Texas beef cattle (Hereford-Brahman) is shown by curve No. 2. All the cattle grew rapidly in the early part of the grazing season, the rate of increase in weight fell off as the season advanced. Curve No. 3 illustrates the growth of the Minnesota steers fed on a high plane of nutrition. However the feeding level was not sufficient to allow the steers to express a maximum rate of growth, as is shown in Guilbert's experiment with Hereford bulls (growth curve No. 5). The growth pattern illustrated by curve No. 6 is more or less theoretical; not very many animals under present normal conditions express their growth rate according to this curve. As Amschler states "it is the great task of modern scientific workers in animal science to improve the ration and to select the breeds which would show their rate of growth similarily to this growth curve."

The normal growth patterns of beef cattle vary to a great extent according to the environment which prevails during their production. It is true that the production and feeding methods on a great number of ranches are dictated and directed by given conditions but these methods could be changed and improved in many cases if the conservative traditional customs of ranchers would not oppose them.

2. The Effect of the Breeding Age on the Growth of the Dam, on Milk Production, on Birth Weight, and Post-natal Growth Rate of Calves

Under normal ranching conditions the young females are bred when two years old. Mumford (1921) (22) enumerates some of the opinions, wide-spread at that time among the practical breeders, on the breeding of young and immature animals:

1. The growth of the young mother is retarded.
2. The ultimate size of the young mother is diminished.
3. The offspring of young parents are smaller, less thrifty and less vigorous.
4. The continued mating of very young parents will ultimately result in decreasing the size of the race or breed.
5. The offspring of very young parents are less valuable for breeding purposes.

To bring some light on this subject Mumford carried on the experiment for ten years, breeding young swine at the youngest possible age. Body measurements, changes in weight,

feed consumption, and parturition dates were carefully recorded and compared with those obtained in the experiment with swine bred at a mature age. The results of his great work can be briefly summarized as follows:

The period of gestation has a tendency to increase the rate of growth of the female. Lactation is apparently a heavy drain on the mother, inhibiting growth, especially during the first part of the lactation period. But the smaller size of mature sows bred at an early age is not significant.

Studies at the Wisconsin Experiment Station indicate that cows which freshen while fairly young - at 22 or 23 months of age - are apt to be the most profitable throughout their period of usefulness and there was no indication of retarded growth. The findings, based on calving and production records of 253 Holstein cows from 40 herds, clearly indicate that cows which bear their first calves at about two years old or slightly less get such a head start in production that those calving for the first time at a more mature age are not able to catch up. On the other hand, it may not be desirable to bring heifers into production before at least eighteen months of age.

While the milk production records of dairy cattle are common and easy to obtain there is an entirely different situation in beef cattle because of the obvious difficulty of testing the beef cows for milk production under normal ranch conditions. The literature contains very little information

concerning the yields of milk produced by beef cows. Gowen (1920) gives the lactation records for three pure bred Aberdeen Angus cows in his report on the Maine Cross breeding experiment with dairy and beef breeds of cattle.

Knapp and Black (1941) (16) studying the factors influencing the rate of gain of Shorthorn calves during the suckling period, found that the milk consumption of the suckling calves had the greatest influence on the growth rate, greater than any other factor, as for instance birth weight, sires, dams, sex, or feed consumption. But the milk production record of the cows is not included in their report.

Cole and Johansson (1933) (6) reported the life-time milk production records of seven purebred Aberdeen Angus cows, milked twice a day. The cows were maintained under the same conditions as dairy cattle. The average milk production was about 3,000 pounds per lactation (within a range of 1000-6000 pounds).

The most detailed studies of milk and butterfat production in beef breeding herds were done by the Agricultural Experiment Station, University of Arkansas during the years 1940-1952. Gifford (1953) (8) published a total of 77 milk and butterfat records, which are based on an eight month lactation period. In this study 28 Hereford, seven Aberdeen Angus and five Shorthorn cows were used. The total milk production during one lactation period was calculated from a one day production record each month, which was obtained by hand

milking one half of the udder one day and the other half the second day.

The results of Gifford's studies are given in Table 3. It is of interest to note that in the Hereford group milk production increases until six years of age or until the fourth lactation when classified according to lactations. The greatest amount of milk was produced by a two year old Aberdeen Angus cow which was milked twice a day after she lost her calf. She produced 2,544 pounds of milk and 100 pounds of butterfat in 244 days. The lowest record of milk and butterfat production was obtained from Hereford cows, being about 675 pounds lower than the average production of Aberdeen Angus and Shorthorns.

Table No. 4 taken from Gifford's report presents the daily milk production of cows in an eight month period and the average daily gain in body weight of their calves. The highest daily milk production was observed during the first month of lactation among the Shorthorn and Hereford cows. The Aberdeen Angus cows showed the highest production during the second month of lactation. In all three breeds the milk production steadily decreased to about one half of the amount in the eighth month of lactation. The Hereford calves made good average gains even though the average daily milk production of their dams are ranged from 8.5 pounds during the first month to 4.1 pounds during the eighth month.

TABLE 3

LACTATION RECORDS OF BEEF COWS ACCORDING TO AGE

Classification	Hereford Production of		Aberdeen-Angus Production of		Shorthorn Production of	
Age in years	Milk	Butterfat	Milk	Butterfat	Milk	Butterfat
	Lbs		Lbs		Lbs	
2 - 3	1,195	35.	1,470	48.3	1,696	49.7
3 - 4	1,160	37.7	1,990	61.1	2,322	76.0
4 - 5	1,455	44.9	2,267	82.1	1,541	34.8
5 - 6	1,412	44.	1,802	66.6	2,128	58.2
6 - 7	1,575	46.5	2,389	85.		
7 and over	1,255	34.8	2,458	88.4		
Lactation						
first	1,175	34.2	1,470	48.3	1,696	49.7
second	1,266	37.8	2,102	69.9	2,390	75.1
third	1,474	44.9	2,159	81.5	2,153	73.5
fourth	1,589	48.4	2,491	50.1	1,541	34.8
fifth	1,324	34.1	2,389	85.	2,134	37.2
Six and later	1,168	34.9	2,458	88.4		
Average: all records	1,303	38.5	1,972	68.7	1,983	58.7

TABLE 4

AVERAGE DAILY MILK PRODUCTION OF COWS AND DAILY GAIN IN BODY WEIGHT OF THEIR CALVES

Months	Hereford		Aberdeen-Angus		Shorthorn	
	Average Daily Milk Production	Average daily gain in calf's weight	Average Daily Milk production	Average daily gain in calf's weight	Average Daily Milk Production	Average daily gain in calf's weight
	Pounds		Pounds		Pounds	
1	8.52	1.27	9.53	1.79	14.55	1.46
2	7.67	1.09	10.08	1.42	11.03	2.13
3	7.26	1.41	9.41	1.28	9.53	1.65
4	6.07	1.47	9.01	1.53	8.03	2.09
5	5.25	1.59	7.85	1.66	8.59	1.66
6	4.79	1.49	7.59	1.32	8.83	1.76
7	4.80	1.59	7.97	1.56	6.52	1.25
8	4.14	1.58	6.83	1.79	6.38	1.56
Mean	6.06	1.44	8.54	1.54	9.18	1.69

According to Gifford there is a considerable degree of correlation between the quantity of milk produced daily by the dams and the daily gains in weight of their suckling calves during the first four months. The correlation coefficients are expressed by the following figures: .60, .71, .52, .35 respectively. During the following four months the correlations are smaller and not significant.

There are still other important problems which are often discussed by beef cattle breeders in regard to milk production of dams and milk consumption of their calves, for instance:

How much milk does a calf need for its maximum growth?

Is the milk production of beef cows sufficient to allow the maximum growth rate of their calves?

Is there any relationship between the milk production of a dam and the growth rate of a calf in the post weaning period?

What are the main factors influencing the milk production of a beef cow?

Some of these problems have already been partially solved but many others require intensive careful investigation.

Ragsdale and Herman (24) reported that when 5 veal calves were reared by the nurse cow method, they averaged 1 pound of gain for each 9.4 pounds of milk consumed. These calves gain approximately 2 pounds daily, therefore, it can be

assumed that the milk consumption was only 18.8 pounds daily.

Similar results were obtained by Beckdel (3) in his experiment with veal calves; 9.4 pounds of milk was required by the calves to make 1 pound of gain. The results from Gifford's experiment show that the amount of milk required by the calves per 1 pound of gain was much lower - being 6.2, 6.5 and 6.9 pounds of milk consumed by Hereford, Aberdeen Angus, and Shorthorn calves respectively.

Yapp and Nevens (28) suggest that 1 pound of milk should be fed daily to a calf for each 10 pounds of body weight, up to the maximum of 15-18 pounds daily. According to Peterson (23) daily milk consumption of a young calf should be 8% of its total weight.

In Gifford's experiment with beef cattle it was found that the milk available to the calves daily - in percentage of their body weight - was as follows: Hereford 10%, Aberdeen-Angus 12.6%, and Shorthorn 15.3%. The average birth weight of the calves was 66 - 53 - 74 pounds respectively.

It seems to be reasonable to conclude that the maximum daily consumption ability of the calves is one of the factors which determines the upper limit in milk production of the highest producing beef cows. If the mammary gland is not emptied at each suckling it is logical to assume that the back-pressure of residual milk will result in diminished subsequent milk output.

The effect of milk production of dams on the growth of their heifer-calves during the post-weaning time has been studied by Gifford. A highly significant correlation has been found between the milk production of dams and the body weight of heifer-calves up to 36 months of age:

The correlation coefficients were: .82, .69, .53, .55 at the age of 8 - 12 - 24 - 36 months respectively.

The following table shows the mean weights of 20 heifers from Gifford's experiment, divided into 3 groups according to the production levels of their dams.

TABLE 5

THE RELATION OF CALF GROWTH RATE TO MILK OUTPUT OF THE DAM

Lactation Period: Milk Lbs.	Average Weight of Heifers in Pounds					
	Birth	4 Mos.	8 Mos.	12 Mos.	24 Mos.	36 Mos.
738	65	182	299	423	741	802
1,322	64	210	397	485	758	899
1,894	65	222	422	523	876	911

EXPERIMENTAL

1. General Outline

Four groups each consisting of seven weanling Hereford heifers were placed on four planes of nutrition on November 23, 1953 and were carried on the four selected levels of feeding until May 1, 1954. A period of one week was allowed for the animals to change from a dry ration to pasture. Then all the animals were placed on adequate pasture until October 13, 1954. The heifers were bred during the months of June and July. During the second winter the bred yearling heifers were again divided into the four original groups and fed on the four planes of nutrition. The second pasture period was the fourth and final phase of this Beef Cattle Research Project and the experiment was terminated on July 31st, 1955.

2. Planes of Nutrition

(A) First Winter Period

The feeding pattern for the four groups of heifers was designed according to the following sequence:

Group I. fed on a low plane of nutrition

Group II. fed on a medium low plane of nutrition

Group III. fed on a medium high plane of nutrition

Group IV. fed on a high plane of nutrition.

(a) Low Plane of Nutrition: - this level of feeding was computed to represent the normal ranch wintering procedure. The heifers in this group were offered alfalfa-grass hay of better than average quality to the limit of appetite. It was estimated that the hay intake would approximate that given in Table 6. Iodized salt was offered free choice.

TABLE 6

ANTICIPATED HAY INTAKE OF LOW PLANE GROUP

Body Weight Pounds	Pounds of Hay per day	Pounds of T.D.N. per day
400	11.2	5.4
425	11.9	5.7
450	12.6	6.0
475	13.3	6.4
500	14.0	6.7

This ration was considered inadequate with respect to protein and energy content. Normal growth was not expected.

(b) Medium Low Plane of Nutrition: - this level of feeding was designed to yield a slight, positive gain over the wintering period. Hay intake was restricted to a specified level at each body weight to conserve on roughage used and to permit adequate intake of supplementary feed. Iodized salt was offered free choice. The feeding standard followed is given in Table 7.

TABLE 7

FEEDING STANDARD USED FOR MEDIUM LOW PLANE GROUP

Body Weight Pounds	Pounds of Hay per Day	Pounds of Supplement "B" per Day	Calculated Pounds of T.D.N. per day
400	9.0	1.5	5.5
425	9.0	1.7	5.6
450	9.0	2.0	5.8
475	9.6	2.0	6.1
500	9.6	2.3	6.3
525	9.6	2.5	6.4
550	9.6	2.9	6.7

This feeding level was based on Morrison's lower recommendations of requirements for wintering beef calves to gain 0.75 to 1.0 pounds per day.

(c) Medium High Plane of Nutrition: - this level of feeding was designed to promote a medium degree of growth and anticipated a daily rate of gain of approximately 1.0 to 1.25 pounds per day. Iodized salt was offered free choice. The feeding standard designed to produce this rate of gain is given in Table 8.

TABLE 8

FEEDING STANDARD DESIGNED TO PRODUCE A RATE OF GAIN of 1.0 to 1.25 POUNDS PER DAY - MEDIUM HIGH PLANE GROUP

Body Weight Pounds	Pounds of Hay per Day	Pounds of Supplement "B" per Day	Calculated Pounds of T.D.N. per Day
400	9.0	2.7	6.3
425	9.0	3.0	6.5
450	9.0	3.2	6.6
475	9.6	3.5	7.1
500	9.6	3.8	7.3
525	9.6	4.1	7.5
550	9.6	4.4	7.7
575	10.5	4.1	8.0

(d) High Plane of Nutrition: - the feeding standard for this group was considered to be improvidently high but was included to give the upper maximum of growth rate. It was anticipated that it would produce a mean rate of gain of 1.5 pounds per day throughout the wintering period. It was anticipated that the heifers in this group would not only achieve maximum growth rate but would also fatten. The proposed feeding standard is given in Table 9.

TABLE 9

FEEDING STANDARD DESIGNED TO PRODUCE A RATE OF GAIN OF 1.5 POUNDS PER DAY HIGH PLANE GROUP

Body Weight Pounds	Pounds of Hay per Day	Pounds of Supplement "A" per Day	Calculated Pounds of T.D.N. per Day
400	4.0	9.6	8.2
425	4.0	10.2	8.6
450	4.0	10.8	9.0
475	4.0	11.4	9.4
500	4.0	12.0	9.8
525	4.0	12.6	10.2
550	4.0	13.2	10.6
575	4.0	13.8	11.0
600	4.0	14.4	11.4
625	4.0	15.0	11.8
650	4.0	15.6	12.1
675	4.0	16.2	12.5
700	4.0	16.8	12.9

The concentrate pellets were formulated as shown in Table I - Appendix IV. and were pelleted through a S.W. pellet mill to yield 1/4" cylindrical pellets having an apparent density of 0.98.

The proximate composition of concentrate and hay is given in Table II - Appendix IV.

B. Second Winter Period

The basis for the calculation of the four planes of nutrition for the second winter period was Morrison's Feeding Standard (1948) and his estimate of dry matter intake in animals in this weight range. This feeding standard was taken as the high plane of nutrition. For the Medium-high plane 90% of the

TABLE 10

FEEDING STANDARD ON A PER-ANIMAL-PER-DAY BASIS

SECOND WINTER PERIOD

Body Weight	TDN in #	Low Plane 70% TDN		Medium-low Plane 80% TDN			Medium-high Plane 90% TDN			High Plane 100% TDN		
		TDN#	Hay#	TDN#	Hay#	Concentrate #	TDN#	Hay#	Concentrate #	TDN#	Hay#	Concentrate #
700	11.6	8.1	16.2	9.3	12.0	5.0	10.4	8.0	9.9	11.6	4.0	14.8
25	11.8	8.3	16.6	9.5	12.3	5.1	10.6	8.2	10.1	11.8	4.1	15.1
50	12.1	8.5	17.0	9.7	12.6	5.2	10.8	8.4	11.3	12.1	4.2	15.4
75	12.3	8.7	17.4	9.8	12.8	5.3	11.1	8.6	10.5	12.3	4.3	15.7
800	12.5	8.8	17.6	10.0	13.1	5.4	11.3	8.8	10.7	12.6	4.4	16.0
25	12.8	8.9	17.8	10.2	13.3	5.5	11.5	9.0	10.9	12.8	4.5	16.3
50	13.0	9.1	18.2	10.4	13.6	5.6	11.7	9.1	11.1	13.0	4.5	16.6
75	13.2	9.3	18.6	10.6	13.9	5.7	11.9	9.3	11.3	13.2	4.6	16.9
900	13.5	9.5	19.0	10.8	14.1	5.8	12.1	9.4	11.5	13.5	4.7	17.1
25	13.7	9.6	19.2	10.9	14.4	5.8	12.3	9.6	11.7	13.7	4.8	17.4
50	13.9	9.8	19.6	11.2	14.6	5.9	12.5	9.8	11.9	13.9	4.9	17.7
75	14.2	9.9	19.8	11.3	14.9	6.0	12.7	10.0	12.1	14.2	5.0	18.0
1000	14.4	10.1	20.2	11.5	15.2	6.1	12.9	10.2	12.3	14.4	5.1	18.3
25	14.6	10.2	20.4	11.7	15.4	6.2	13.2	10.4	12.5	14.6	5.2	18.6
50	14.8	10.4	20.8	11.9	15.7	6.2	13.4	10.6	12.7	14.8	5.3	18.9
75	15.1	10.5	21.0	12.1	16.0	6.3	13.6	10.7	12.9	15.1	5.4	19.2
1100	15.3	10.7	21.4	12.2	16.2	6.4	13.8	10.9	13.1	15.3	5.5	19.4
25	15.6	10.8	21.6	12.4	16.5	6.5	14.0	11.1	13.3	15.6	5.6	19.7
50	15.8	11.0	22.0	12.6	16.8	6.6	14.2	11.3	13.4	15.8	5.6	20.1
75	16.0	11.2	22.4	12.8	17.0	6.7	14.4	11.5	13.6	16.0	5.7	20.3
1200	16.3	11.3	22.6	13.0	17.3	6.8	14.6	11.6	13.8	16.3	5.8	20.7

High plane was used, for the Medium-low plane 80% and for the Low plane 70%, expressed in pounds of T.D.N. The feeding standard is given in Table 10.

3. Experimental Results and Discussion:

The results obtained in this experiment are presented in a chronologic sequence according to feeding periods as follows:

A first winter period

B first pasture period

C second winter period

D second pasture period

The growth curves of all experimental animals are given in Appendix I. The regression lines were calculated by the method of least squares. Weekly body weight records of all experimental animals can be found in Appendix II. Feed consumption data are given in Appendix III.

A. First Winter Period:

Table 11 contains the body weights of weanling heifers at the beginning of the experiment, their gain in weight during the winter-feeding period and the average daily gain - according to the four groups. Because neither age nor birth weight of the heifers was known, equal body weights of the animals were used as the basis for comparison of daily gain, daily feed intake and of the feed efficiency among the groups - as it is evident from Tables 12 - 15.

The highest daily gain during the winter period was made by group IV on the high plane of nutrition. The rate of gain expressed in percentage of the average body weight was .271% in comparison with group I, II, III, showing the rate of gain .140%, .162% and .192% respectively.

The results of the feed efficiency, presented in Table 14, are in agreement with the basic principle, that as an animal becomes heavier its feed efficiency becomes lower, which means that more feed is required per one pound of gain made. A discrepancy can be observed in group III - at the body weight of 450 and 500 pounds, the efficiency of feed expressed in pounds of T.D.N. is 7.1 and 6.4 respectively. The figure 7.1 does not represent the average of the whole group as it was calculated for 3 animals only. The remainder of the animals of this group were heavier at the beginning of the experiment. A similar case occurred in Group IV at the body weight of 650 pounds - which was reached by 3 animals only.

Assuming that the hay contains 50% T.D.N. and the concentrate 65% T.D.N., the highest feed efficiency per 1 pound of gain was shown by the animals in Group IV, fed a ration containing a high amount of concentrate.

Table 15 indicates the cost of feed required by animals per 1 pound of gain at different body weights, for instance: at 500 pounds of body weight the feed cost per 1 pound of gain varies very slightly; a greater difference in cost can be observed at 550 or 600 pounds of body weight; the most expensive gain was made by Group IV.

TABLE 11

GAIN IN BODY WEIGHT DURING THE FIRST WINTER PERIOD
(WEIGHT GIVEN IN LBS.)

	Heifer No.	K-Value	Body Weight Begin.	Body Weight End	Gain In 161 days	Average Daily gain
Group I	30	.001753	432	572	140	.87
	31	.001157	513	618	105	.65
	32	.001441	470	592	122	.76
	33	.001486	441	561	120	.75
	34	.001483	503	639	136	.85
	35	.000781	419	476	57	.35
	36	.001702	446	586	140	.87
		Total	3224	4044	820	5.10
		Average	460.5	577.7	117	.73
Group II	37	.001509	501	639	138	.86
	38	.001742	417	552	135	.84
	39	.001473	473	599	126	.78
	40	.001658	444	580	136	.84
	41	.001393	444	556	112	.70
	42	.002071	400	558	158	.98
	43	.001517	454	579	125	.78
		Total	3133	4063	930	5.78
		Average	447.6	580	132.9	.83
Group III	44	.002016	486	673	187	1.16
	45	.002270	483	697	214	1.33
	46	.001880	495	670	175	1.09
	47	.001737	449	595	146	.91
	48	.001641	426	555	129	.80
	49	.001797	459	613	154	.96
	50	.002062	432	602	170	1.06
		Total	3230	4405	1175	7.31
		Average	461.4	629.3	167.9	1.04
Group IV	51	.003028	435	708	273	1.70
	52	.002592	441	646	205	1.39
	53	.001654	465	608	143	.89
	54	.003371	472	813	341	2.12
	55	.003163	429	715	286	1.78
	56	.002544	429	646	217	1.35
	57	.002643	405	620	215	1.34
		Total	3076	4756	1680	10.57
		Average	439.4	679.4	240	1.51

TABLE 12

DAILY GAIN AT DIFFERENT BODY WEIGHTS IN LBS

Group	450	500	550	600	650
I	.741	.798	.827		
II	.772	.812	.893		
III	.816	.958	1.053	1.176	1.336
IV	1.257	1.445	1.589	1.628	1.911

TABLE 13

DAILY FEED INTAKE PER ANIMAL AT DIFFERENT BODY WEIGHTS IN LBS

Group No.	450		500		550		600		650	
	Hay	Concent.	Hay	Concent.	Hay	Concent.	Hay	Concent.	Hay	Concent.
I	9.3		12.9		15.3					
II	7.5	2.	9.	2.3	9.6	2.9				
III	7.5	3.2	8.	3.7	9.6	4.1	10.5	5.		
IV	2.	9.	4.	10.	4.	13.2	4.	14.4	4.	16.6

TABLE 14

FEED EFFICIENCY PER 1 POUND OF GAIN AT DIFFERENT BODY WEIGHTS - IN LBS.

Group	450		*	500			550			600			650		
	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN
I	12.6		6.3	16.2		8.1	18.5		9.3						
II	9.7	2.6	6.5	11.1	2.8	7.3	10.8	3.3	7.5						
III	9.2	3.9	7.1	8.4	3.9	6.4	9.1	3.9	7.	8.9	4.3	7.3			
IV	1.6	7.2	5.5	2.8	6.9	5.9	2.5	8.3	6.7	2.5	8.8	7.	2.1	8.7	6.8

* Assuming that hay contains 50% TDN and concentrate contains 65% TDN

TABLE 15

COST OF FEED PER 1 POUND OF GAIN AT DIFFERENT BODY WEIGHTS IN CENTS *

Group	450	500	550	600	650
I	12.6	16.2	18.5		
II	14.9	16.7	17.4		
III	17.	16.2	16.9	17.5	
IV	16.	16.6	19.1	20.1	19.5

* Price of feed used in calculation:

1 ton of hay $20.00
1 ton of concentrate... 40.00

TABLE 16

FIRST WINTER FEEDING PERIOD: SUMMARY OF RESULTS

WEIGHT GIVEN IN LBS.

Group	Number of Animals	Average Body Wgt at the Begin.	Average Body Wgt at the End.	Total Gain per Animal	Total Gain per Group	Total feed consumption per group in Lbs. Hay	Total feed consumption per group in Lbs. Concen.	Cost of Feed $	Feed Efficiency per 1 Lb. of gain Hay	Feed Efficiency per 1 Lb. of gain Conc.	Feed Efficiency per 1 Lb. of gain TDN.
I	7	460.5	577.7	117.	820.	14,840		148.40	18.1		9.1
II	7	447.6	580.	132.9	930.	10,220	2,681	155.82	11.	2.9	7.4
III	7	461.4	629.3	167.9	1175.	10,269	4,578	194.25	8.7	3.9	6.9
IV	7	439.4	679.4	240.	1680.	3,871	12,880	296.31	2.3	7.7	6.1

Cost of 1 Pound of Gain:

¢ 18.	...	Group I
¢ 16.8	...	Group II
¢ 16.5	...	Group III
¢ 17.6	...	Group IV

A summary of the results obtained during the first winter period is given on Table 16. The animals of Group IV, were one hundred pounds heavier than those of Group I and the difference in body weight of the animals in Groups II and III was approximately 50 pounds. A very small difference was shown between Groups I and II - resulting from a lower body weight of Group II at the beginning of the feeding period and from a high quality hay fed. It could be safely concluded that the difference between these two groups would be much more noticeable under normal ranching conditions, where poor quality hay is fed in most cases.

Using the given purchase prices for feed ($20. per 1 ton of hay, $40. per 1 ton of concentrate) the most expensive gain was made by the animals of Group I (18¢); Group IV comes second (17.6¢); Group II occupies the third place and the cheapest gain was shown by Group III.

A further analysis of production cost is given in a tabulated form:

TABLE 17

COST OF ADDITIONAL GAIN IN BODY WEIGHT

Group	Total Gain Lbs	Total Feed $	Additional gain Lbs	Additional cost $	Additional cost per 1 pound ¢
I	820	148.40			
II	930	155.82	50	7.42	14.8
III	1175	194.25	245	38.43	15.7
IV	1680	296.31	505	102.06	20.2

The production cost of the additional gain in Group III varies only slightly from that of group II. The level of feeding would be fully justified if the producer would intend to sell the breeding stock. He could expect a higher price for the animals of Group III because of their better condition and appearance.

To support the conclusions concerning the advantages of high feeding practices of beef cattle, made at the beginning in this thesis, let us compare the cost of additional gain of Group IV with the production cost of Group I.

Group	Total Gain Lbs	Total Cost $	Additional Gain Lbs	Additional Cost $	Additional Cost per 1 Pound ¢
I	820	148.40			
IV	1680	296.31	860	147.91	17.2

It is evident that twice as much beef was produced in the same period of time in Group IV and the production cost of 1 pound of gain was slightly lower than in Group I.

B. First Pasture Period

During a period of one week which was allowed for the animals to adapt themselves from a dry ration to the pasture, the heifers were fed a gradual increasing quantity of grass. On May 7, 1954 all the animals were placed together on pasture and changes in body weight were recorded weekly. The pasture period lasted 160 days. The gain in weight made by the animals

during this period is recorded on Table No. 18. The highest rate of gain was observed in Group II being 1.53 pounds per day. The highest total gain made by Group II, was 1,716 pounds; that of the three remaining groups in descending order was 1,630 pounds for Group III, 1,580 pounds for Group I, and 1,032 pounds for Group IV. If we compare the average daily gain made by the animals at equal body weight we find that at 650 pounds of body weight the highest daily gain was shown by the animals of Group I. This high rate of growth occurred during the first few weeks on pasture. Later on Group II occupied the first place in regard to rate of gain as indicated in Table No. 19. The influence of pasture on growth of the animals is most evident from the growth curves. Group I fed on the low plane of nutrition showed the highest increase in weight during the first seven weeks. This increase in weight is also noticeable on the growth curves of the animals in Group II but in a smaller degree. The animals of Group IV fed on the high plane of nutrition showed, at the beginning of the pasture period, a decrease in rate of growth. This indicates that the pasture alone for this group meant a lower plane of nutrition than their winter feeding standard. The sudden loss in body weight after the seventh week on pasture that is visible on the majority of the growth curves can probably be explained by the animals running about wildly when frightened by the noise of shot guns in the vicinity.

TABLE 18

GAIN IN BODY WEIGHT DURING THE FIRST PASTURE PERIOD

(WEIGHT GIVEN IN LBS.)

	Heifer No.	K-Value	Body Weight at the Begin.	End	Gain in 160 Days	Average Daily Gain
Group I	30	.004061 .001888	576	774	198	1.24
	31	.004071 .002278	619	862	243	1.52
	32	.004123 .002493	597	865	268	1.68
	33	.003289 .002063	596	783	214	1.34
	34	.004098 .003104 .002526	637	904	267	1.67
	35	.003020 .002386	473	655	182	1.14
	36	.003759 .001932	603	811	208	1.30
		Total	4074	5654	1580	9.89
		Average	582	807.7	225.7	1.41
Group II	37	.002887 .002283	652	874	222	1.39
	38	.004810 .002519	576	856	280	1.75
	39	.002178	607	853	246	1.54
	40	.003980 .002488	571	820	249	1.56
	41	.003769 .002316	574	827	253	1.58
	42	.002275	589	824	235	1.47
	43	.003625 .002373	607	838	231	1.44
		Total	4176	5892	1716	10.73
		Average	596.6	841.7	245.1	1.53

TABLE 18 (CONTINUED)

	Heifer No	K-Value	Body Weight at the Begin.	End	Gain in 160 days	Average Daily Gain
Group III	44	.003825 .001767	642	876	234	1.46
	45	.002868 .002130	697	954	257	1.61
	46	.003161 .001987	668	879	211	1.32
	47	.001821	609	796	187	1.17
	48	.003381 .002024	566	775	209	1.31
	49	.003345 .002182	601	833	232	1.45
	50	.004942 .002651	593	893	300	1.88
		Total	4376	6006	1630	10.20
		Average	625.1	858	232.9	1.46
Group IV	51	.002699 .001279	682	835	153	.96
	52	(Died)				
	53	.004929 .002514	595	880	285	1.78
	54	.002474 .001150	764	923	159	.99
	55	.001583	709	896	187	1.17
	56	.001420	649	801	152	.95
	57	.001962 .002317	621	717	96	.60
		* Total	4020	5052	1032	6.45
		Average	670	842	172	1.08
	* Corrected for 6 Animals		4690	5894	1204	7.53

TABLE 19

DAILY GAIN AT DIFFERENT BODY WEIGHTS IN LBS.

Group	650	700	750	800
I	2.535	1.492	1.648	1.846
II	2.184	1.643	1,761	1.878
III	2.092	1.519	1.554	1.672
IV	1.911	1.459	1.367	1.483

TABLE 20

FIRST PASTURE PERIOD : SUMMARY OF RESULTS

WEIGHT GIVEN IN LBS

Group	Number of Animals	Body Weight at Begin.	Body Weight at End.	Total Gain Per Animal	Total Gain Per Group	Average Daily gain per animal	No. of Acres
I	7	582.	807.7	225.7	1,580.	1.41	
II	7	596.6	841.7	245.1	1,716.	1.53	14
III	7	625.1	858.	232.9	1,630	1.46	
IV	6	670.	842.	172.	1,032.	1.08	

Total:	5,958 Lbs	14 Acres
Lbs of Beef per acre	425.5 Lbs	

As can be seen on Table No. 20 the total gain made by all groups during the grazing season on fourteen acres of pasture consisted of 5,958 pounds. This accounted for 425.5 pounds of beef production per acre of pasture.

If we consider winter feeding and pasture as one production period the resulting calculation shows the most profitable level of feeding for wintering of weanling heifers. Assuming that the cost for all four groups is constant except for feed during the winter the final difference in production cost becomes more evident at the end of the pasture period. Table No. 2 compares the additional gain and its cost among the groups.

TABLE 21

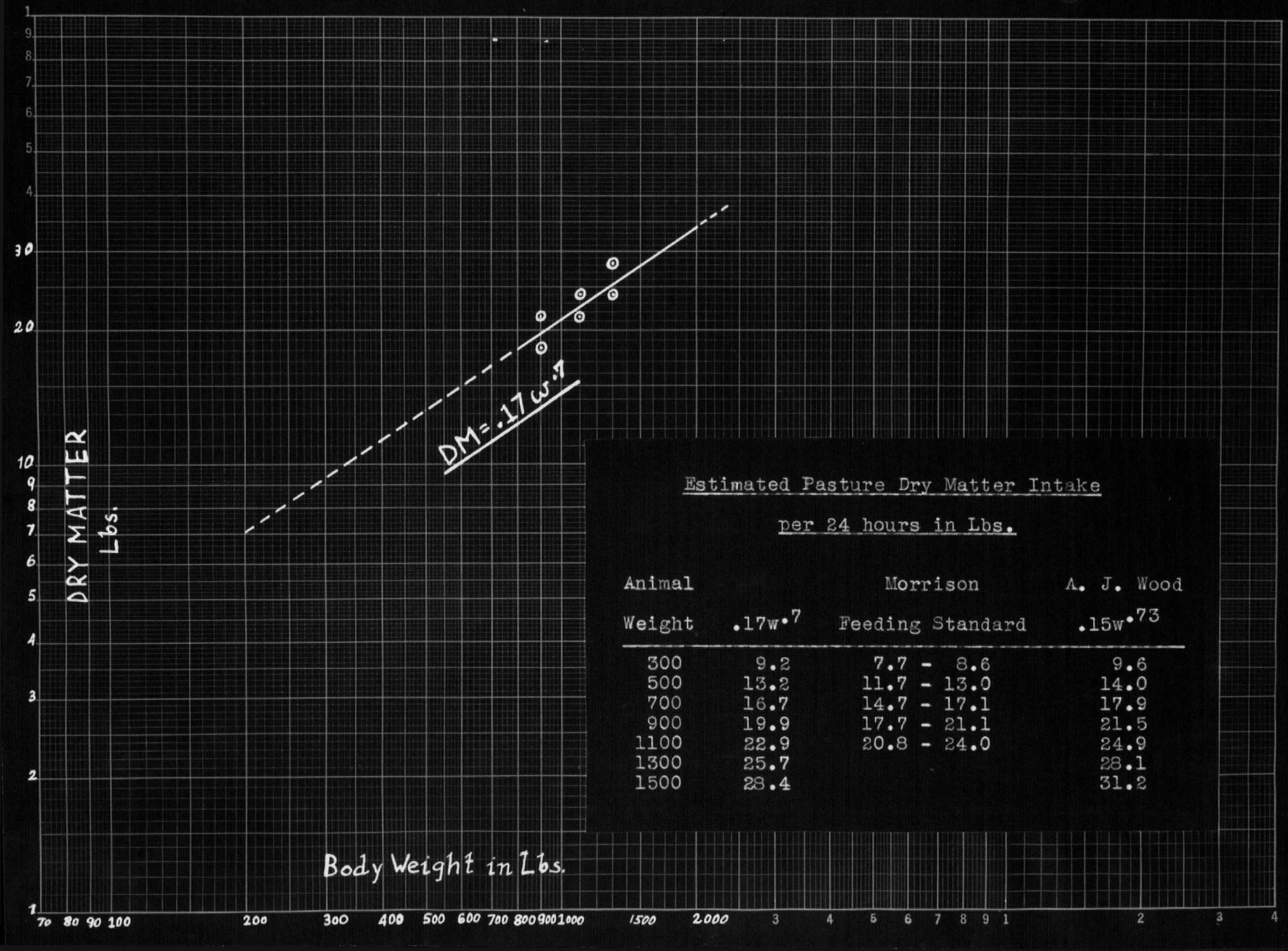
Group	Average Body Weight	Total Gain Pounds	Additional Gain - Lbs	Cost of Feed	Cost of Additional Gain $
I	808	2380		148.40	
II	842	2646	266	155.82	7.42
III	858	2863	217	194.25	38.43
IV	842	2856	7	296.31	102.06

The additional gain of 266 pounds of the animals in Group II increased the total cost of feed by $7.42, while the cost of additional gain in Group III was much higher $38.43. This higher level of nutrition would be justified only if the rancher would intend to sell the bred heifers at the end of the pasture period. He could expect a better price for the animals of Group III than for those of Group II as a result of

slightly better appearance. On the other hand if the breeder wants to keep the heifers for his own breeding stock the most profitable winter feeding level would be those of Group II which made the best use of the pasture. There was no significant difference in body weight between the animals of Group II and Group III at the end of the pasture period.

The problems of management during the summer are simple in comparison with those arising during the winter. As soon as pastures turn green the feeding problems are largely solved because grass is an ideal ration for young growing animals. Grass alone ordinarily provides a satisfactory ration during the grazing season. Therefore the emphasis on the maximum use of pasture in beef production is very important. "Grass is the cheapest source of nutrients for bovines, especially when it is consumed in situ" (Hamilton 1952). Therefore, the main duty of the rancher must be to make an effort to manage his pastures in such a way that the animals can make the best use of them and express the maximum growth during the grazing season. An important problem which frequently arises on ranches is whether or not the animals obtain a sufficient amount of grass during the grazing season.

To solve this problem for our experiment a calculation was made in order to determine the pasture dry matter requirements of all experimental animals. The calculation was based on the results of an experiment with the Shorthorn cows



Estimated Pasture Dry Matter Intake

per 24 hours in Lbs.

Animal Weight	.17w$^{.7}$	Morrison Feeding Standard	A. J. Wood .15w$^{.73}$
300	9.2	7.7 - 8.6	9.6
500	13.2	11.7 - 13.0	14.0
700	16.7	14.7 - 17.1	17.9
900	19.9	17.7 - 21.1	21.5
1100	22.9	20.8 - 24.0	24.9
1300	25.7		28.1
1500	28.4		31.2

which was carried on during the summer of 1955. The main purpose of this experiment was the determination of the influence of aureomycin on pregnant and lactating cows (Kitts, 1955 - unpublished data). Simultaneously the daily grass intake was recorded and moisture content of the green forage was determined. Using the actual date from this experiment the dry matter requirement of animals at different body weights was calculated by the method of least squares. The calculation is shown on Table No. 4, Appendix V. The following equation was derived:

$$\text{Dry matter requirement} = .17\ w^{.7}$$

where $\underline{w}$ is animal body weight in pounds

The regression line of dry matter intake is shown on Figure 5.

Using this equation the total requirement of pasture dry matter was calculated for all experimental animals. As it is shown on Table V - Appendix V, 2.743 tons of dry matter per acre was the necessary production requirement. Assuming that the spoilage of grass on pasture consists of 25%, the total requirement was 3.43 tons per acre. According to the state of the pasture during the summer 1954 it could be safely concluded that the amount of grass available on the pasture met the dry matter requirement of all animals.

C. Second Winter Period

The third phase of this experiment can be characterized as a wintering period of bred beef heifers under four different planes of nutrition.

The heifers were divided again into four original groups; three animals (No. 35, 37, 49) were sold so that the equal number of animals in each group was used for the continuation of the experiment.

The feeding standard used during this period is given on Table 10. and the feed consumption record can be found in Table II - Appendix III.

The results presented on following Tables No. 22 - 26 are based on the period of 150 days - up to the birth of the first calf; the following two months was the period of calving which is discussed separately.

The influence of different planes of nutrition on the growth rate of bred yearling heifers is clearly seen on the growth curves: Group I coming from pasture on hay ration only showed a very large decline in the growth rate. The average daily gain in weight was decreased from 1.41 pounds on pasture to .55 pounds during the second winter period. A slight decrease of rate of gain was also observed in Group II. There was not any remarkable change in the growth rate of Group III. and in most cases the growth curve of these animals is represented by the straight line covering 2 phases of the experiment: the first pasture and the second winter period. The rate of gain in Group IV - fed on the high plane of nutrition - was lower than that of Group III. In some cases a tendency to increase the growth rate was observed; however the change in the growth rate on the average was not significant. The

TABLE 22

GAIN IN BODY WEIGHT DURING THE SECOND WINTER PERIOD
(WEIGHT GIVEN IN LBS)

	Heifer No.	K-Value	Body Weight at the Begin.	Body Weight at the End	Gain in 150 days	Average Daily gain
Group I	30	.0003728	811	855	44	.29
	31	.0008898	902	1022	120	.80
	32	.0003819	880	928	48	.32
	33	.0007745	815	910	95	.63
	34	.0006420	930	1020	90	.60
	36	.0008010	833	935	102	.68
		Total	5171	5670	499	3.32
		Average	861.8	945.	83.2	.55
Group II	38	.001136	875	1000	125	.83
	39	.001316	837	1010	173	1.09
	40	.001576	810	1015	205	1.37
	41	.001676	826	1050	224	1.49
	42	.001546	826	1030	204	1.36
	43	.001758	856	1102	246	1.64
		Total	5030	6207	1177	7.78
		Average	838.3	1034.5	196.2	1.30
Group III	44	.001574	935	1171	236	1.57
	45	.001677	981	1246	265	1.77
	46	.002001	907	1207	300	2.
	47	.002081	815	1099	284	1.89
	48	.001604	792	999	207	1.38
	50	.001799	889	1150	261	1.74
		Total	5319	6872	1553	10.35
		Average	886.5	1145.3	258.8	1.73
Group IV	51	.001759	850	1094	244	1.63
	53	.001888	858	1123	265	1.77
	54	.001916	948	1246	298	1.99
	55	.001514	911	1132	221	1.47
	56	.001736	802	1028	226	1.51
	57	.001785	740	946	206	1.37
		Total	5109	6569	1460	9.74
		Average	851.5	1094.8	243.3	1.62

TABLE 23

DAILY GAIN AT DIFFERENT BODY WEIGHT IN LBS.

(SECOND WINTER PERIOD - 150 DAYS)

Group	850	900	950	1000	1100
I	.552	.641	.645	.766	
II	1.338	1.351	1.426	1.501	
III	1.566	1.684	1.721	1.789	2.009
IV	1.523	1.563	1.678	1.763	1.946

TABLE 24

FEED EFFICIENCY PER 1 POUND OF GAIN AT DIFFERENT BODY WEIGHTS
(IN LBS.)

Group	850 ✱			900			950			1000			1100		
	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN	Hay	Conc.	TDN
I	39.2		16.5	29.6		14.8	30.4		15.2	26.4		13.2			
II	10.2	4.2	7.8	10.4	4.3	8.0	10.2	4.1	7.8	10.1	4.1	7.7			
III	5.8	7.1	7.5	5.6	6.8	7.2	5.7	6.9	7.3	5.7	6.9	7.3	5.4	6.5	6.9
IV	2.9	10.9	8.6	3.	10.9	8.6	2.9	10.5	8.3	2.9	10.4	8.3	2.8	10.	7.9

✱ Assuming that hay contains 50% TDN and concentrate contains 65% TDN

TABLE 25

COST OF FEED IN 1 POUND OF GAIN AT DIFFERENT BODY WEIGHTS
(IN CENTS)✱

Group	850	900	950	1000	1100
I	32.9	29.6	30.4	26.4	
II	18.6	19.	18.4	18.3	
III	20.	19.2	19.5	19.5	18.4
IV	24.7	24.8	23.9	23.7	22.8

✱ Based on purchasing price: $20. 1 ton of hay
$40. 1 ton of concentrate

average daily gain made by group IV was 1.62 pounds in comparison with 1.73 pounds by Group III.

The highest total gain in this 150 day period was reached by the animals of Group III - consisting of 1553 pounds. The lowest gain - 499 pounds - was made by Group I (Table 22).

A comparison of the daily gain in weight at equal body weights among the groups indicates that the highest gain throughout the whole period was made by Group III - as it is shown on Table 23.

The feed efficiency data given on Table 24 support the previous findings of many investigators that the gestation period does not mean a very high stress on the young growing animal. The animals in all four groups showed an increasing trend of feed efficiency towards parturition. The gain in body weight of a pregnant animal is primarily caused by an increasing weight of the foetus and by accumulation of the amniotic and allantoic fluids. The feed requirement in the net energy sense, to make one pound of gain of the foetal tissues is much lower - as it is built mainly from muscle tissue. The difference in net energy requirements to make one pound of gain in the protein sense and fat was shown in the first part of this thesis.

Table No. 26 contains a summary of the results obtained during the second winter period. The feed efficiency per one pound of gain is twice as small in Group IV as in

Group I - expressed in pounds of T.D.N. Only a slight difference in the feed efficiency is noticeable between Groups II and III. The cheapest gain during this period was made by the animals of Group II, the highest cost was required by Group IV. The first three periods considered as one unit were the bases for the calculation presented in Table No. 27. As can be seen from the results the animals of Group II were most profitable according to the lowest cost per one pound of gain. The figures in column three do not express the absolute value of the production cost of one pound of gain but are the means for comparison of all the groups. The cost of the additional gain in Group II - 944 pounds - was $71.53. This means that each additional pound in Group II cost 7.58 cents, so that the feeding standard of this Group seems to be most economical. The additional 570 pounds of gain in Group III were produced at approximately three times the cost of Group II. This feeding standard as was stated previously would be justified only if the bred heifers were intended for sale. Even though the total gain of Group IV was 77 pounds lower than that of Group III the total cost of feed was $144.68 higher. The raising of breeding stock on a high plane of nutrition as Group IV was fed would be very unprofitable for the rancher.

The last two months of the winter feeding period which were not included in the previous calculation were the period of calving. Practically all the calves were born between

TABLE 26

SECOND WINTER PERIOD : SUMMARY OF RESULTS*

WEIGHT GIVEN IN LBS.

Group	Number of Animals	Average Body Wgt. at the Begin.	End.	Total Gain per Animal	per Group	Total feed consumption per group in Lbs Hay	Concen.	Cost of Feed $	Feed Efficiency per 1 Lb. of gain Hay	Conc.	TDN
I	6	861.8	945.	83.2	499	16,581.6		168.52	33.8		16.9
II	6	838.3	1034.5	196.2	1177	12,816.6	5,233.	232.63	10.9	4.4	8.3
III	6	886.5	1145.3	258.8	1530	10,103.8	10,991.4	320.92	6.5	7.1	8.
IV	6	851.5	1094.8	243.3	1460	4,414.8	15,969.6	363.54	3.	10.9	8.6

* Calculations are based on the period of 150 days up to the birth of the first calf

Cost of 1 Pound of Gain:

¢ 33.8	...	Group I
¢ 19.8	...	" II
¢ 20.7	...	" III
¢ 24.9	...	" IV

TABLE 27

Group	Total Gain during the First 3 Periods	Total Cost of feed $	Average Cost of 1 Pound of gain ¢	Additional Gain	Cost of Additional Gain Total	Cost of Additional Gain Per 1 Lb.
I	2879	316.92	11.			
II	3823	388.45	10.16	944	71.53	7.58
III	4393	515.17	11.73	570	126.72	22.23
IV	4316	659.85	15.29	77	144.68	

TABLE 28

PARTURITION DATA

Cow No.	Loss of Body Wgt. by calving in Lbs.	Calf Weight In Lbs	Calf Weight In % of cow's body weight	Sex of calves	Calving Percent.
30	67.	31.	3.63	Heifer	
31	91.	62.	6.07	Heifer	
32					
33	90.	59.	6.32	Heifer	
34	107.	63.	6.05	Bull	
36	109.	67.	6.96	Heifer	
Total	464.	282.	29.03		83.3%
Average	92.8	56.4	5.81		
38	105.	55.	4.83	Heifer	
39	82.	51.	4.71	Heifer	
40	125.	75.	7.03	Bull	
41	99.	50.	4.06	Heifer	
42					
43	150	77.	6.78	Bull	
Total	561.	308.	27.41		
Average	112.2	61.6	5.48		83.3%
44	115.	63.	5.29	Heifer	
45	130.	70.	5.45	Heifer	
46	145.	70.	5.74	Bull	died
47	134.	71.	5.87	Bull	
48	96.	61.	5.80	Heifer	died
50	168.	81.	6.40	Bull	died
Total	788.	416.	34.55		
Average	131.3	69.3	5.76		50% (100%)
51	131	62	5.29	Heifer	
53	148	73	5.96	Heifer	
54	112	59	4.34	Heifer	
55	102	55	4.68	Bull	
56	118	67	5.95	Bull	
57	123	61	5.70	Heifer	
Total	734	377	31.92		
Average	122.3	62.8	5.32		100%
All Groups Average	114.6	62.9	5.59	Heifers 63.6% Bulls 36.4%	79.17

March 16 and May 11 except three which were born later on the pasture. The weight of the calves expressed in percentage of the dam's body weight does not show any significant difference between the groups, the average being 5.59 per cent. (Table No. 28). The average birth weight of the calves was 62.9 pounds; the heaviest calves were born in Group III, the smallest in Group I, as was anticipated. The lowest average of the birth weight of the calves in Group I was caused by calve No. 30 weighing 31 pounds. Although this calf was small it was kept with the herd for the purpose of further experimentation. Of twenty-four heifers 22 gave birth to calves; however 3 of them died shortly after being born thus making the calving percentage 79.17%. Five of the six cows in Group III showed physical difficulties at the calving and required assistance. One cow in each of the other groups had the same calving difficulties. The highest loss of body weight through calving was observed in Group III, the average being 131.3 pounds. Of all the calves born 63.6% were heifers and 36.4 bulls.

D. The Second Pasture Period

The fourth and final phase of this feeding experiment had two main objectives: to determine the influence of lactation on the growth rate and development of two-year old cows and to determine whether or not the two-year olds are able to produce a sufficient amount of milk for maximum growth of the calves.

A remarkable difference in the growth rate of the young cows can be observed among the four groups by studying the last segment of their growth curves.

The cows in Group I similarly as in the first pasture period - increased their rate of gain more than 100% in comparison with that of the previous period. After three - four weeks on pasture the decline of the growth rate occurred always indicating an ascending tendency. During the period of 77 days on pasture - when the experiment was terminated - this group reached the highest total gain in weight - 605 pounds in comparison with 348 pounds of Group II, 242 pounds of Group III and 165 pounds of Group IV. (Table 29).

The high daily gain of this group was probably due to insufficient ration at the beginning of the lactation period. Fed on a medium quality hay only, the cows did not receive a sufficient amount of nutrients for growth and milk production after parturition. The inhibited growth and loss of body weight was the result. When placed on pasture their daily feed intake was high enough to allow the cows to produce a sufficient amount of milk as well as to replace the body tissue used up in the first few weeks of lactation for milk production. The maintenance cost of this group was the lowest among the groups according to the lowest body weight at the beginning of the pasture period.

A similar situation was observed in Group II but to a lesser extent. The maintenance cost was much higher because

TABLE 29

CHANGES IN BODY WEIGHT DURING THE SECOND PASTURE PERIOD

(WEIGHT GIVEN IN LBS.)

	Cow No.	K-Value	Body Weight at the Begin.	End	Total gain or loss in 77 days		Average daily gain - loss
Group I	30	.007864 .000469	842	969	127		1.65
	31	.004686 .001210	894	988	94		1.22
	32	.003886 .000706	964	1056	92		1.19
	33	.005637 .000072	837	924	87		1.13
	34	.004430 .000684	921	1041	120		1.56
	36	.003131 .000488	843	928	85		1.11
		Total	5301.	5906.	605.		7.86
		Average	883.5	984.	100.8		1.31
Group II	38	.002329	1084	1138	54.)	59	0.77
		.000114	✱1073	1078	5.)		
	39	.000083	1018	1024	6.		0.08
	40	.000471	978	1011	33.		0.43
	41	.003604	1142	1231	89.)	117.	
		.000591	✱1122	1150	28.)		1.52
	42	.002369 .000615	1135	1219	84.		1.09
	43	.001999 .000135	1029	1078	49.		0.64
		Total	6386.	✦ 6560	348.		4.53
		Average	1064.3	1093.3	58.		0.76

✱ After parturition

✦ 174 Lbs lost by calving

TABLE 29 (CONTINUED)

	Cow No.	K-Value	Body Weight at the Begin.	End	Total gain or loss in 77 days		Average daily gain - loss
Group III	44	.003043	1126	1175	49)	21	0.27
		-.000026	1149	1147	-28)		
	45	.002193	1194	1269	75)	7	0.09
			1208	1201	-68)		
	46	.003521	1145	1212	67		0.87
		.000165					
	47	.002414	1072	1073	1		0.01
		-.000446					
	48	.005386	942	1012	70		0.91
		.000192					
	50	.004550	1076	1152	76		0.99
		.000117					
		Total	6555.	6797	242		3.14
		Average	1092.5	1132.8	40.3		0.52
Group IV	51	.002791	1069	1133	64.)	19	0.25
		-.000594	1115	1088	-45.)		
	53	.004950	1066	1142	76.)	69	0.90
		-.000124	1142	1135	- 7.)		
	54	.000154	1230	1243	13.		0.17
	55	.000730	1095	1153	58.		0.75
	56	-.000170	1070	1060	-10.		-0.13
	57	.000217	1054	1070	16.		0.21
		Total	6584	6749	165.		2.15
		Average	1097.3	1124.8	27.5		0.36

the cows were about 180 pounds heavier than the animals of Group I. This offers an explanation of the slightly lower rate of gain of this group as compared with that observed in Group I. Entirely different growth patterns were found in Group III and Group IV. The change from the dry lot to pasture also resulted in an increasing rate of gain during the first 2 - 3 weeks, the increase being much lower than that of groups I and II. Group III consisting of three lactating and three non-lactating cows expresses very clearly the influence of lactation on the rate of growth of young cows. While the non-lactating cows followed the pattern of Group I with an increasing growth rate throughout the whole period, the lactating cows showed a noticeable decrease in the rate of gain - expressed by the negative K-value on the growth curves. Only one exception can be pointed out - lactating cow No. 55 in Group IV showed an increasing trend of growth rate during the whole pasture period.

These heavy and fat cows of Groups III and IV did not receive a sufficient amount of grass to meet the high maintenance cost and milk production. No other result could be expected than the loss of body weight or lower milk production. The second possibility will be discussed in connection with growth rate of the calves.

Still another problem arose during the second pasture period: whether or not the pasture provides grass in sufficient

amount for all experimental animals. A similar calculation was carried on as was done for the first pasture period (see Table V, Appendix V). The total dry matter requirement per acre was 3.07 tons. To this figure it was necessary to add 30% to express the spoilage made by the grazing animals, so that the dry matter requirement per acre was 3.99 tons ($\cong$ 4 tons). If we take into consideration that at least 10 calves were also consuming grass and that the 7 acres of pasture produced a lower yield per acre due to renovation, we can conclude that the pasture did not produce a sufficient amount of grass for all the experimental animals. It was necessary after the experiment was terminated, to feed the animals supplemental green forage.

E. Growth Rate of Calves

All calves were identified with eartags having the last two figures identical with numbers of their dams. As can be seen from the growth curves (Appendix I) there is a marked difference in the growth pattern between Groups I and IV. The calves of Group I showed a higher rate of gain during the first 5 to 6 weeks; after this period the rate of gain declined as is indicated by a well marked "break" on the growth curves. A similar change in rate of gain was not observed in Group IV with the one exception of calf No. 55. Calf No. 30 was not considered as normal, weighing 31 pounds at birth - that is about one half of the average birth weight of all

calves. Its rate of growth was slightly lower than the average of Group I and it did not change during the experimental period. There was no evidence of any of the typical characteristics of dwarfism shown by this calf aside from its small size.

The growth patterns of the calves within Group II and III vary to a larger extent: about 50% show a similarity to Group I and the other half follows the pattern of Group IV.

The difference in average rate of gain among the groups was not significant - as it is evident from Table 30. Table 31 shows that the birth weight of the bull calves was considerably higher than that of the heifer calves.

Table 33 presents a comparison of body weight of calves at the same age. It is of interest to note that the calves of Group I reached a higher weight at any given age than Group IV, although the average birth weight was practically the same. This explanation for this difference is not apparent from the experimental data. Further work should be carried out to confirm this finding and if possible seek an explanation for its occurrance.

The results obtained in Groups II and III do not express a true representation of the groups since they were calculated using data from only three animals.

The body weight range of dams was too narrow in this experiment to draw any valuable conclusions on the influence of body weight on the birth weight of the calves. The

TABLE 30

RATE OF GROWTH OF CALVES
(WEIGHT GIVEN IN LBS.)

Group	Calf No.	Birth Wgt.	Calculation Weight	K-Value	Body Weight at the end of experiment	Total Gain	Age in Days	Average daily gain	Sex
I	30	31	34	.01217	182	148	137	1.08	F
	31	62	63	.02774 .01332 .00678	336	273	136	2.01	F
	33	59	59	.02132 .00888	224	165	98	1.68	F
	34	63	63	.02071 .00979	247	184	98	1.88	M
	36	67	66	.01888 .00931	227	161	97	1.66	F
Total		282	285		1216	931		8.31	
Average		56.4	57	.01489	243.2	186.2		1.66	
II	38	55	56	.01609	106	50	39	1.28	F
	39	51	49	.02162 .01041	172	123	83	1.48	F
	40	75	79	.01251	299	220	104	2.12	M
	41	50	54	.01761	114	60	42	1.43	F
	43	77	76	.01088	276	200	119	1.68	M
Total		308	314		967	653		7.99	
Average		61.6	62.8	.01485	193.4	130.6		1.60	

TABLE 30 (CONTINUED)

Group	Calf No.	Birth Wgt.	Calculated Weight	K-Value	Body Weight at the end of experiment	Total gain	Age in days	Average daily gain	Sex
III	44	63	64	.01945 .00940	307	243	123	1.98	F
	45	70	70	.01978 .01632 .00899	268	198	112	1.77	F
	47	71	68	.02239 .00916	205	137	88	1.56	M
Total		204	202		780	578		5.31	
Average		68.	67.3	.01507	260	192.7		1.77	
IV	51	62	67	.01190	219	152	98	1.55	F
	53	73	70	.01338 .01042	172	102	84	1.21	F
	54	59	57	.01579 .01442	229	172	91	1.89	F
	55	55	59	.01734 .00979	234	175	105	1.67	M
	56	67	65	.01125	158	93	80	1.16	M
	57	61	62	.02990	105	43	18	2.39	F
Total		377	380		1117	737		9.87	
Average		62.8	63.3	.01491	186.2	122.8		1.65	

TABLE 31

MEAN BIRTH WEIGHT OF CALVES ACCORDING TO SEX

Bull calves	70.1 Lbs
Heifer calves . . .	61.4 Lbs

TABLE 32

DAILY GAIN AT DIFFERENT BODY WEIGHT OF CALVES

IN LBS.

Group	100	150	200	230
I	1.73	1.93	2.07	2.38
II	1.35	1.69	2.26	2.69
III	2.05	1.75	1.83	2.12
IV	1.37	1.96	2.41	2.44

TABLE 33

COMPARISON OF BODY WEIGHT AT THE SAME AGE OF CALVES

(WEIGHT IN LBS.)

Group	Calf No.	Birth Weight	Days 30	Days 60	Days 90
I	* 30	34	49	71	103
	31	63	118	177	246
	33	59	113	159	208
	34	63	118	170	227
	36	66	115	161	212
Average		62.8	116	166.8	223.3
II	38	56	92		
	39	49	96	135	185
	40	79	120	175	255
	41	54	92		
	43	76	105	145	202
Average		62.8	101	151.6	214
III	44	64	115	170	226
	45	70	108	176	220
	+ 46	70			
	47	68	121	158	209
	+ 48	61			
	+ 50	81			
Average		69.	114.6	168	218.3
IV	51	67	98	140	200
	53	70	105	134	183
	54	57	95	147	227
	55	59	99	151	202
	56	65			
	57	62	90	126	
Average		63.3	97.4	139.6	203.

* Calf No. 30 was not included into calculations

+ Calves No. 46, 48, 50 died shortly after birth

highest average of the calves' weight at birth was observed in Group III.

According to the growth rate of the calves, milk production of all two-year old cows was considered as sufficient under the given management conditions. Table 34 shows the weight changes of the cows over a time constant lactation period.

TABLE 34

THE INFLUENCE OF LACTATION ON BODY WEIGHT OF DAMS

Group	Average Body Wgt before parturition - Lbs.	Average Body Wgt. 90 days after parturition Lbs.	Loss of Body Weight Lbs.
I	964	958	6
II	1132	1080	52
III	1204	1155	49
	* 1171	1118	* 53
IV	1193	1135	58

* Data for non-lactating cows that lost their calves shortly after birth.

As it is evident from this table the cows did not reach the body weight which they had before parturition during the first three months of lactation. The smallest difference was observed in Group I, the slowest recovery after parturition was shown by the cows of Group IV. According to these results lactation retarded the growth of the experimental animals. The data of non-lactating cows in Group III supports our statement that the pasture did not provide sufficiently high plane of nutrition.

SUMMARY AND CONCLUSIONS

Four groups of weanling Hereford heifers were placed on four different winter planes of nutrition for a period of two years according to the following pattern:

Group I - Low plane of nutrition

Group II - Medium-low plane of nutrition

Group III - Medium-high plane of nutrition

Group IV - High plane of nutrition

During the summer seasons the heifers were kept on pasture providing the same feeding level for all animals. The one year old heifers were bred during the months of June and July. All animals were weighed weekly and feed consumption was recorded weekly.

To illustrate the growth rate of the heifers, K-values were calculated for all animals by the method of least squares and their growth curves were constructed. At the end of the second winter period all parturition data were carefully recorded and the rate of growth of the calves studied.

From the results obtained in this experiment the following conclusions can be drawn:

(1) The first post-weaning winter period is very important in regard to the feeding level of young growing heifers. The medium-low plane of nutrition (Group II) showed the best results from the economic point of view.

(2) Young heifers can be bred as yearlings if the previous winter-feeding level allows them to grow continuously and to reach at least 700 pounds body weight before the breeding period starts.

(3) The gestation period did not result in a decreased growth rate of the bred heifers.

(4) The physical difficulties of parturition in two year old heifers do not appear to be insurmountable if the winter plane of nutrition is adequate.

(5) The lactation period means a heavy drain on the young female hence a high level of nutrition must be provided in terms of sufficient amount of pasture dry matter during the grazing season.

(6) Average birth weight of calves was 62.9 pounds, being higher for bull calves than heifer calves.

(7) Pasture dry matter requirements for beef cattle may be calculated from the following equation:

$$DM = 0.17\ w^{.7}$$

(w is animal weight given in pounds)

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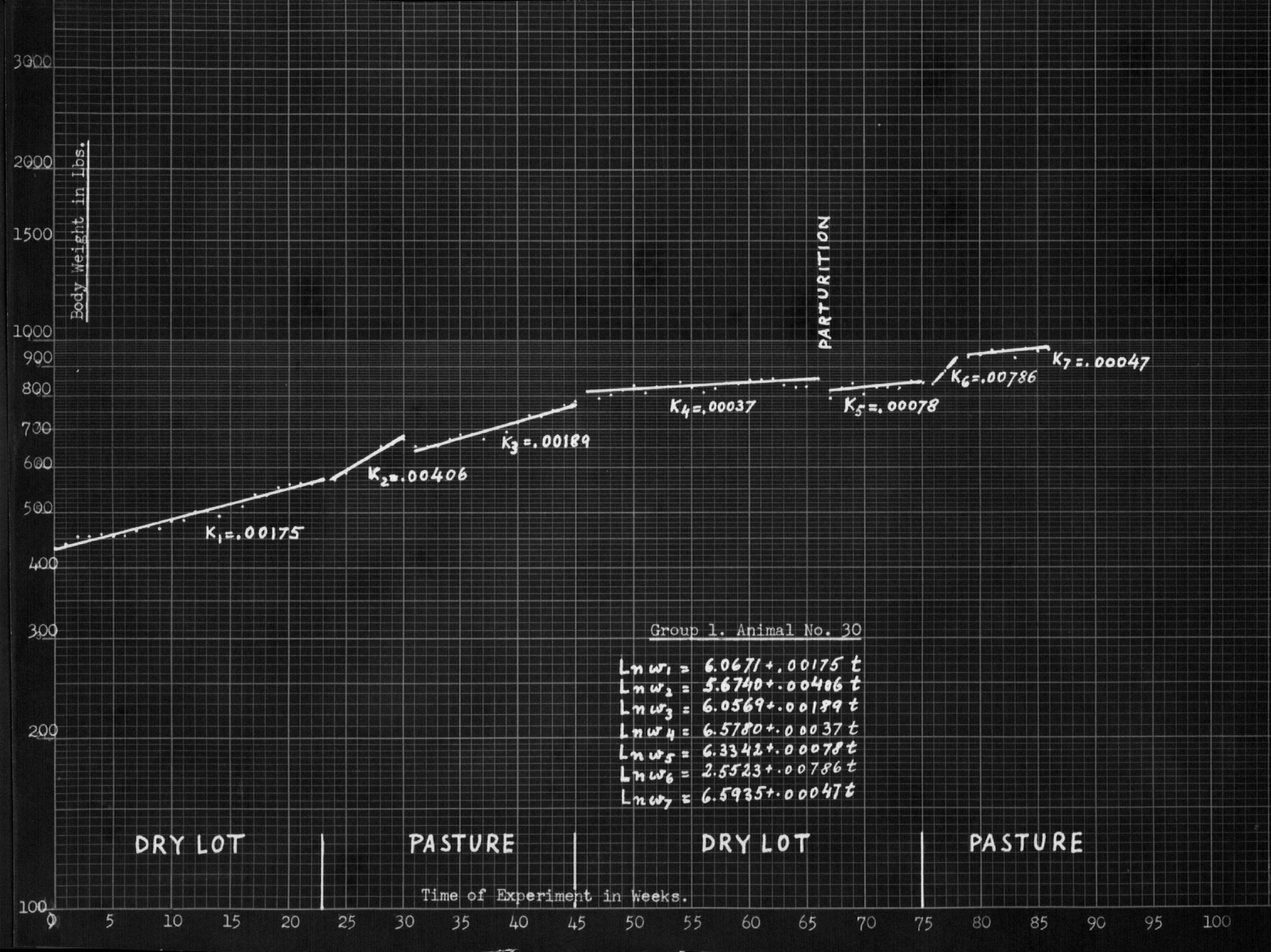
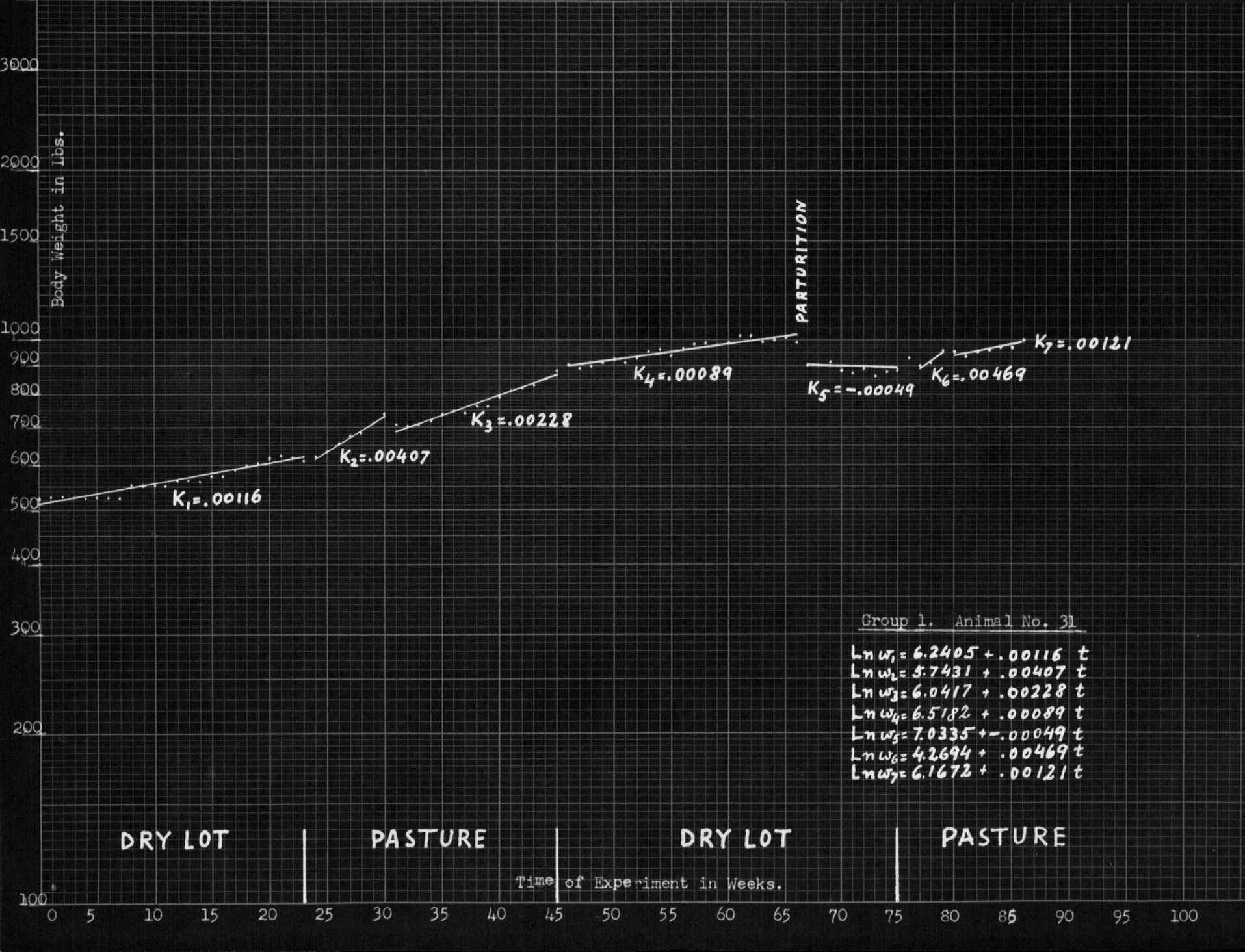
APPENDIX I

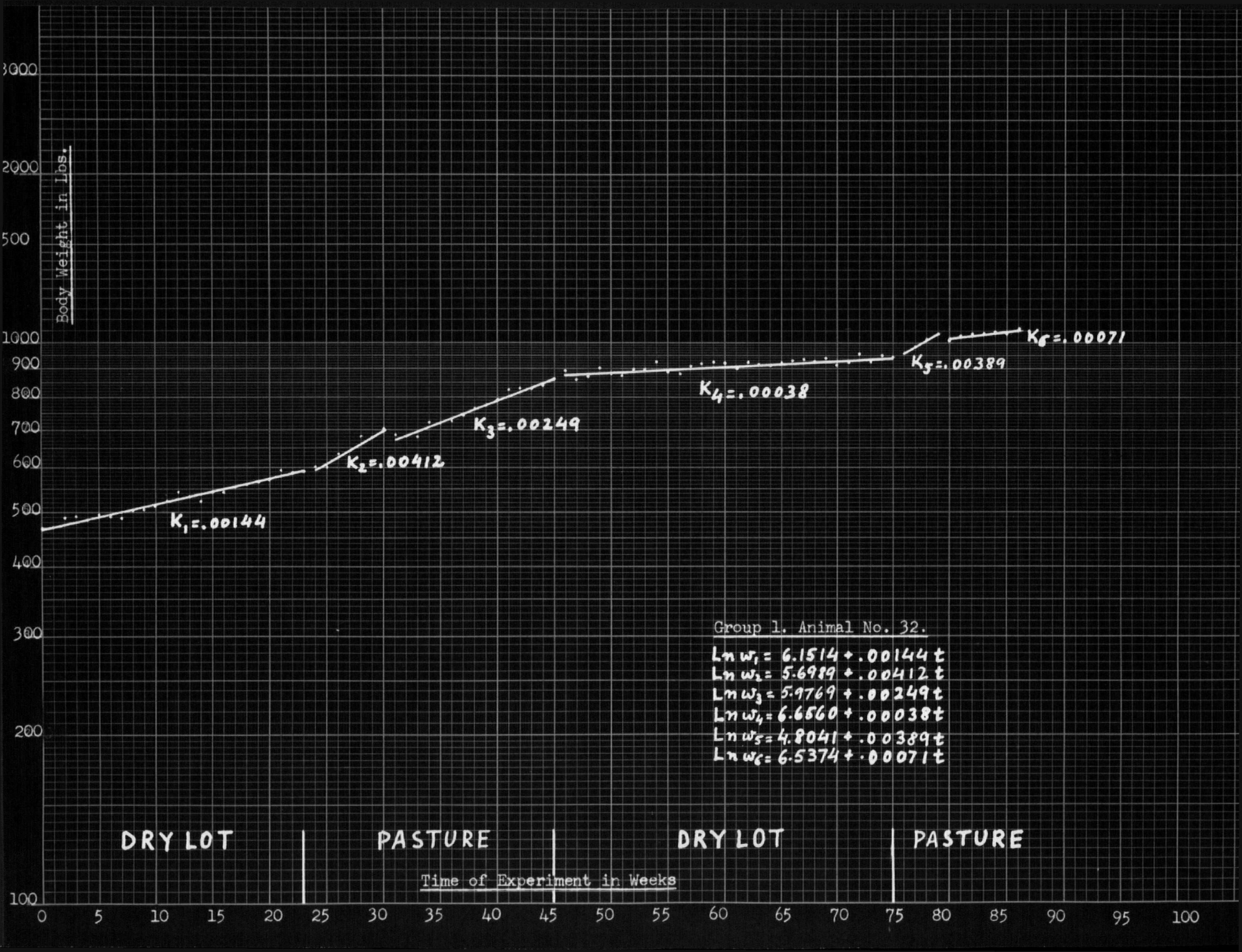
Animal Growth Curves

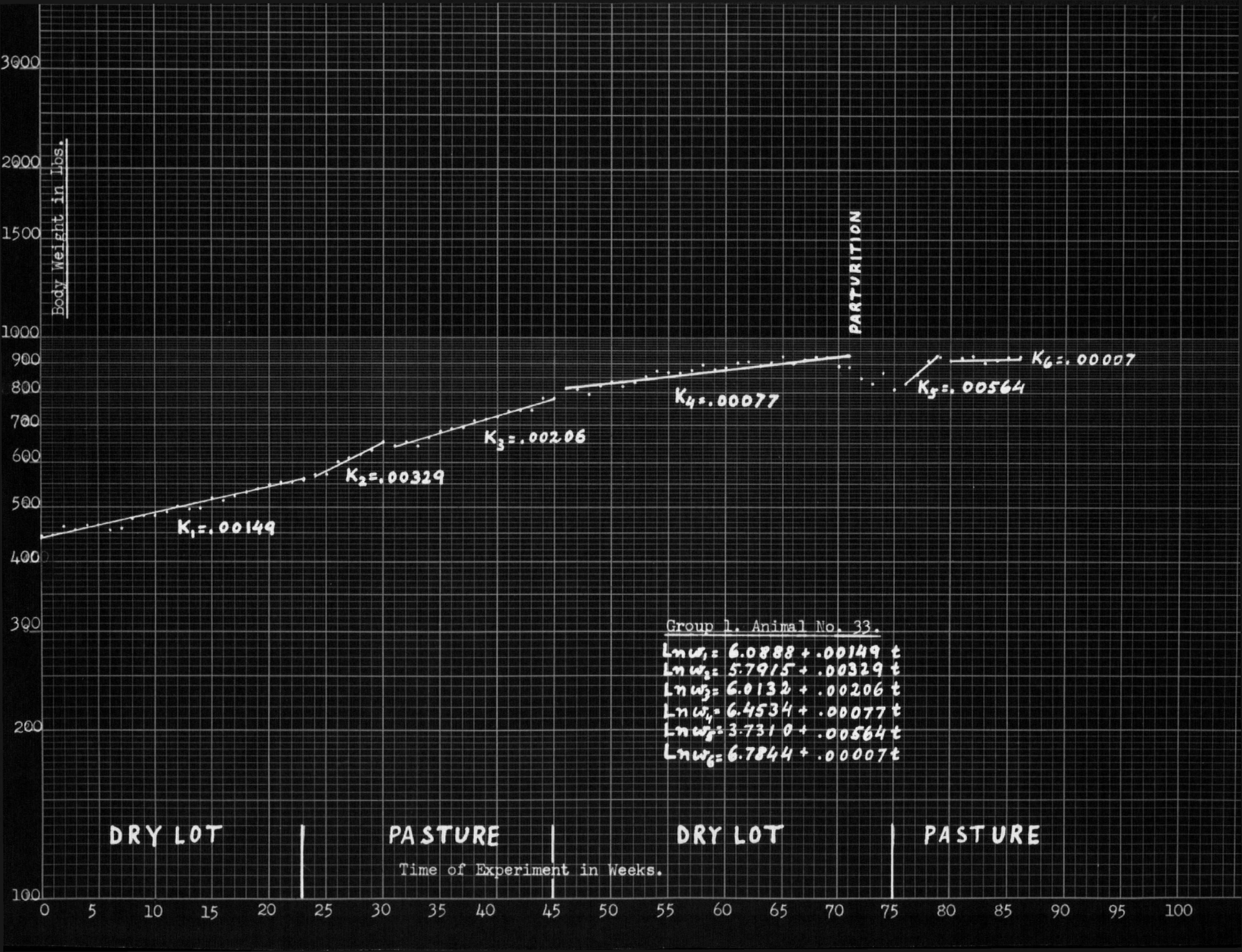

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00175
K_2=.00406
K_3=.00189
K_4=.00037
K_5=.00078
K_6=.00786
K_7=.00047
Group 1. Animal No. 30
$Ln\ w_1 = 6.0671 + .00175\ t$
$Ln\ w_2 = 5.6740 + .00406\ t$
$Ln\ w_3 = 6.0569 + .00189\ t$
$Ln\ w_4 = 6.5780 + .00037\ t$
$Ln\ w_5 = 6.3342 + .00078\ t$
$Ln\ w_6 = 2.5523 + .00786\ t$
$Ln\ w_7 = 6.5935 + .00047\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

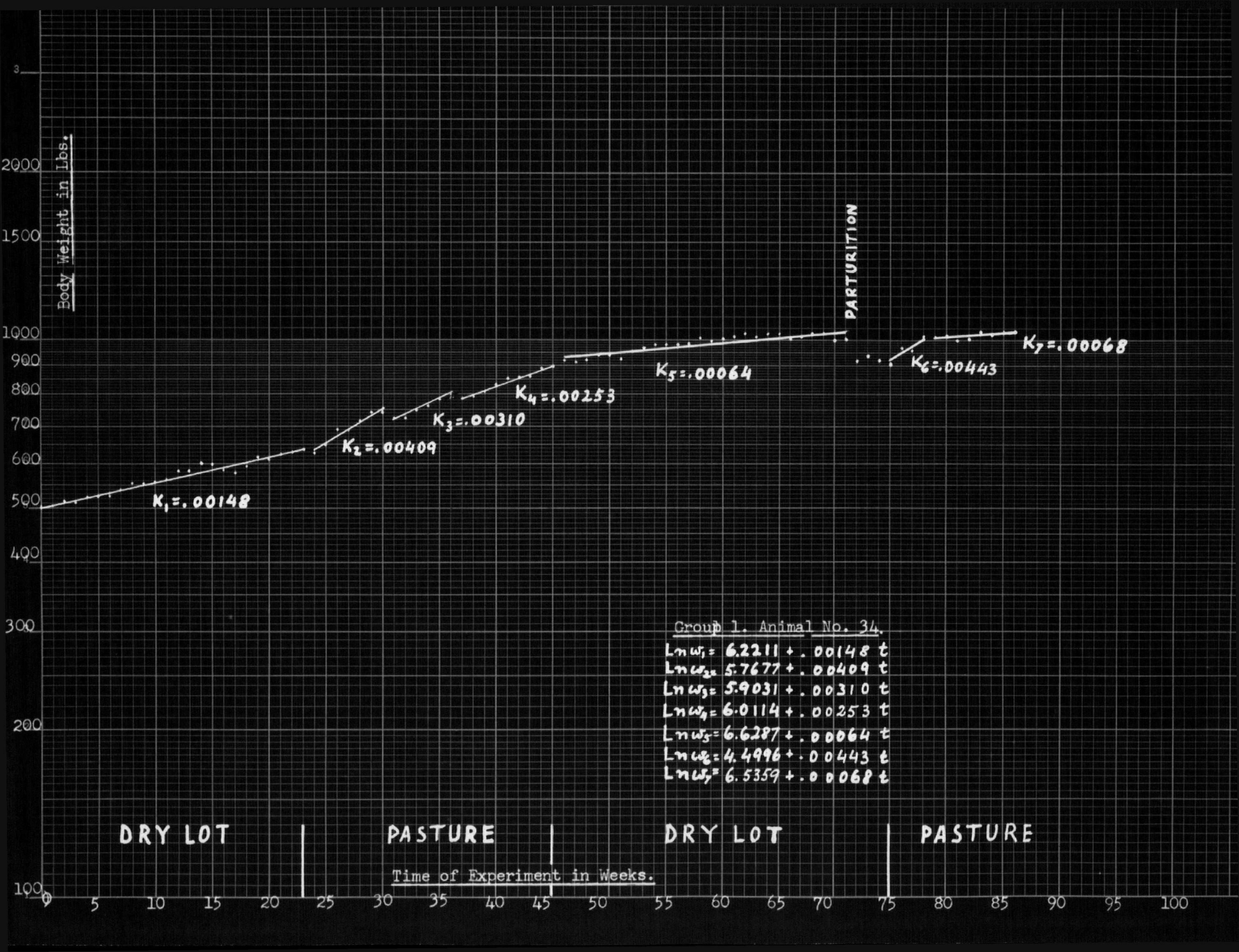


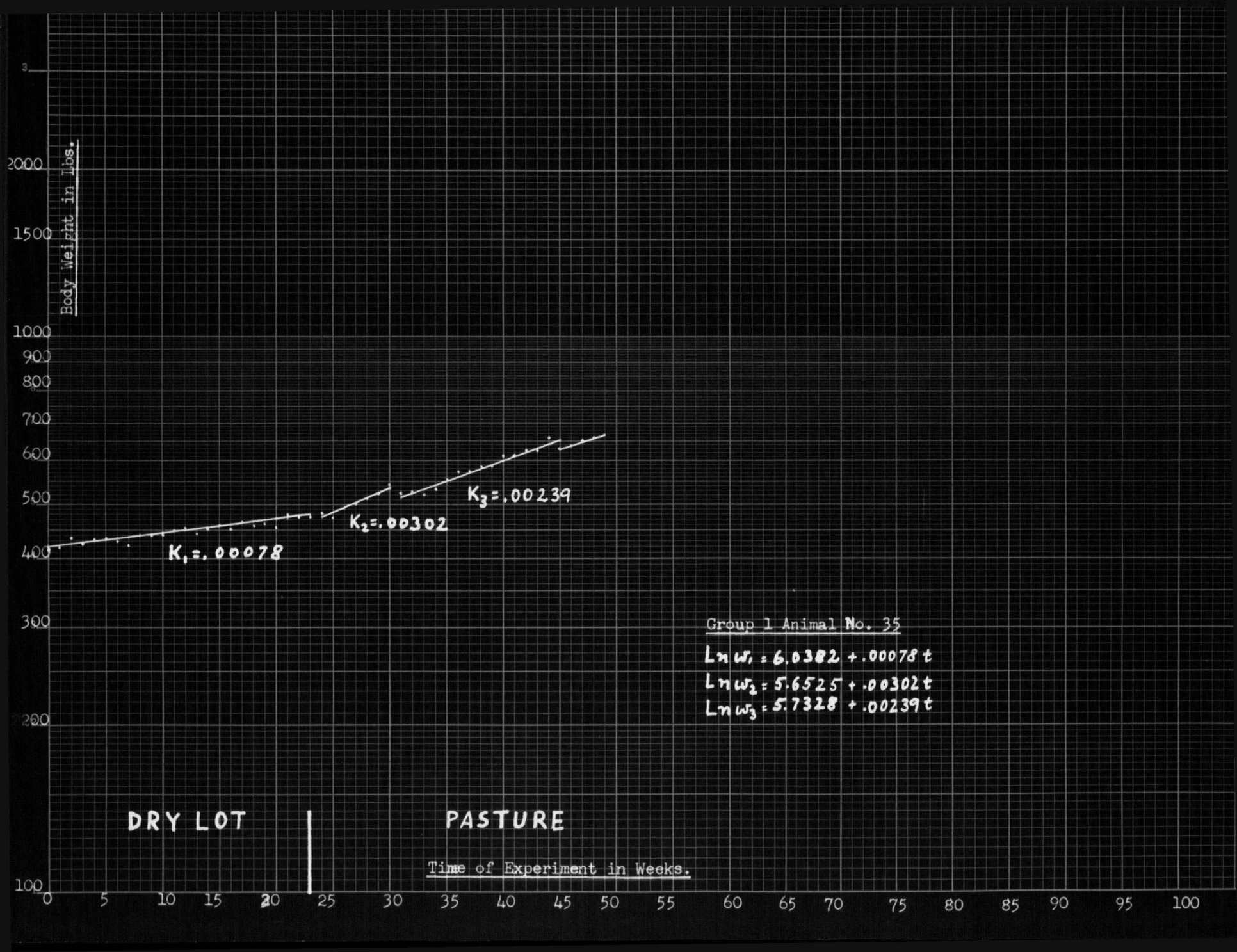
Group 1. Animal No. 31

$\ln w_1 = 6.2405 + .00116\ t$
$\ln w_2 = 5.7431 + .00407\ t$
$\ln w_3 = 6.0417 + .00228\ t$
$\ln w_4 = 6.5182 + .00089\ t$
$\ln w_5 = 7.0335 + -.00049\ t$
$\ln w_6 = 4.2694 + .00469\ t$
$\ln w_7 = 6.1672 + .00121\ t$


Body Weight in Lbs.
3000
2000
500
1000
900
800
700
600
500
400
300
200
100
K_1=.00144
K_2=.00412
K_3=.00249
K_4=.00038
K_5=.00389
K_6=.00071
Group 1. Animal No. 32.
Ln w_1= 6.1514 + .00144 t
Ln w_2= 5.6989 + .00412 t
Ln w_3= 5.9769 + .00249 t
Ln w_4= 6.6560 + .00038 t
Ln w_5= 4.8041 + .00389 t
Ln w_6= 6.5374 + .00071 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00149
K_2=.00329
K_3=.00206
K_4=.00077
K_5=.00564
K_6=.00007
Group 1. Animal No. 33.
$Ln w_1$= 6.0888 + .00149 t
$Ln w_2$= 5.7915 + .00329 t
$Ln w_3$= 6.0132 + .00206 t
$Ln w_4$= 6.4534 + .00077 t
$Ln w_5$= 3.7310 + .00564 t
$Ln w_6$= 6.7844 + .00007 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


Body Weight in Lbs.
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00148
K_2=.00409
K_3=.00310
K_4=.00253
K_5=.00064
K_6=.00443
K_7=.00068
Group 1. Animal No. 34.
$Ln w_1$= 6.2211 + .00148 t
$Ln w_{2x}$ 5.7677 + .00409 t
$Ln w_3$= 5.9031 + .00310 t
$Ln w_4$= 6.0114 + .00253 t
$Ln w_5$= 6.6287 + .00064 t
$Ln w_6$= 4.4996 + .00443 t
$Ln w_7$= 6.5359 + .00068 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

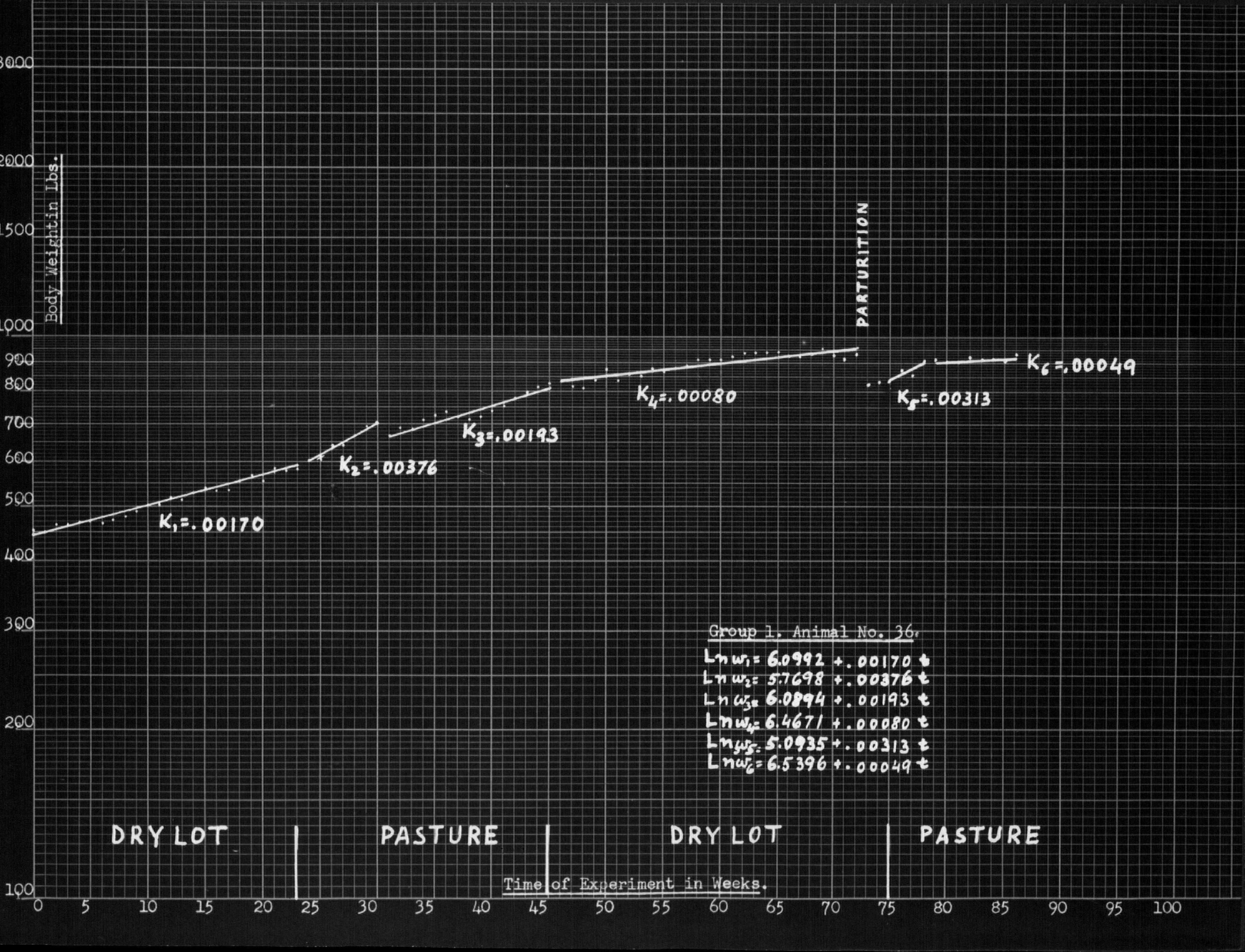


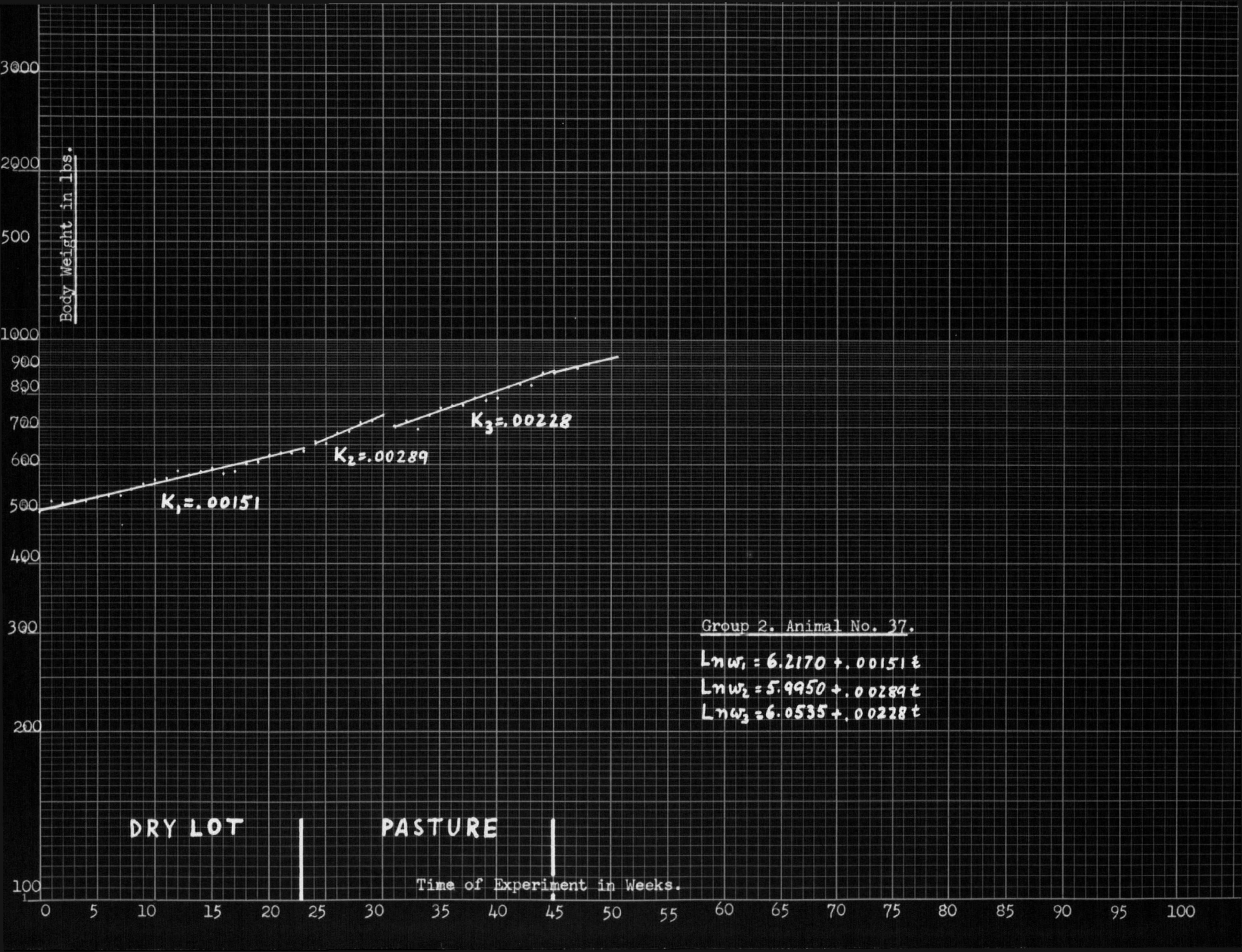
Group 1 Animal No. 35

$\ln w_1 = 6.0382 + .00078\,t$

$\ln w_2 = 5.6525 + .00302\,t$

$\ln w_3 = 5.7328 + .00239\,t$


Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00170
K_2=.00376
K_3=.00193
K_4=.00080
K_5=.00313
K_6=.00049
Group 1. Animal No. 36.
Ln w_1= 6.0992 + .00170 t
Ln w_2= 5.7698 + .00376 t
Ln w_3= 6.0894 + .00193 t
Ln w_4= 6.4671 + .00080 t
Ln w_5= 5.0935 + .00313 t
Ln w_6= 6.5396 + .00049 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

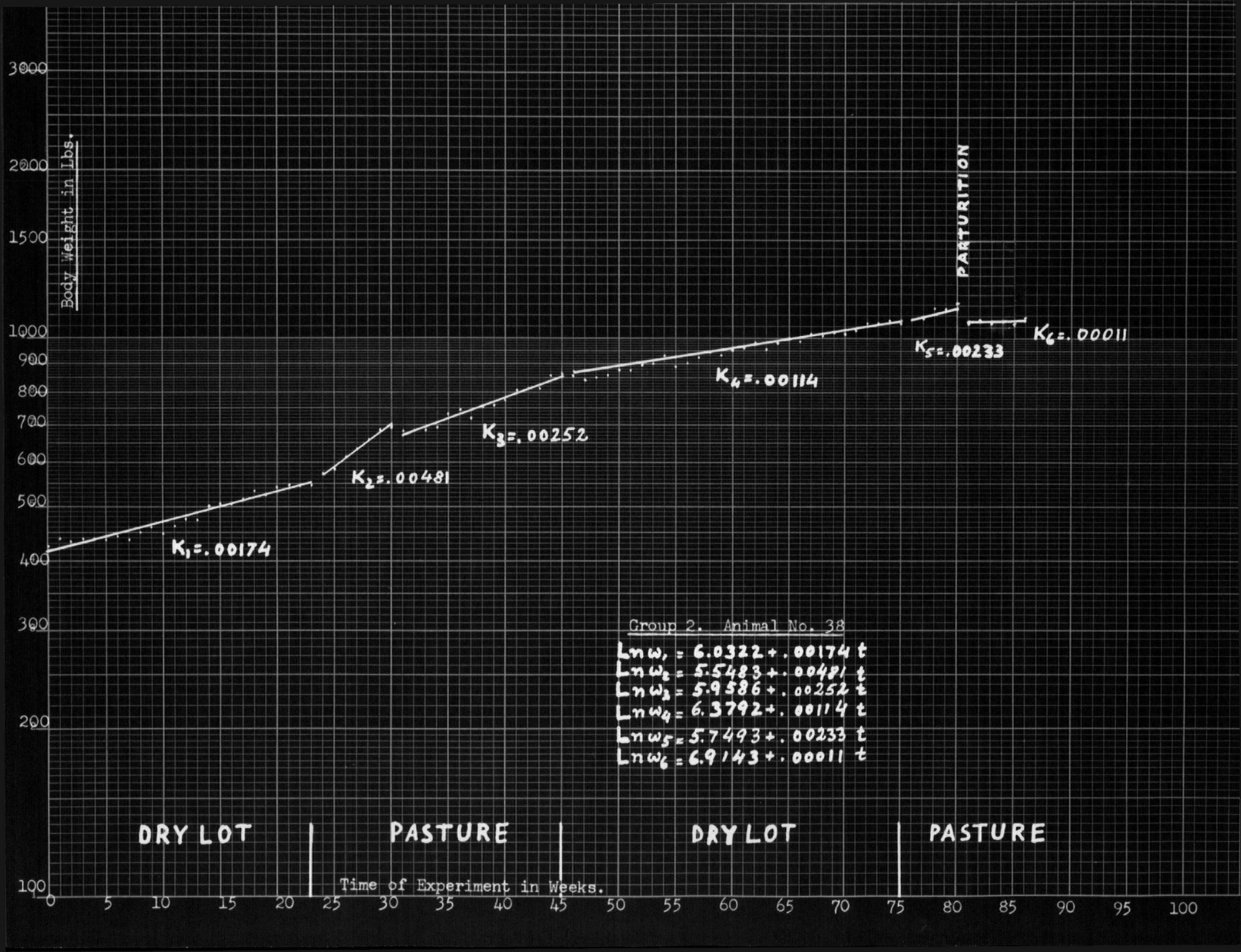


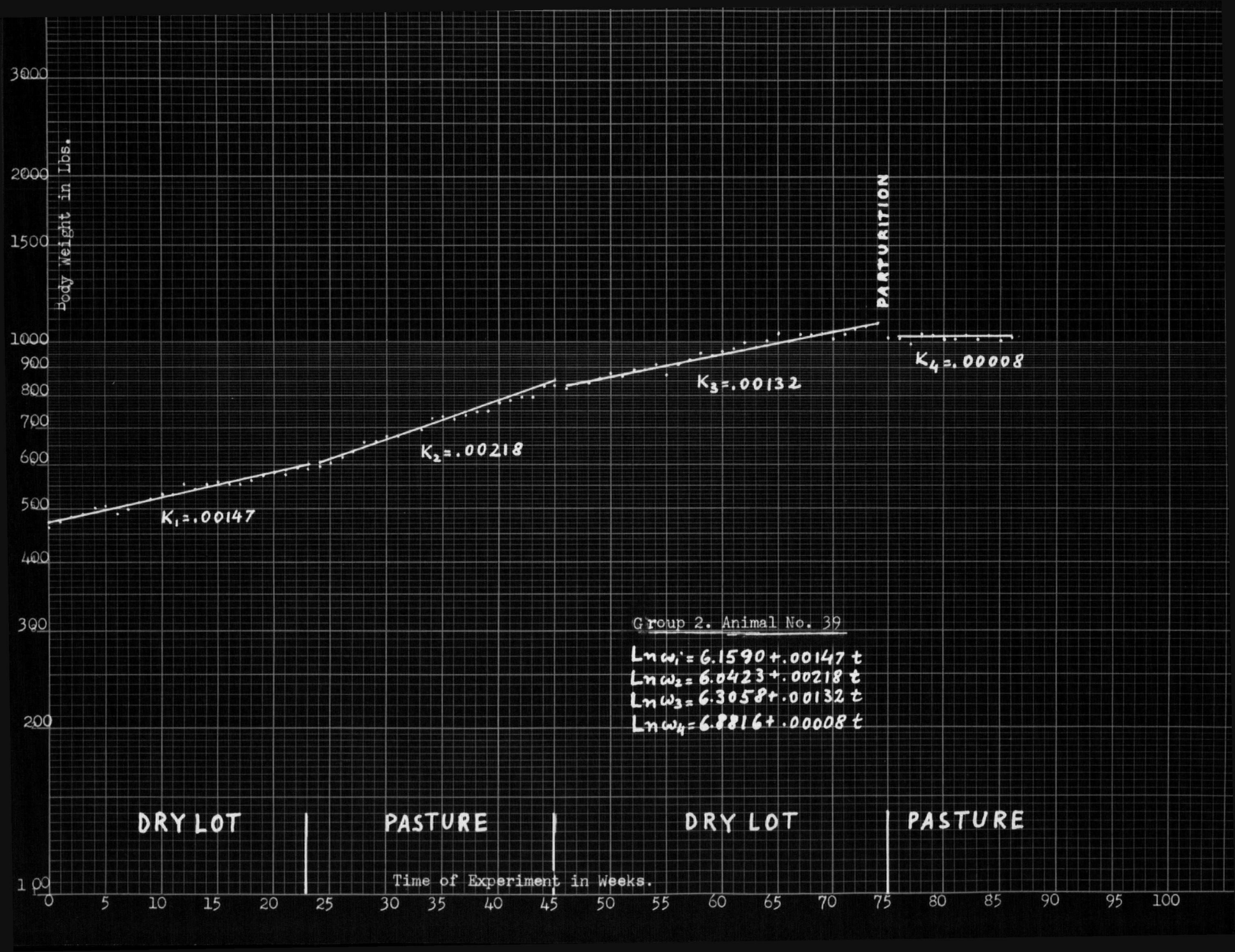
Group 2. Animal No. 37.

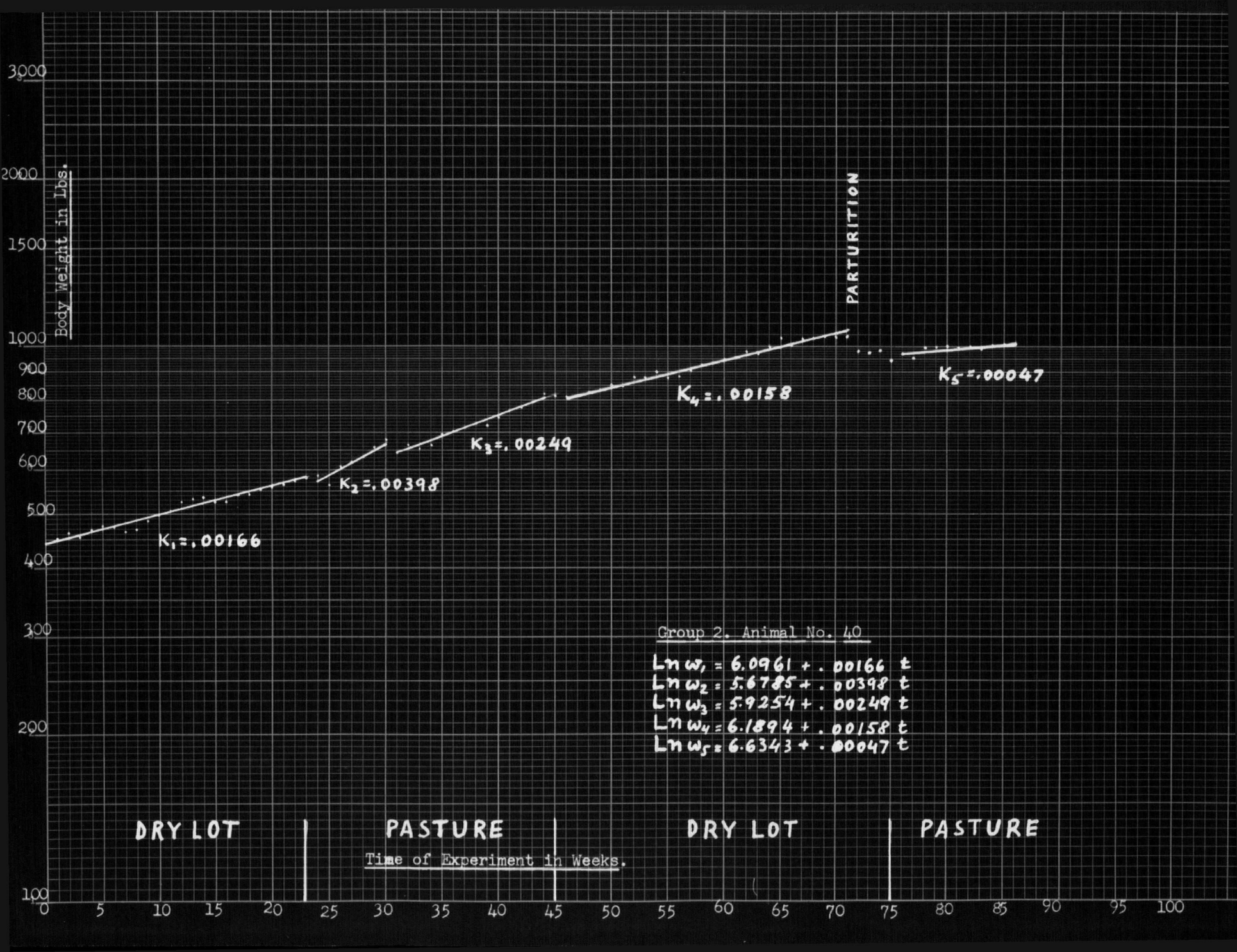
$Ln w_1 = 6.2170 + .00151\,t$

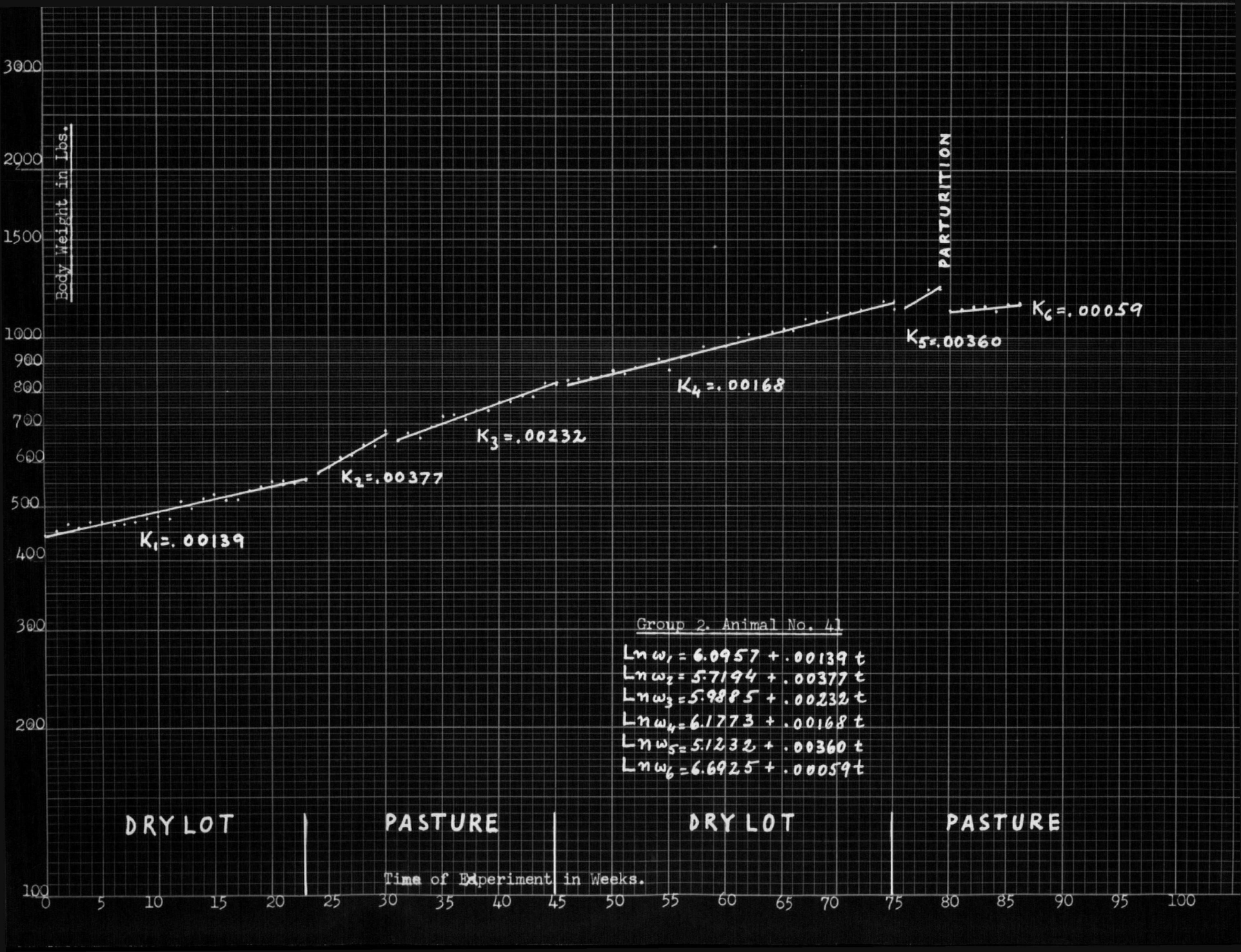
$Ln w_2 = 5.9950 + .00289\,t$

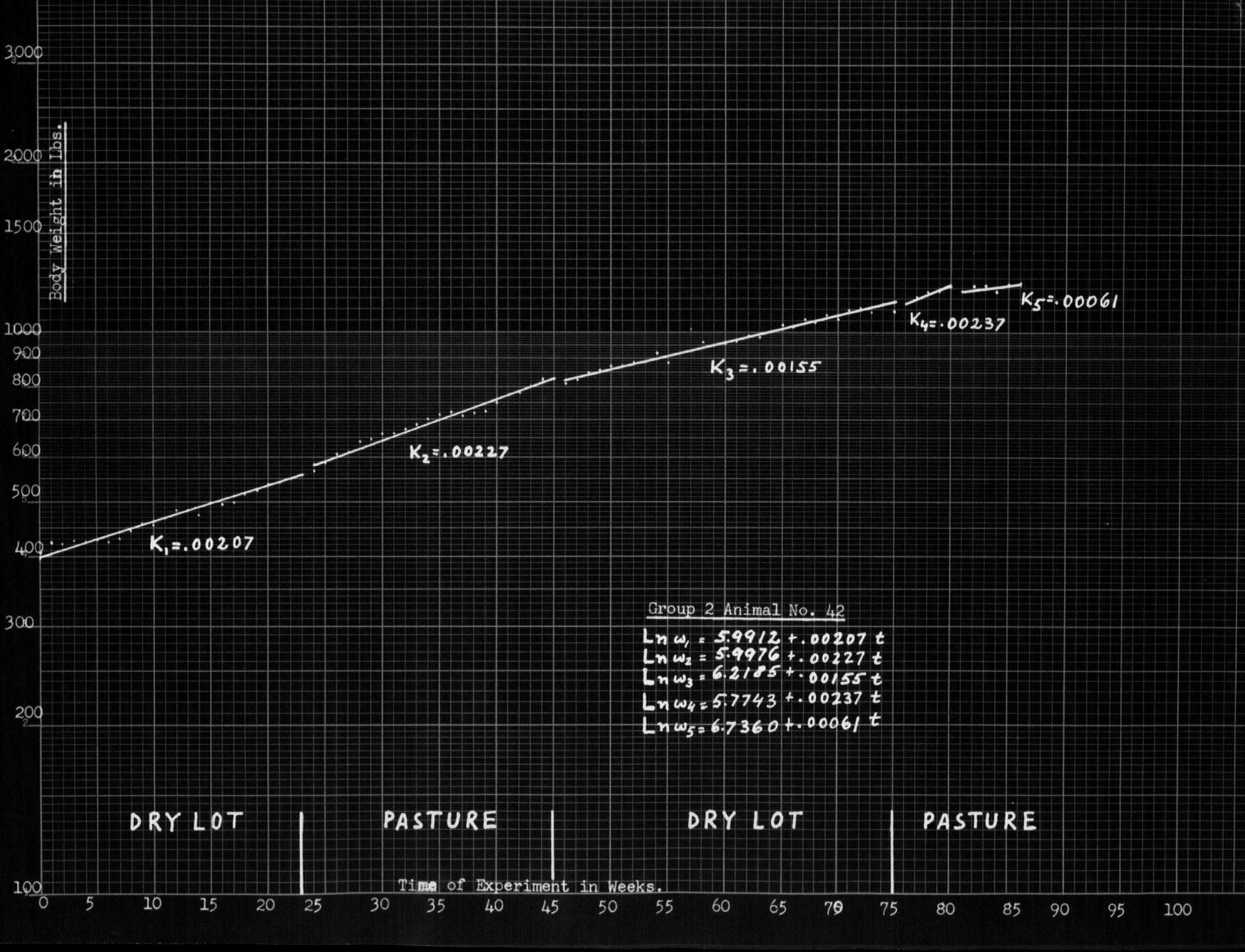
$Ln w_3 = 6.0535 + .00228\,t$

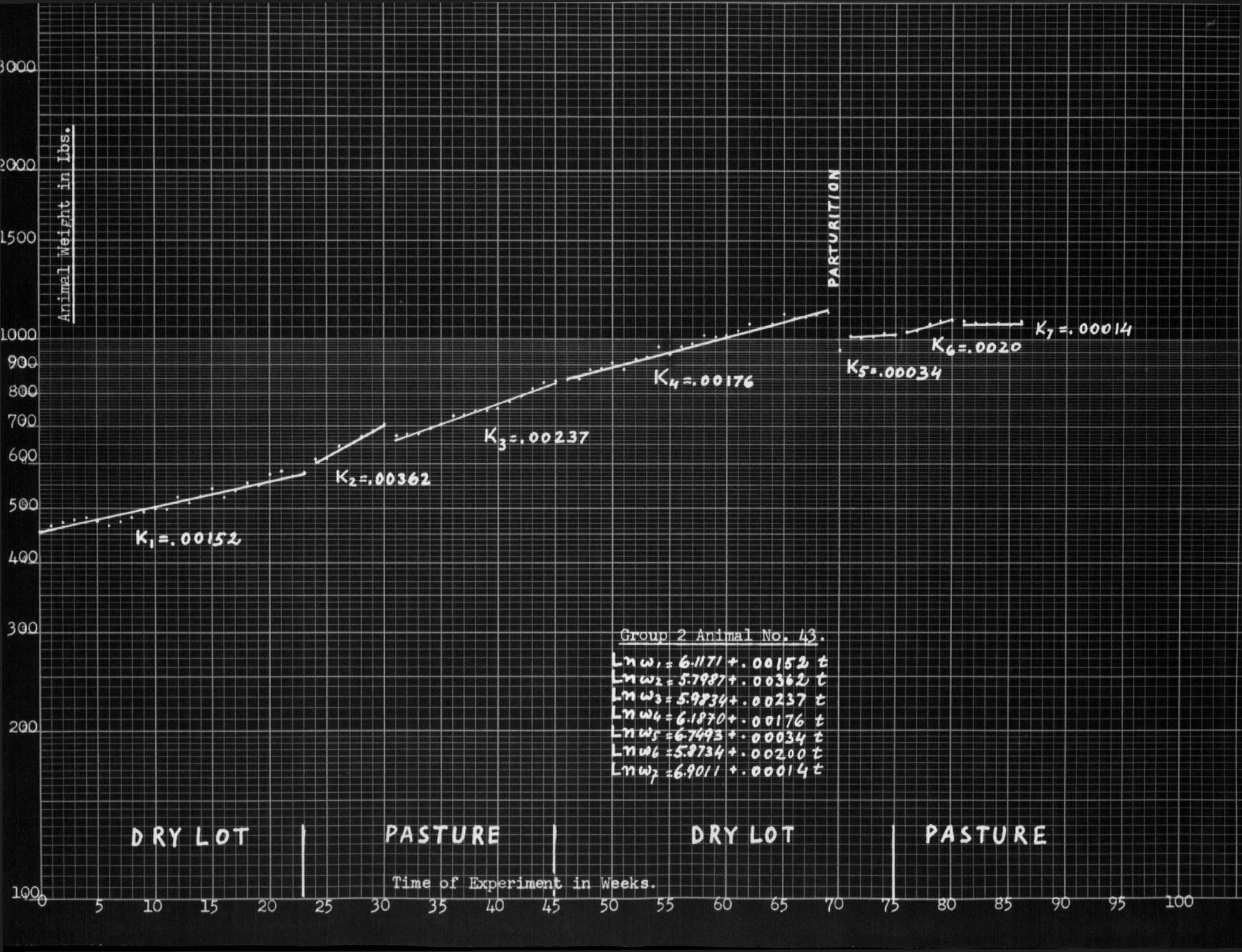

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00174
K_2=.00481
K_3=.00252
K_4=.00114
K_5=.00233
K_6=.00011
Group 2. Animal No. 38
$Ln\,\omega_1 = 6.0322 + .00174\,t$
$Ln\,\omega_2 = 5.5483 + .00481\,t$
$Ln\,\omega_3 = 5.9586 + .00252\,t$
$Ln\,\omega_4 = 6.3792 + .00114\,t$
$Ln\,\omega_5 = 5.7493 + .00233\,t$
$Ln\,\omega_6 = 6.9143 + .00011\,t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

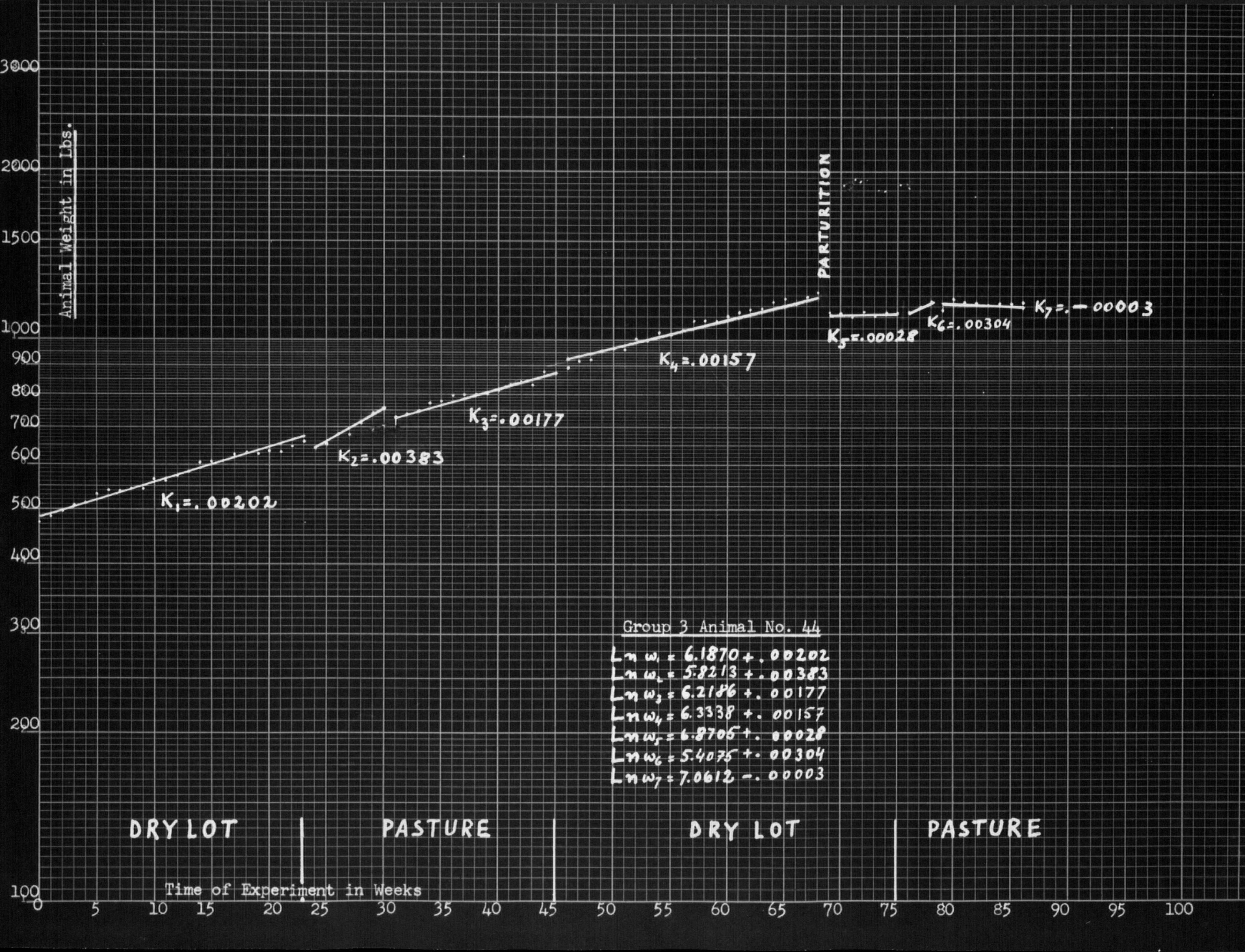

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00147
K_2=.00218
K_3=.00132
K_4=.00008
Group 2. Animal No. 39
$Ln\,\omega_1 = 6.1590 + .00147\,t$
$Ln\,\omega_2 = 6.0423 + .00218\,t$
$Ln\,\omega_3 = 6.3058 + .00132\,t$
$Ln\,\omega_4 = 6.8816 + .00008\,t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

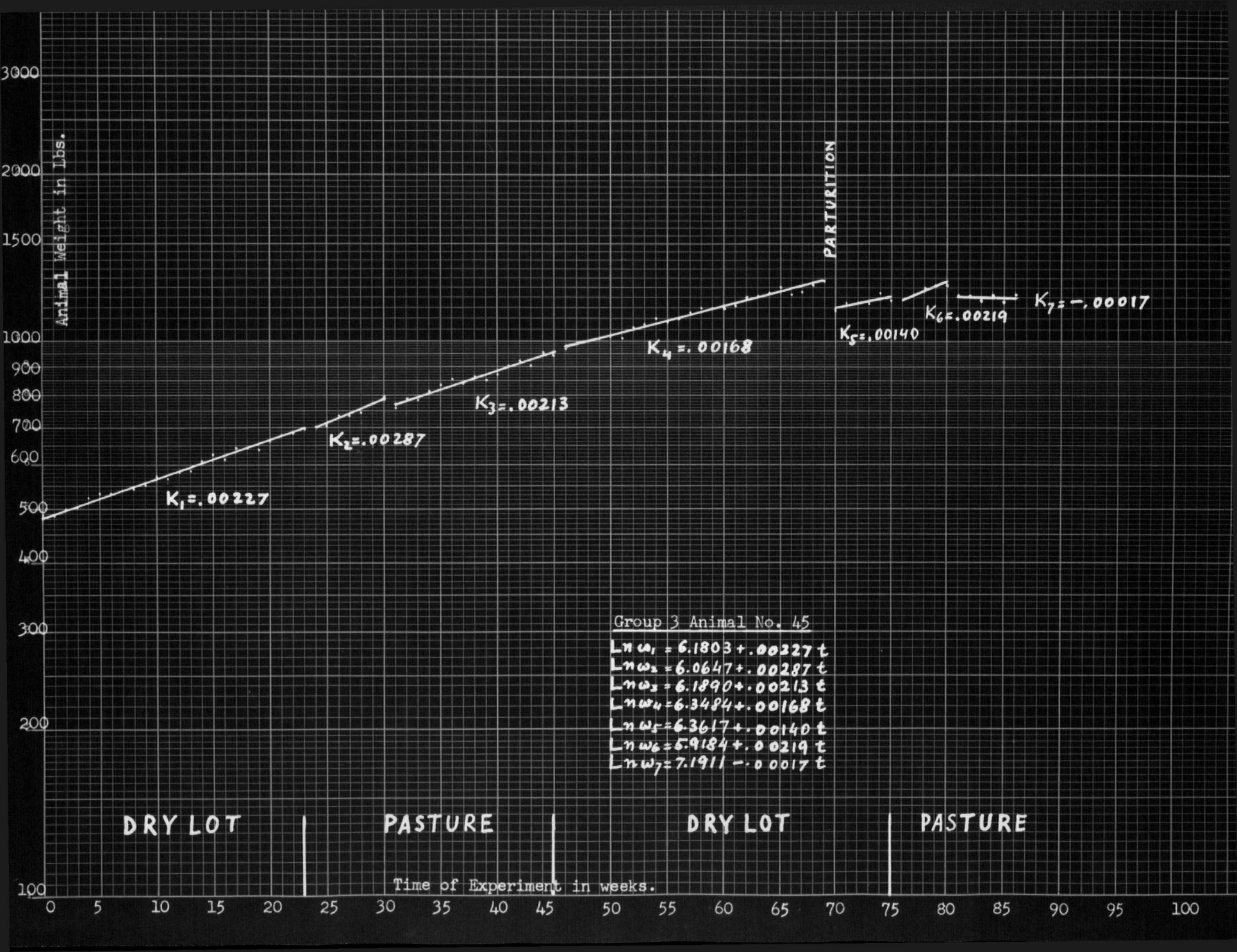

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
$K_1 = .00166$
$K_2 = .00398$
$K_3 = .00249$
$K_4 = .00158$
$K_5 = .00047$
Group 2. Animal No. 40
$\ln w_1 = 6.0961 + .00166\ t$
$\ln w_2 = 5.6785 + .00398\ t$
$\ln w_3 = 5.9254 + .00249\ t$
$\ln w_4 = 6.1894 + .00158\ t$
$\ln w_5 = 6.6343 + .00047\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

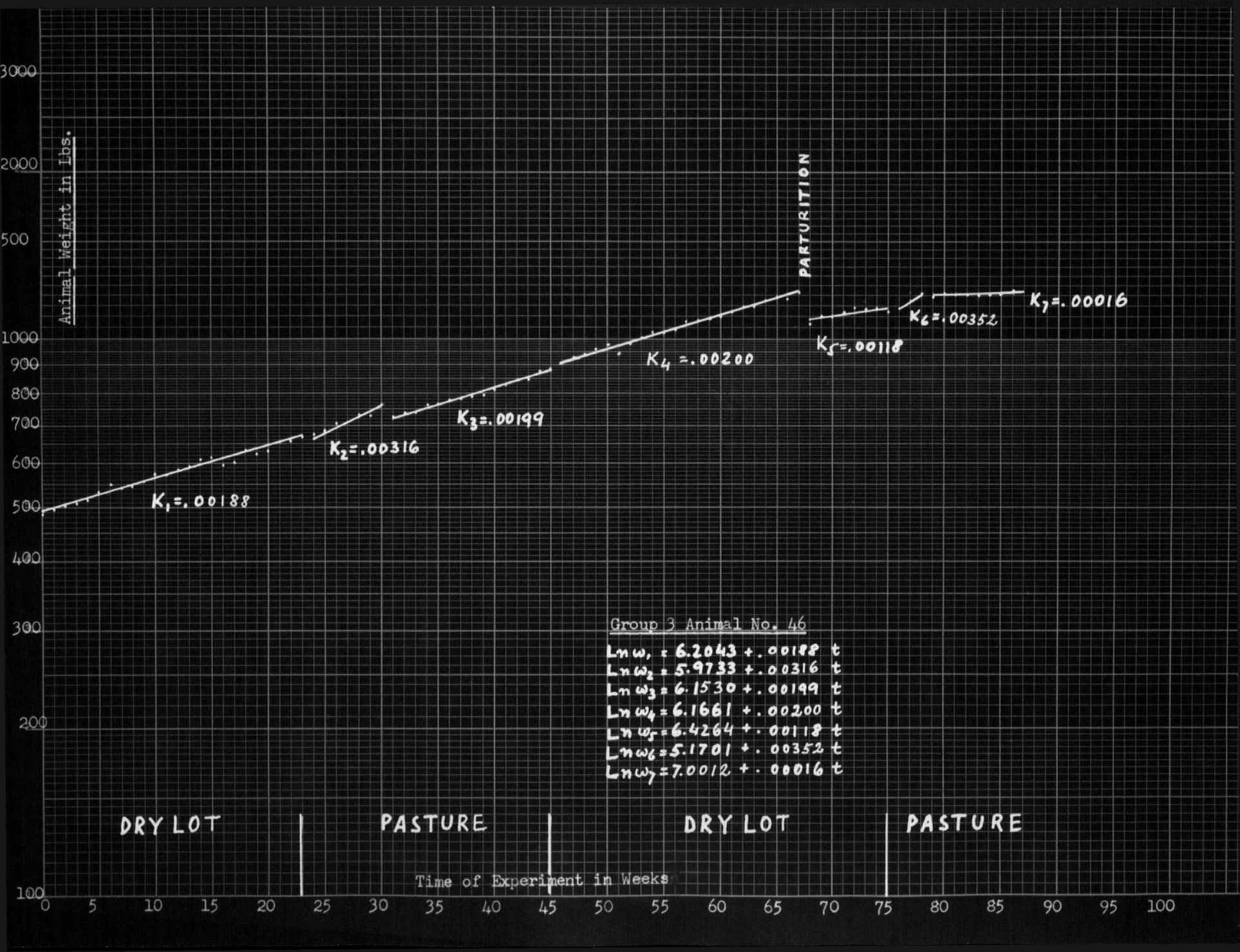

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00139
K_2=.00377
K_3=.00232
K_4=.00168
K_5=.00360
K_6=.00059
Group 2. Animal No. 41
$Ln\ \omega_1 = 6.0957 + .00139\ t$
$Ln\ \omega_2 = 5.7194 + .00377\ t$
$Ln\ \omega_3 = 5.9885 + .00232\ t$
$Ln\ \omega_4 = 6.1773 + .00168\ t$
$Ln\ \omega_5 = 5.1232 + .00360\ t$
$Ln\ \omega_6 = 6.6925 + .00059\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

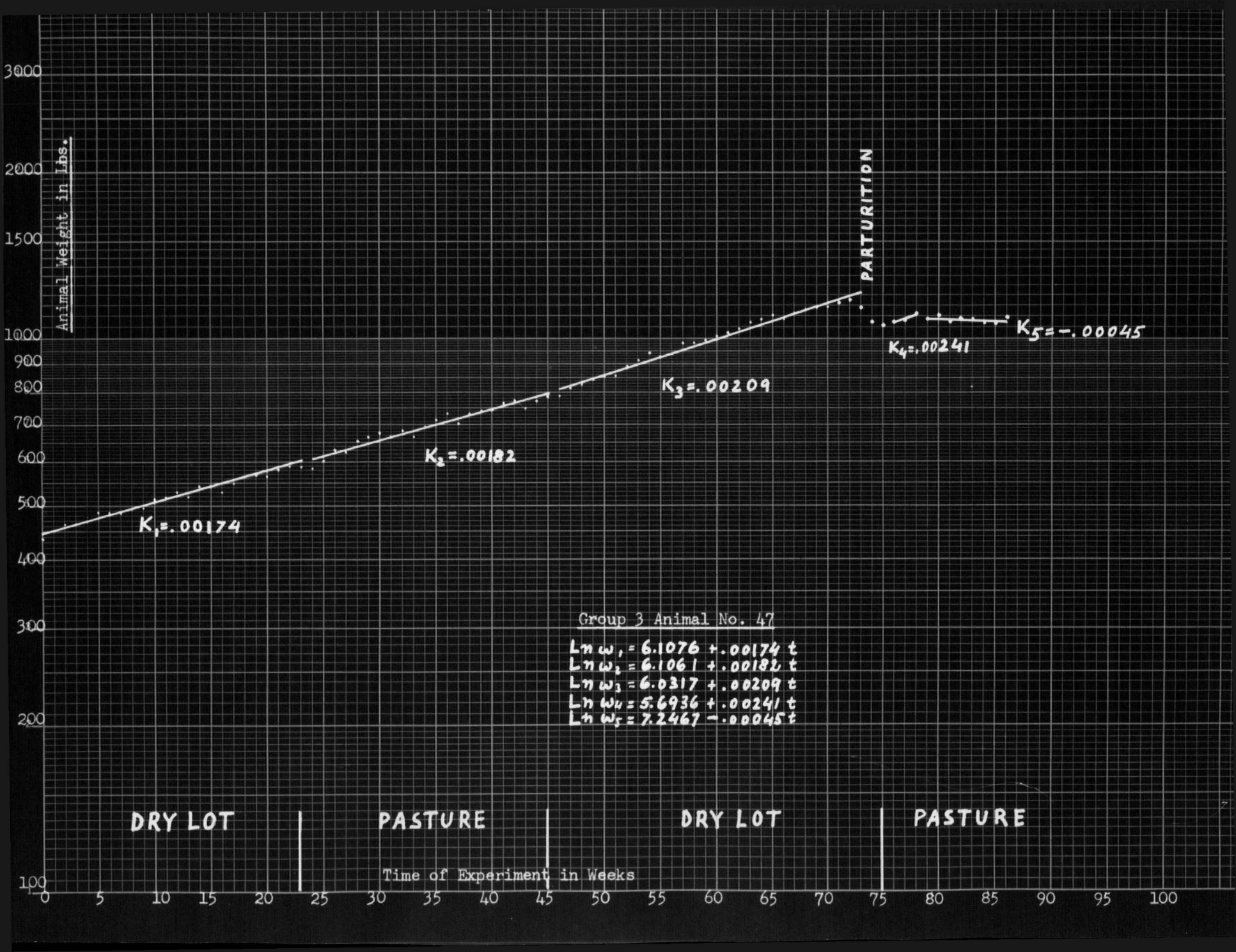

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
K_1=.00207
K_2=.00227
K_3=.00155
K_4=.00237
K_5=.00061
Group 2 Animal No. 42
Ln ω_1 = 5.9912 + .00207 t
Ln ω_2 = 5.9976 + .00227 t
Ln ω_3 = 6.2185 + .00155 t
Ln ω_4 = 5.7743 + .00237 t
Ln ω_5 = 6.7360 + .00061 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

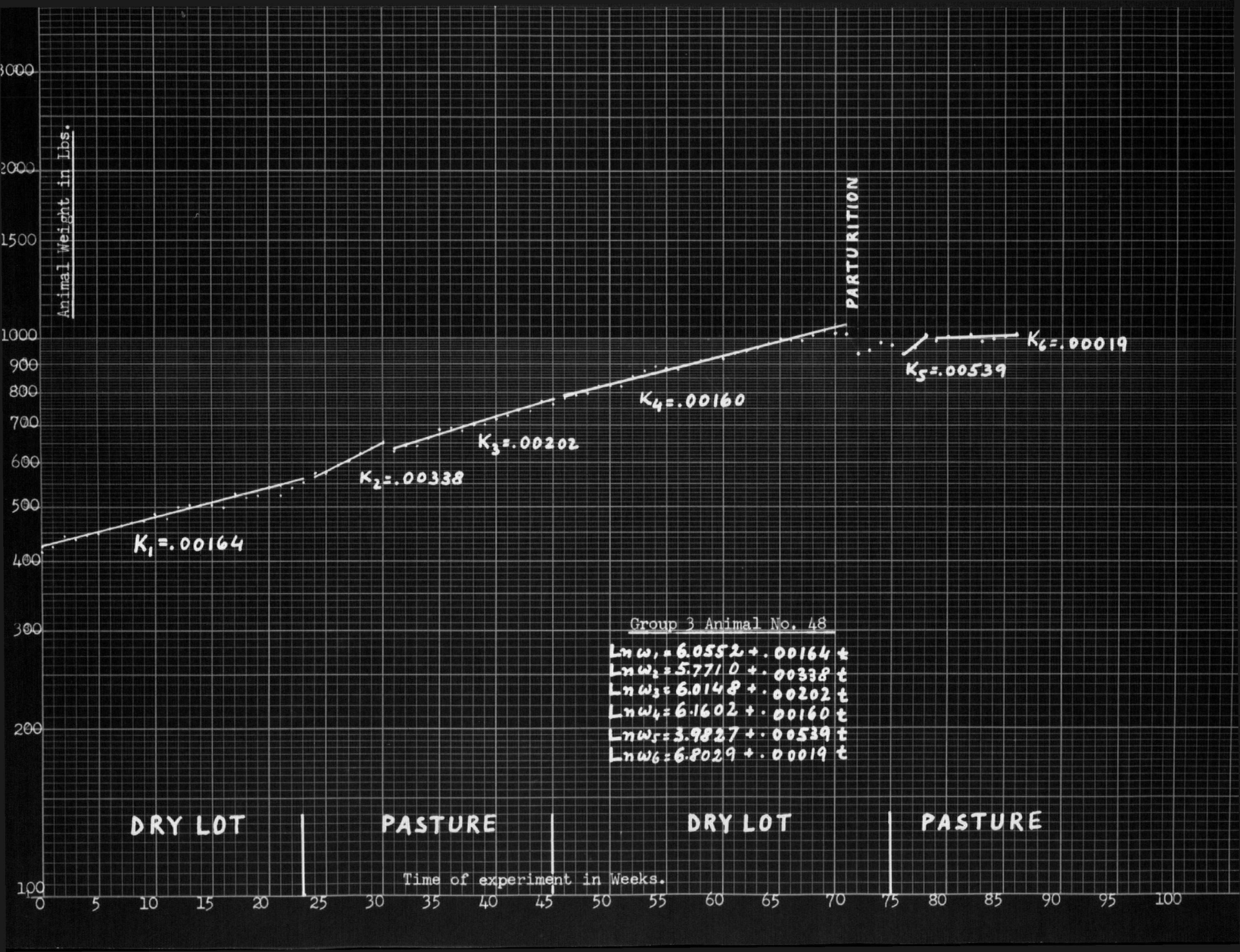

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00152
K_2=.00362
K_3=.00237
K_4=.00176
K_5=.00034
K_6=.0020
K_7=.00014
Group 2 Animal No. 43.
$Ln\ w_1 = 6.1171 + .00152\ t$
$Ln\ w_2 = 5.7987 + .00362\ t$
$Ln\ w_3 = 5.9834 + .00237\ t$
$Ln\ w_4 = 6.1870 + .00176\ t$
$Ln\ w_5 = 6.7493 + .00034\ t$
$Ln\ w_6 = 5.8734 + .00200\ t$
$Ln\ w_7 = 6.9011 + .00014\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

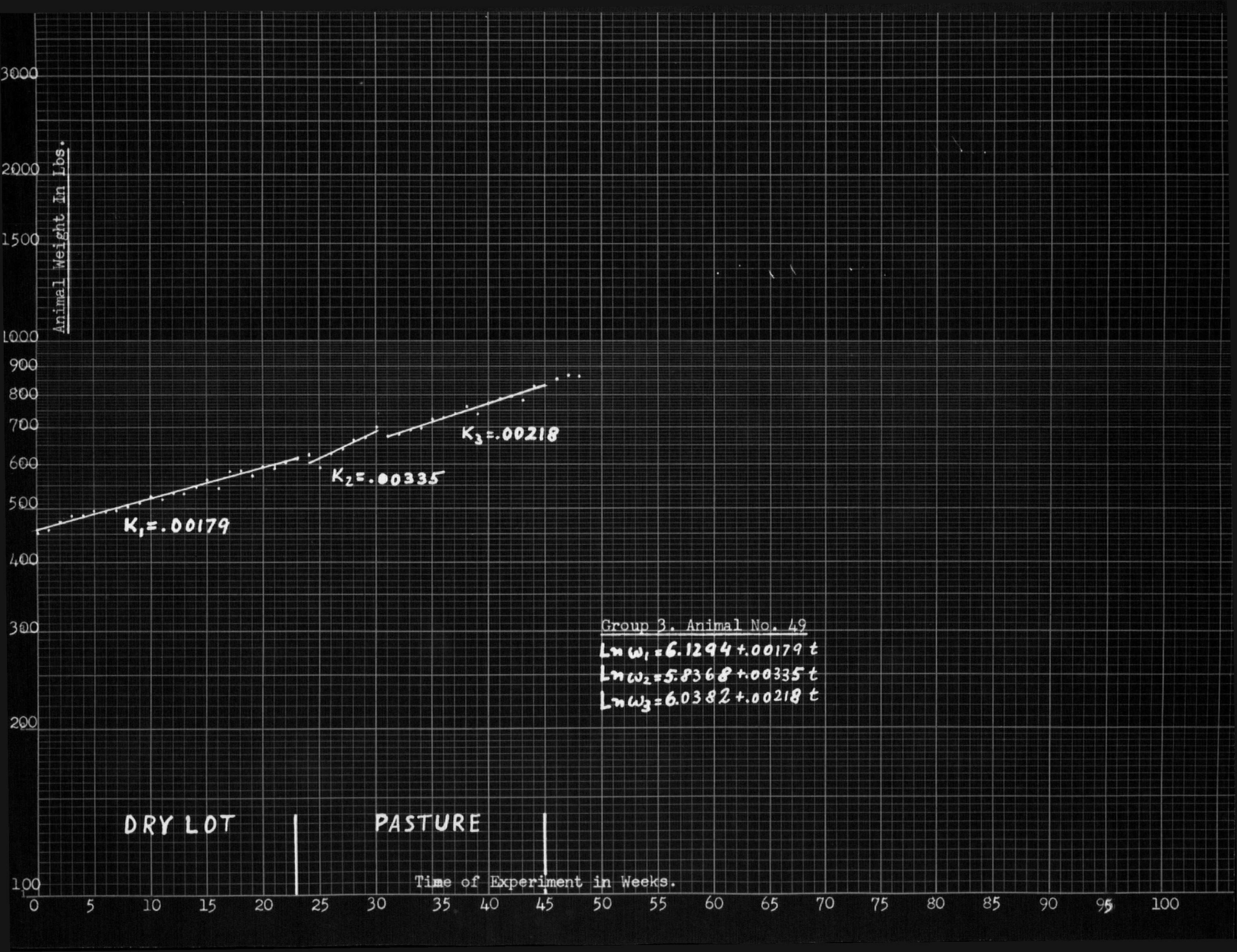

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00202
K_2=.00383
K_3=.00177
K_4=.00157
K_5=.00028
K_6=.00304
K_7=.-00003
Group 3 Animal No. 44
$Ln\ w_1 = 6.1870 + .00202$
$Ln\ w_2 = 5.8213 + .00383$
$Ln\ w_3 = 6.2186 + .00177$
$Ln\ w_4 = 6.3338 + .00157$
$Ln\ w_5 = 6.8706 + .00028$
$Ln\ w_6 = 5.4075 + .00304$
$Ln\ w_7 = 7.0612 - .00003$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100


Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00227
K_2=.00287
K_3=.00213
K_4=.00168
K_5=.00140
K_6=.00219
K_7=-.00017
Group 3 Animal No. 45
$\ln \omega_1 = 6.1803 + .00227\,t$
$\ln \omega_2 = 6.0647 + .00287\,t$
$\ln \omega_3 = 6.1890 + .00213\,t$
$\ln \omega_4 = 6.3484 + .00168\,t$
$\ln \omega_5 = 6.3617 + .00140\,t$
$\ln \omega_6 = 5.9184 + .00219\,t$
$\ln \omega_7 = 7.1911 - .00017\,t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


Animal Weight in Lbs.
3000
2000
500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00188
K_2=.00316
K_3=.00199
K_4=.00200
K_5=.00118
K_6=.00352
K_7=.00016
Group 3 Animal No. 46
$\ln \omega_1 = 6.2043 + .00188\ t$
$\ln \omega_2 = 5.9733 + .00316\ t$
$\ln \omega_3 = 6.1530 + .00199\ t$
$\ln \omega_4 = 6.1661 + .00200\ t$
$\ln \omega_5 = 6.4264 + .00118\ t$
$\ln \omega_6 = 5.1701 + .00352\ t$
$\ln \omega_7 = 7.0012 + .00016\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00174
K_2=.00182
K_3=.00209
K_4=.00241
K_5=-.00045
Group 3 Animal No. 47
Ln ω_1 = 6.1076 +.00174 t
Ln ω_2 = 6.1061 +.00182 t
Ln ω_3 = 6.0317 +.00209 t
Ln ω_4 = 5.6936 +.00241 t
Ln ω_5 = 7.2467 -.00045 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00164
K_2=.00338
K_3=.00202
K_4=.00160
K_5=.00539
K_6=.00019
Group 3 Animal No. 48
$\ln \omega_1 = 6.0552 + .00164\ t$
$\ln \omega_2 = 5.7710 + .00338\ t$
$\ln \omega_3 = 6.0148 + .00202\ t$
$\ln \omega_4 = 6.1602 + .00160\ t$
$\ln \omega_5 = 3.9827 + .00539\ t$
$\ln \omega_6 = 6.8029 + .00019\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

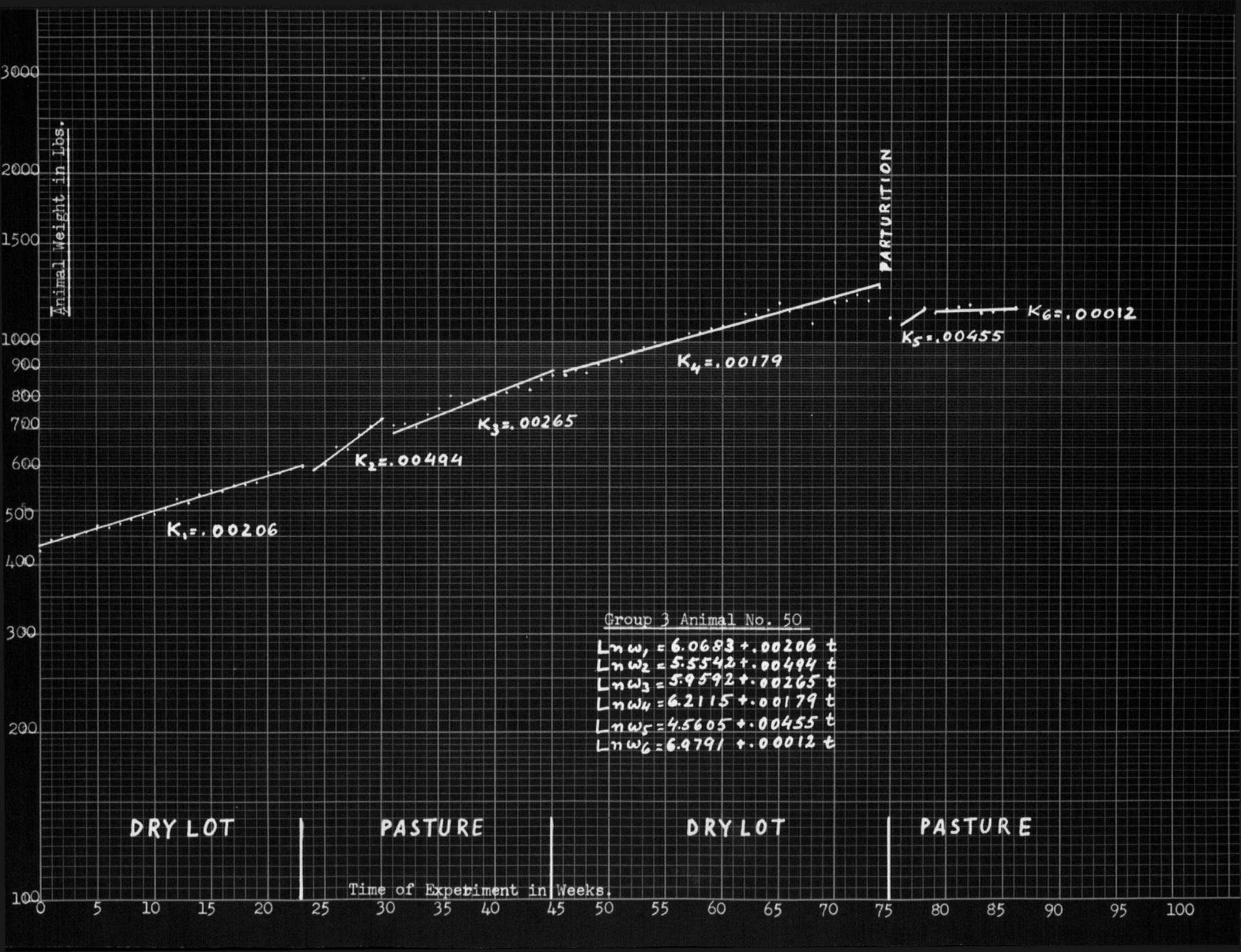


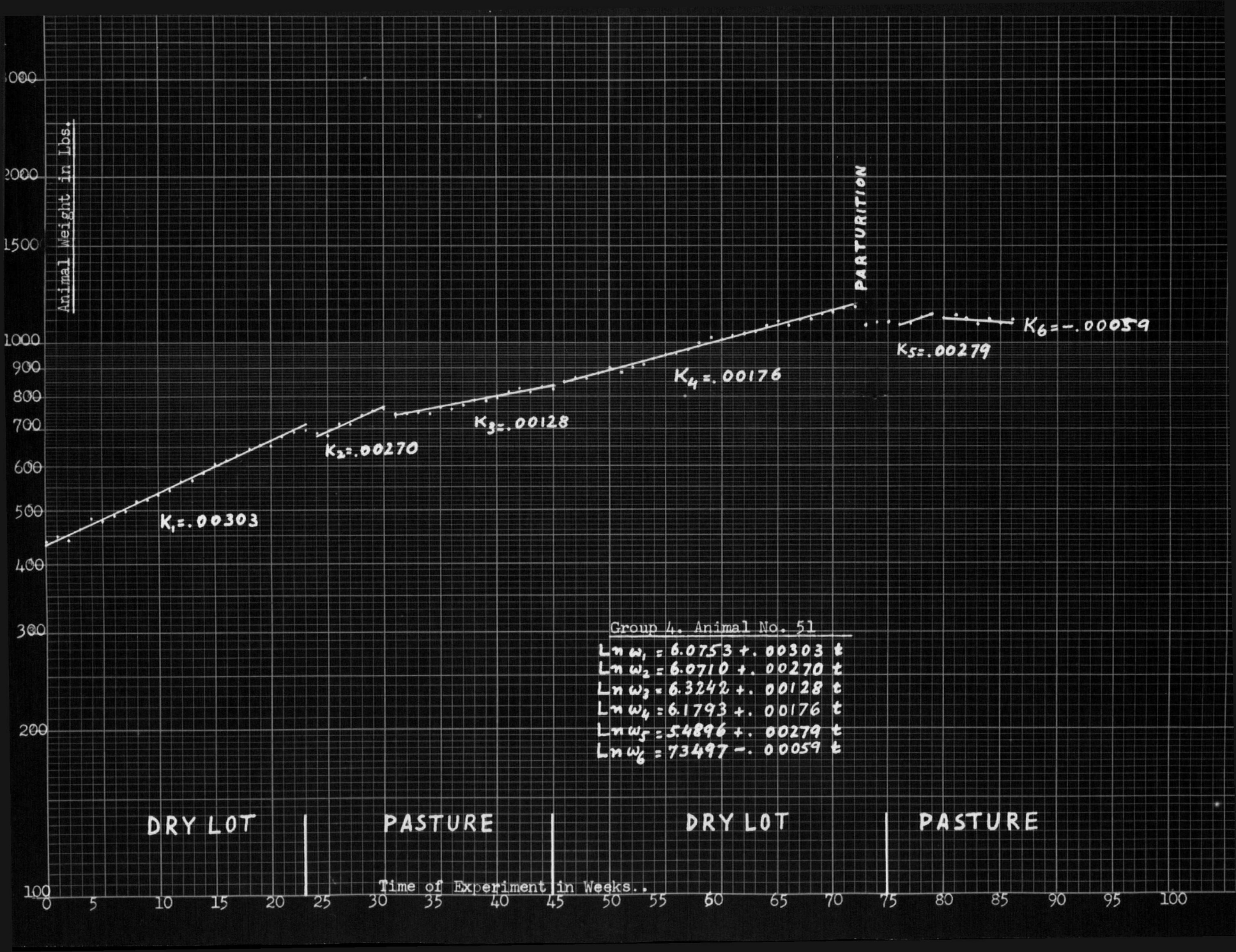
Group 3. Animal No. 49

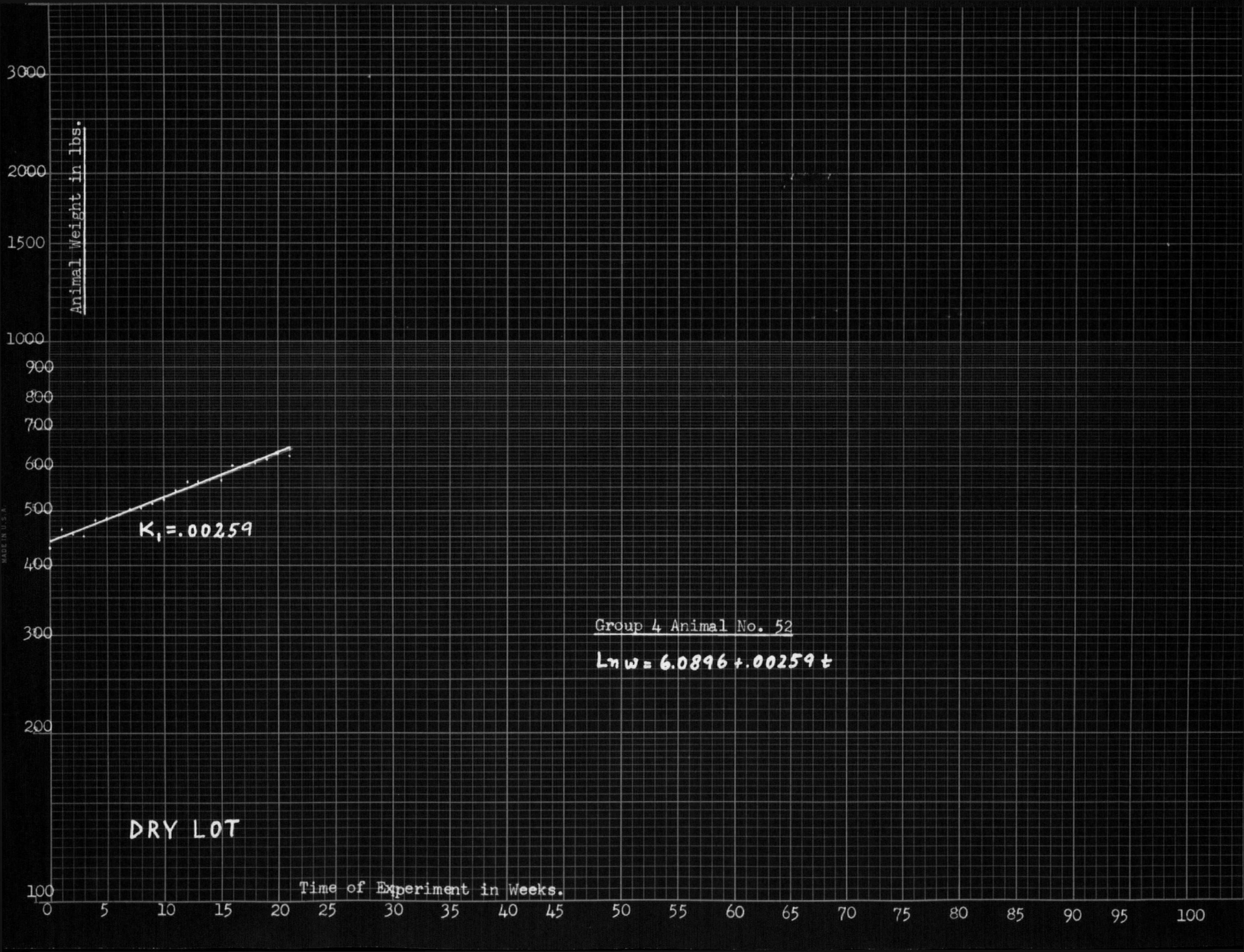
$\ln \omega_1 = 6.1294 + .00179\,t$

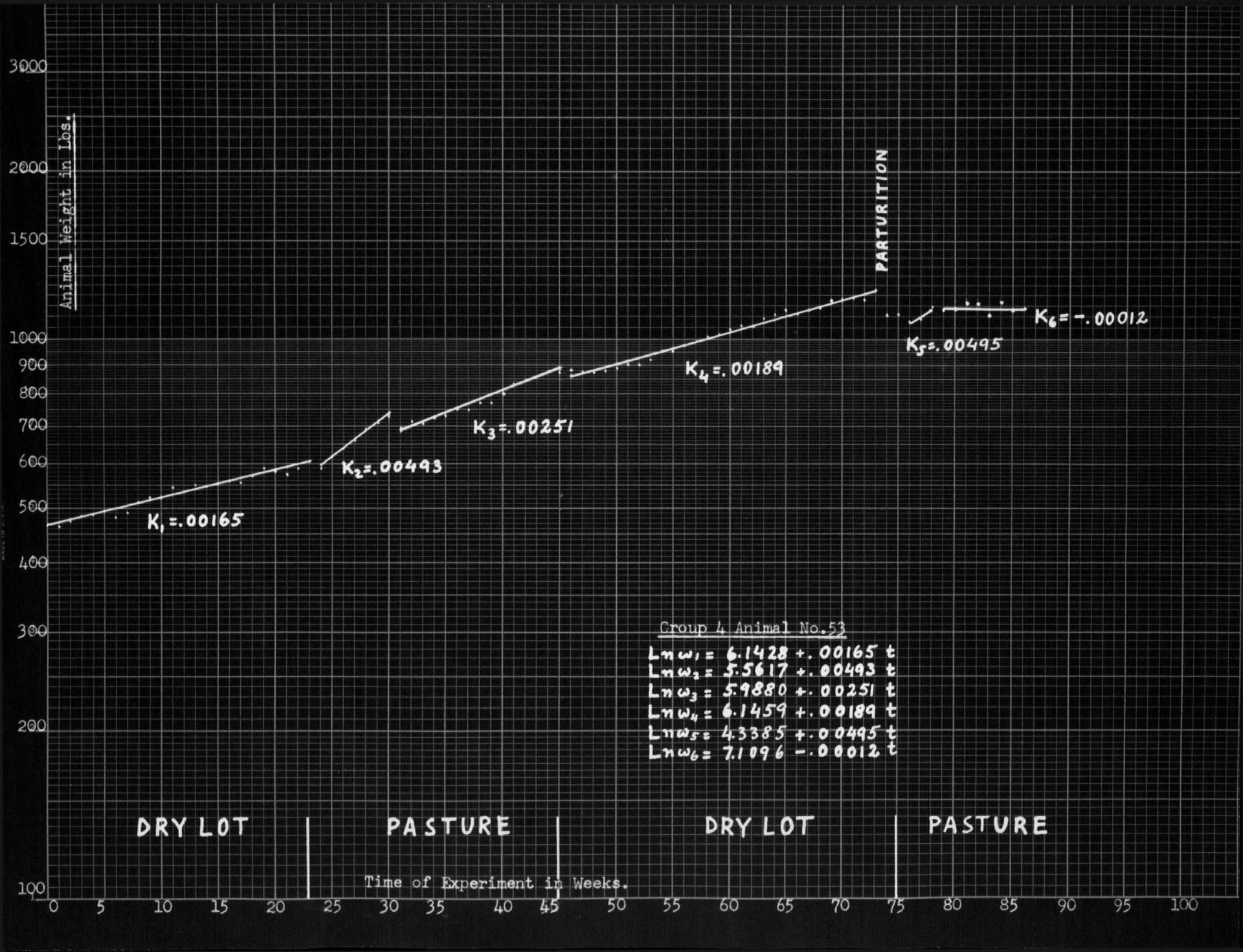
$\ln \omega_2 = 5.8368 + .00335\,t$

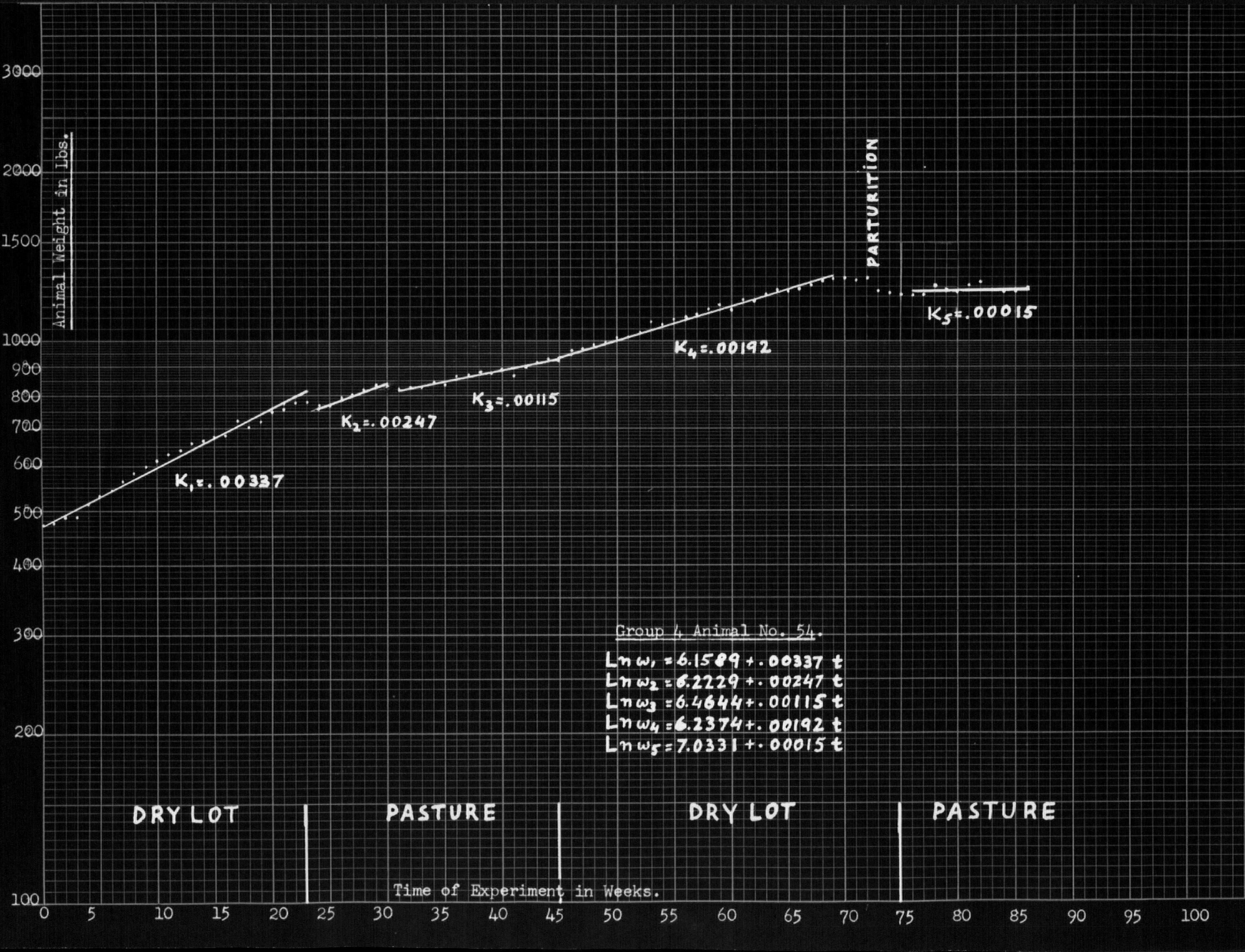
$\ln \omega_3 = 6.0382 + .00218\,t$

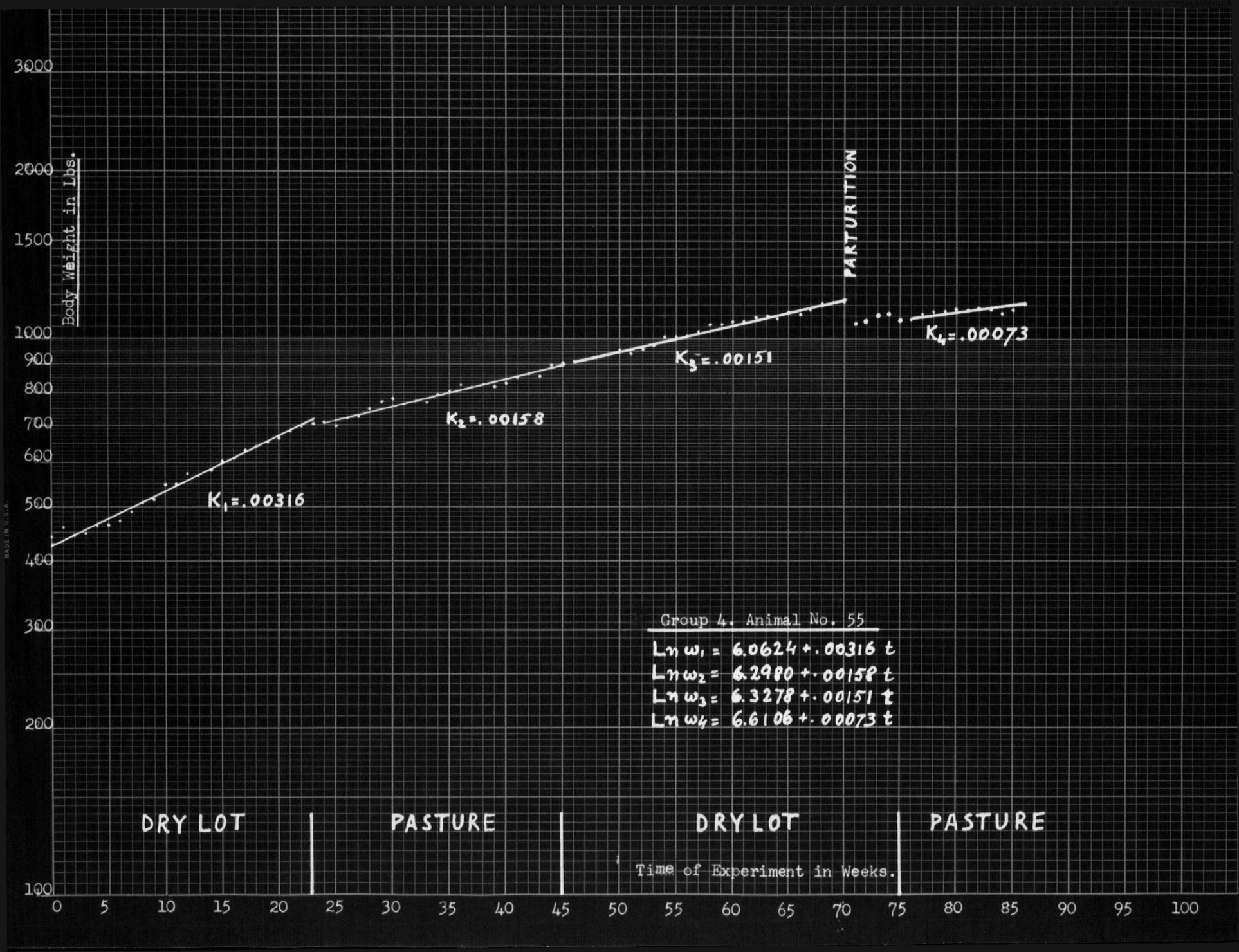

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00206
K_2=.00494
K_3=.00265
K_4=.00179
K_5=.00455
K_6=.00012
Group 3 Animal No. 50
$\ln w_1 = 6.0683 + .00206\ t$
$\ln w_2 = 5.5542 + .00494\ t$
$\ln w_3 = 5.9592 + .00265\ t$
$\ln w_4 = 6.2115 + .00179\ t$
$\ln w_5 = 4.5605 + .00455\ t$
$\ln w_6 = 6.9791 + .00012\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

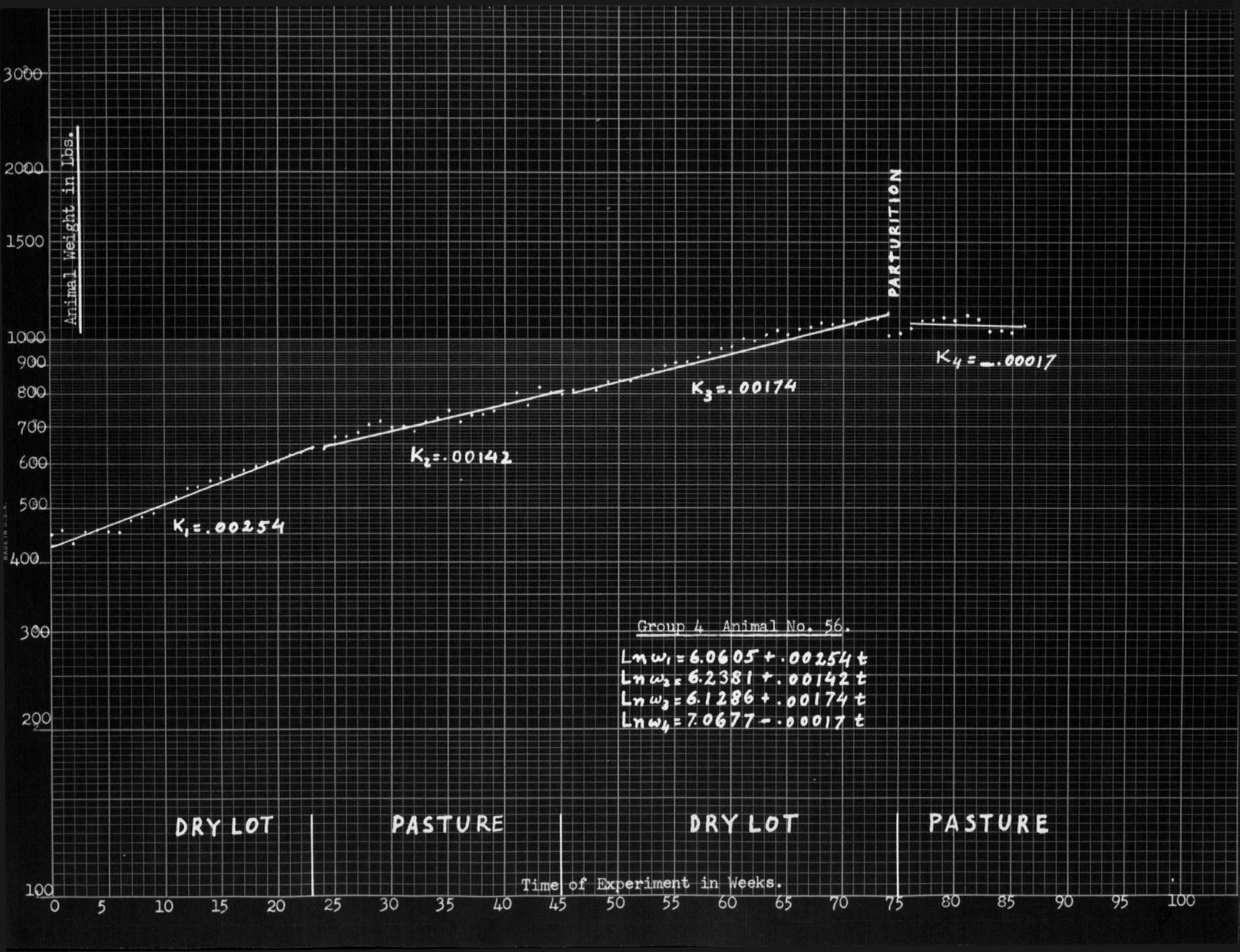

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00303
K_2=.00270
K_3=.00128
K_4=.00176
K_5=.00279
K_6=-.00059
Group 4. Animal No. 51
$Ln\ w_1 = 6.0753 + .00303\ t$
$Ln\ w_2 = 6.0710 + .00270\ t$
$Ln\ w_3 = 6.3242 + .00128\ t$
$Ln\ w_4 = 6.1793 + .00176\ t$
$Ln\ w_5 = 5.4896 + .00279\ t$
$Ln\ w_6 = 73497 - .00059\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks..
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

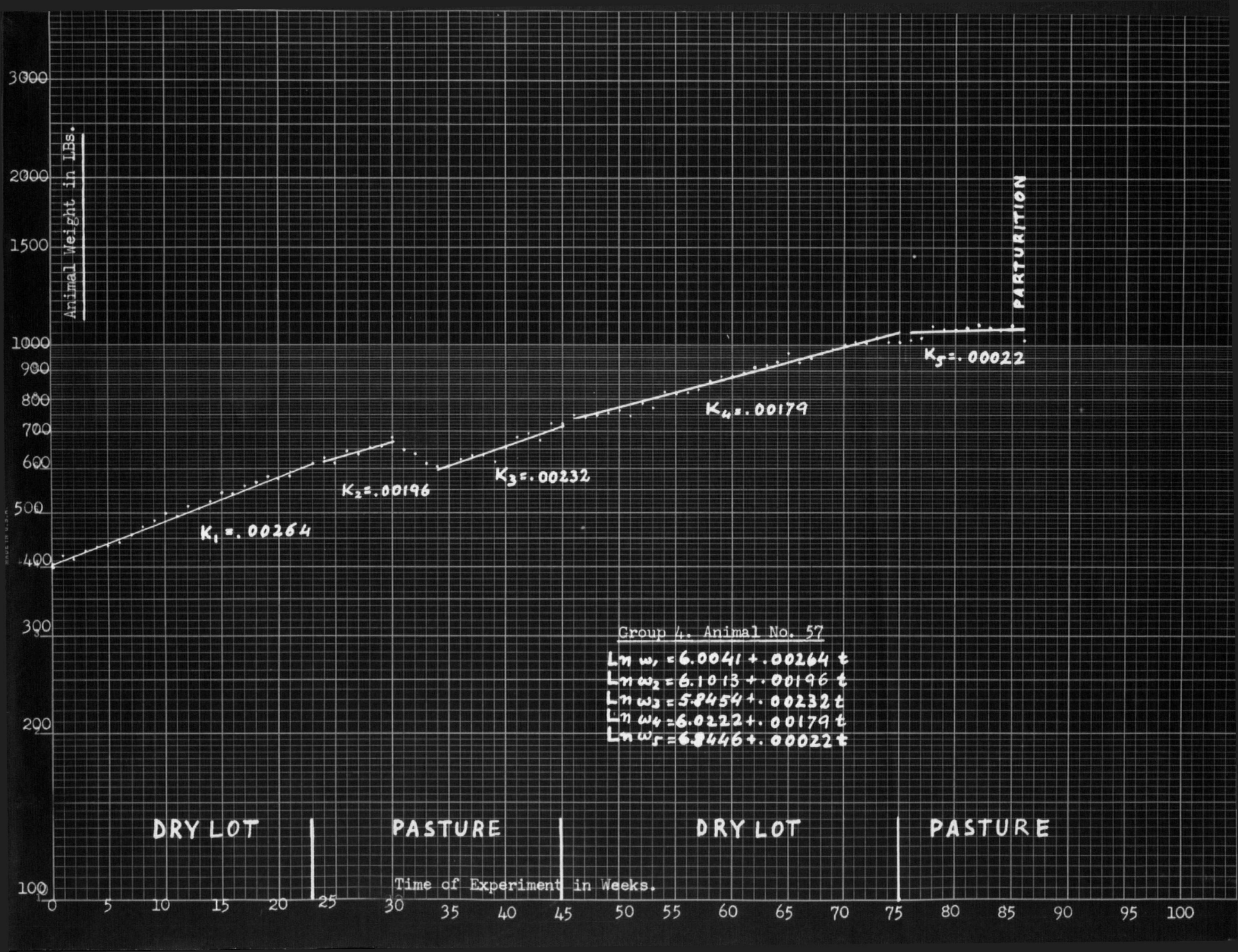

Animal Weight in lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
$K_1 = .00259$
Group 4 Animal No. 52
$Ln\ w = 6.0896 + .00259\ t$
DRY LOT
Time of Experiment in Weeks.
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

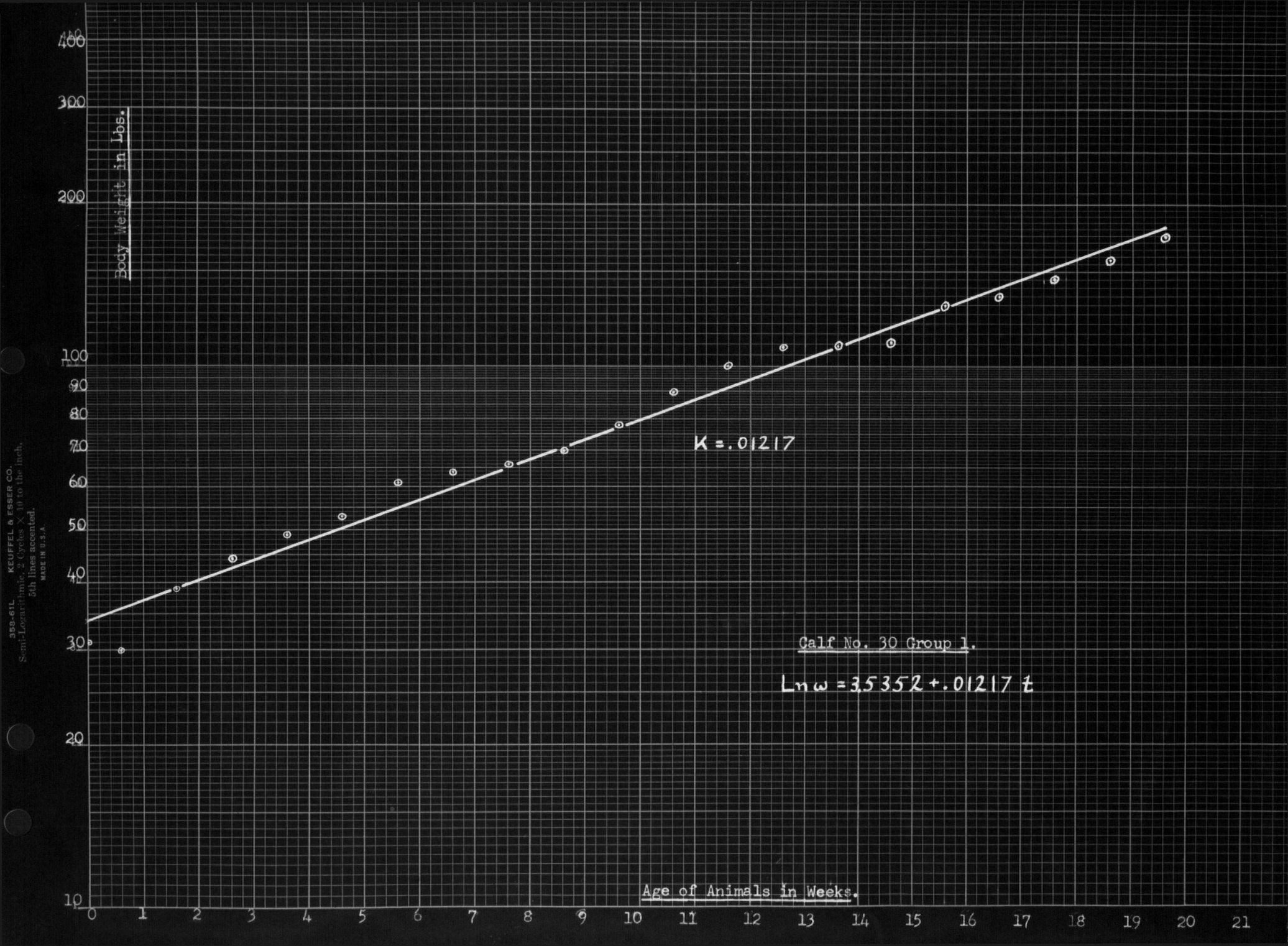

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1 = .00165
K_2 = .00493
K_3 = .00251
K_4 = .00189
K_5 = .00495
K_6 = -.00012
Group 4 Animal No. 53
$Ln\,\omega_1 = 6.1428 + .00165\,t$
$Ln\,\omega_2 = 5.5617 + .00493\,t$
$Ln\,\omega_3 = 5.9880 + .00251\,t$
$Ln\,\omega_4 = 6.1459 + .00189\,t$
$Ln\,\omega_5 = 4.3385 + .00495\,t$
$Ln\,\omega_6 = 7.1096 - .00012\,t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

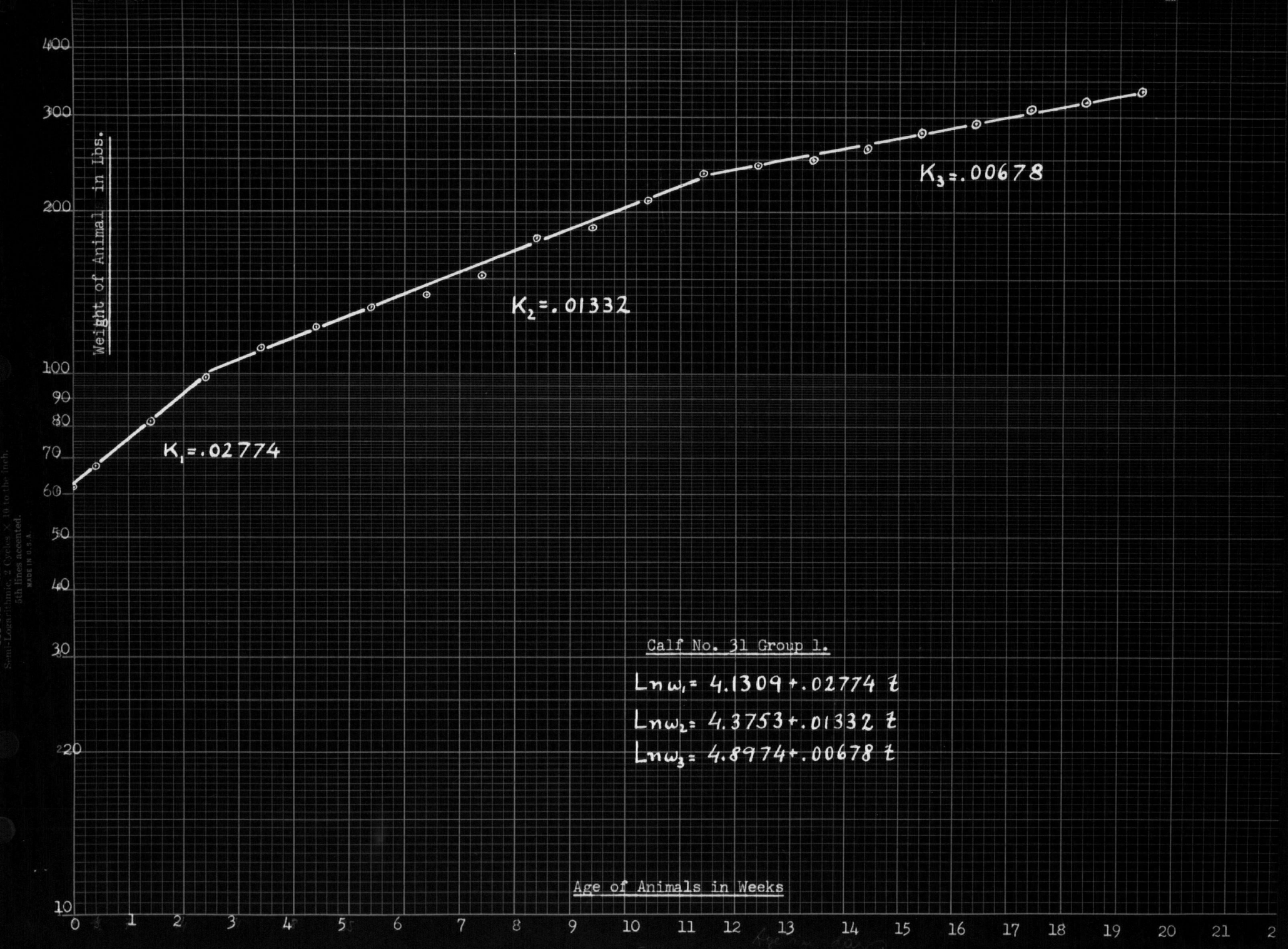

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00337
K_2=.00247
K_3=.00115
K_4=.00192
K_5=.00015
Group 4 Animal No. 54.
$Ln\ \omega_1 = 6.1589 + .00337\ t$
$Ln\ \omega_2 = 6.2229 + .00247\ t$
$Ln\ \omega_3 = 6.4644 + .00115\ t$
$Ln\ \omega_4 = 6.2374 + .00192\ t$
$Ln\ \omega_5 = 7.0331 + .00015\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

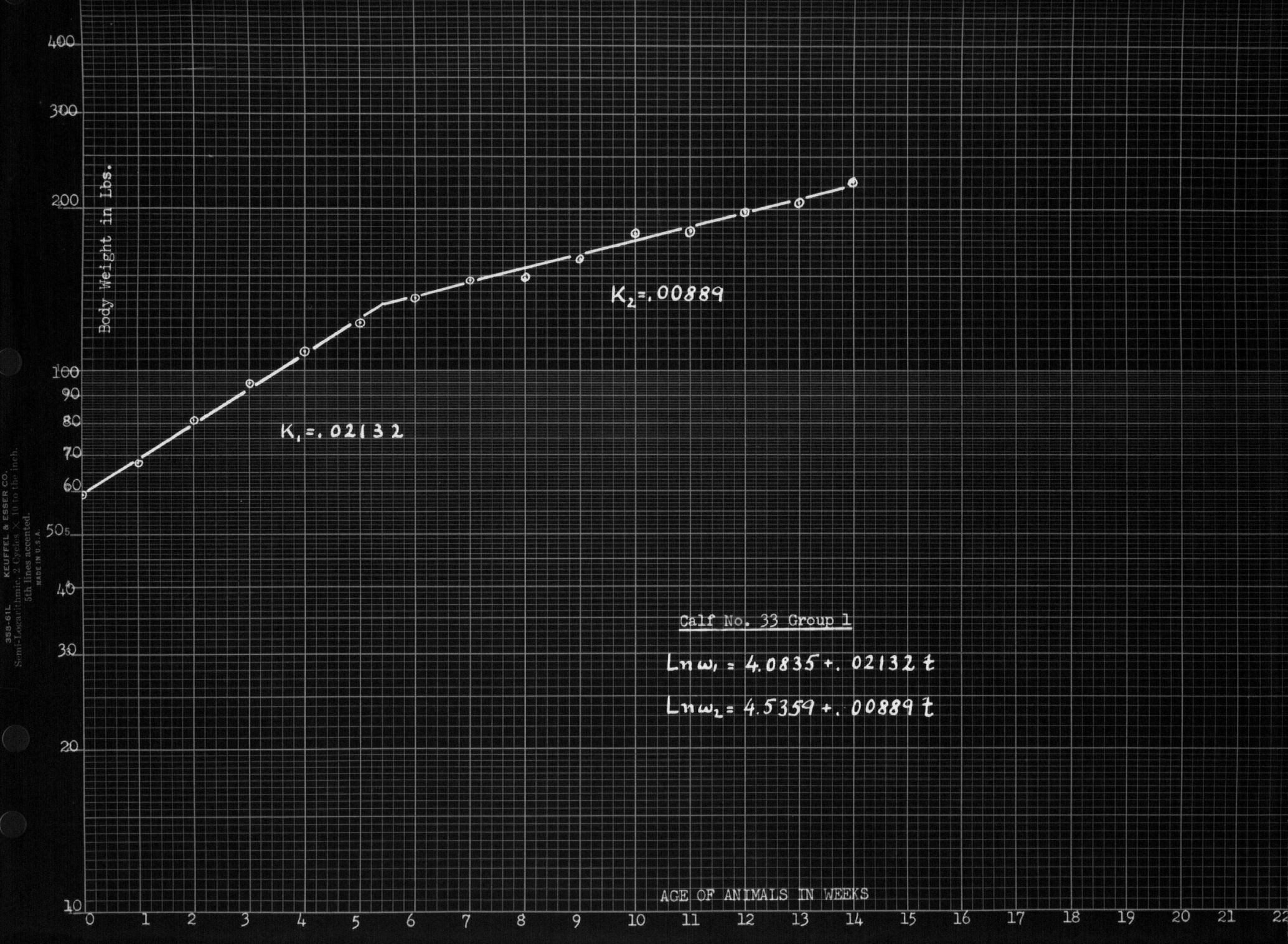

Body Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
K_1=.00316
K_2=.00158
K_3=.00151
K_4=.00073
Group 4. Animal No. 55
Ln ω_1 = 6.0624 +.00316 t
Ln ω_2 = 6.2980 +.00158 t
Ln ω_3 = 6.3278 +.00151 t
Ln ω_4 = 6.6106 +.00073 t
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

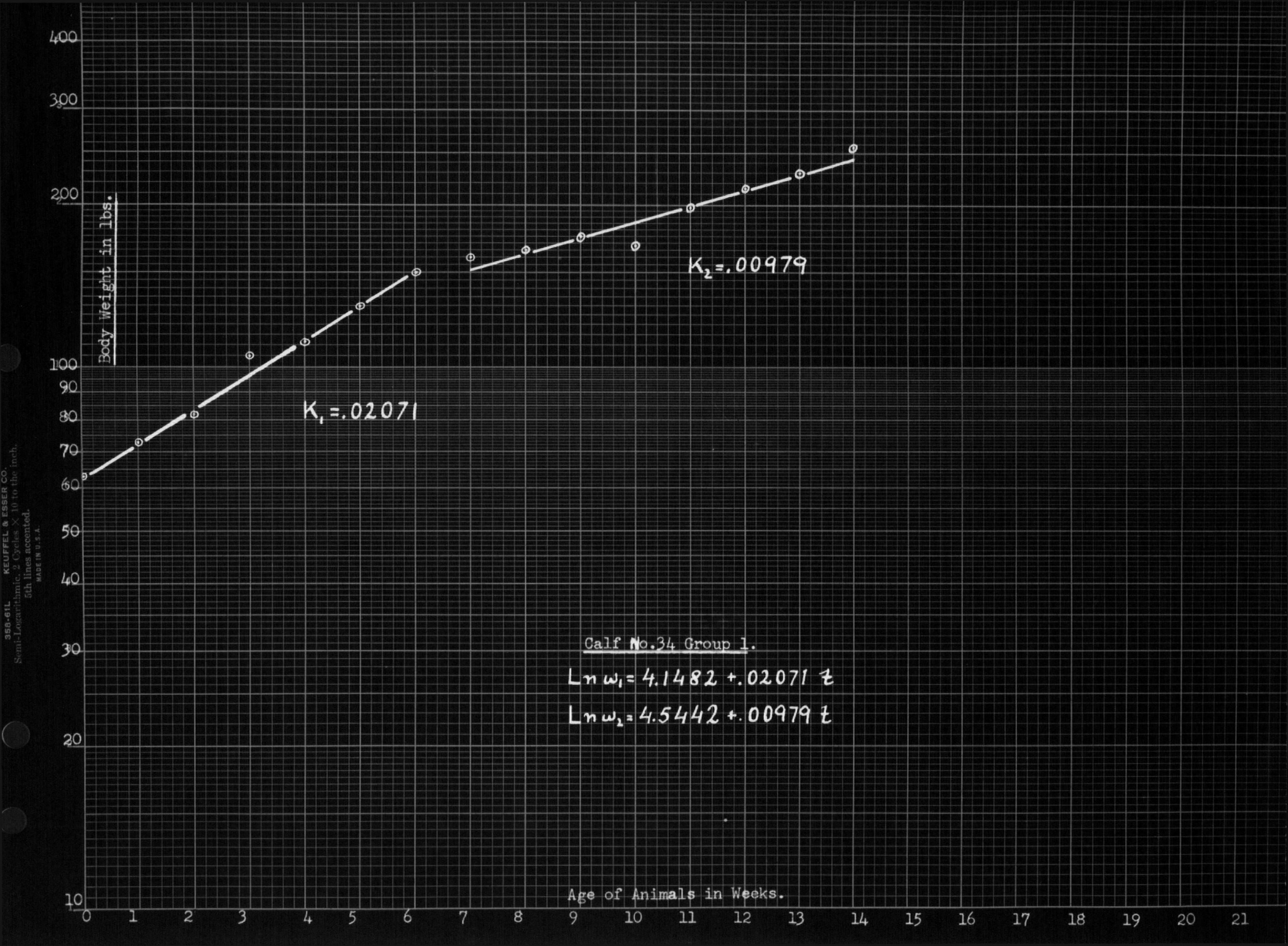

Animal Weight in Lbs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
$K_1 = .00254$
$K_2 = .00142$
$K_3 = .00174$
$K_4 = -.00017$
Group 4 Animal No. 56.
$Ln\,\omega_1 = 6.0605 + .00254\,t$
$Ln\,\omega_2 = 6.2381 + .00142\,t$
$Ln\,\omega_3 = 6.1286 + .00174\,t$
$Ln\,\omega_4 = 7.0677 - .00017\,t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

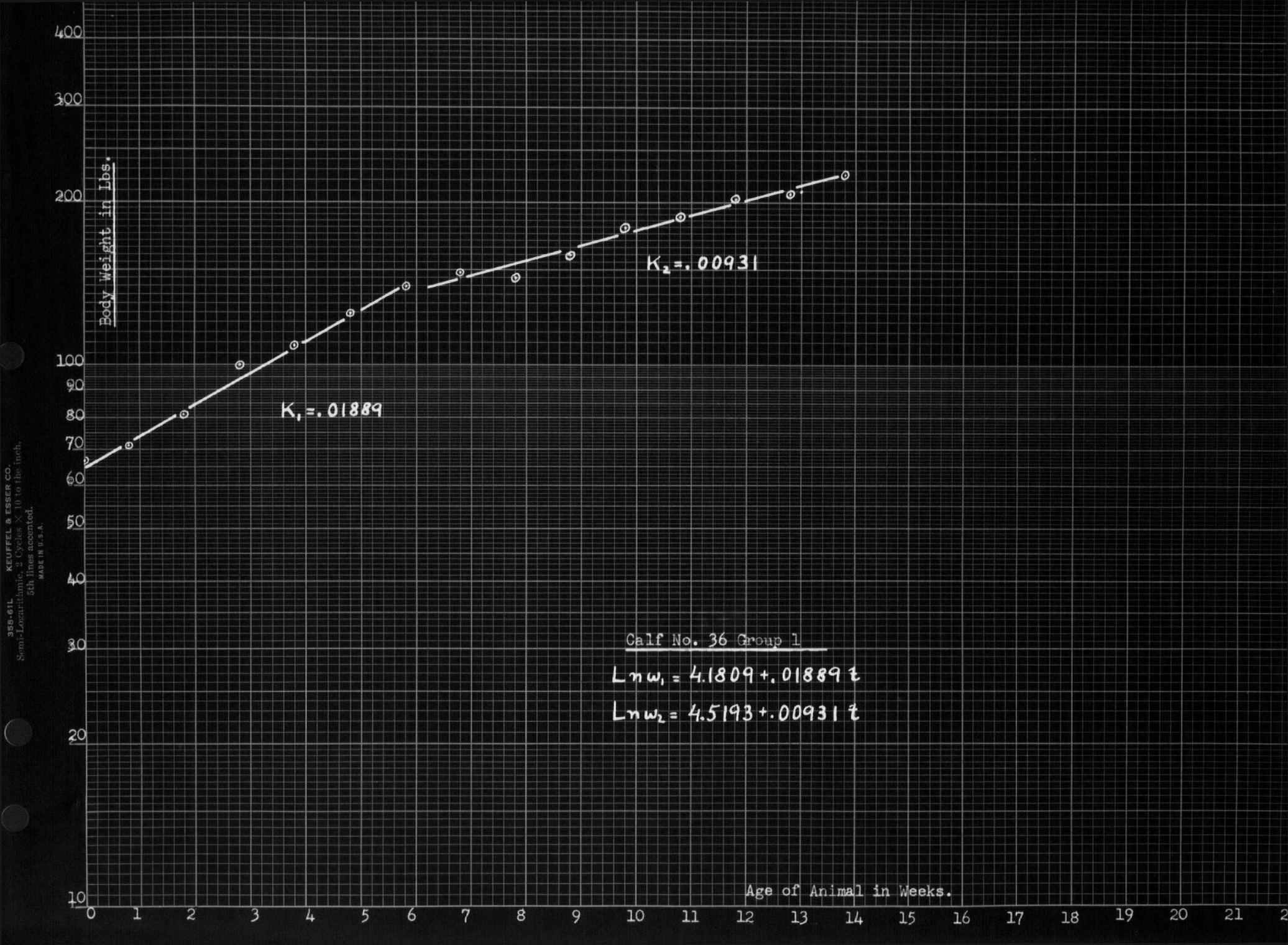

Animal Weight in LBs.
3000
2000
1500
1000
900
800
700
600
500
400
300
200
100
PARTURITION
$K_1 = .00264$
$K_2 = .00196$
$K_3 = .00232$
$K_4 = .00179$
$K_5 = .00022$
Group 4. Animal No. 57
$Ln\ w_1 = 6.0041 + .00264\ t$
$Ln\ w_2 = 6.1013 + .00196\ t$
$Ln\ w_3 = 5.8454 + .00232\ t$
$Ln\ w_4 = 6.0222 + .00179\ t$
$Ln\ w_5 = 6.0446 + .00022\ t$
DRY LOT
PASTURE
DRY LOT
PASTURE
Time of Experiment in Weeks.
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

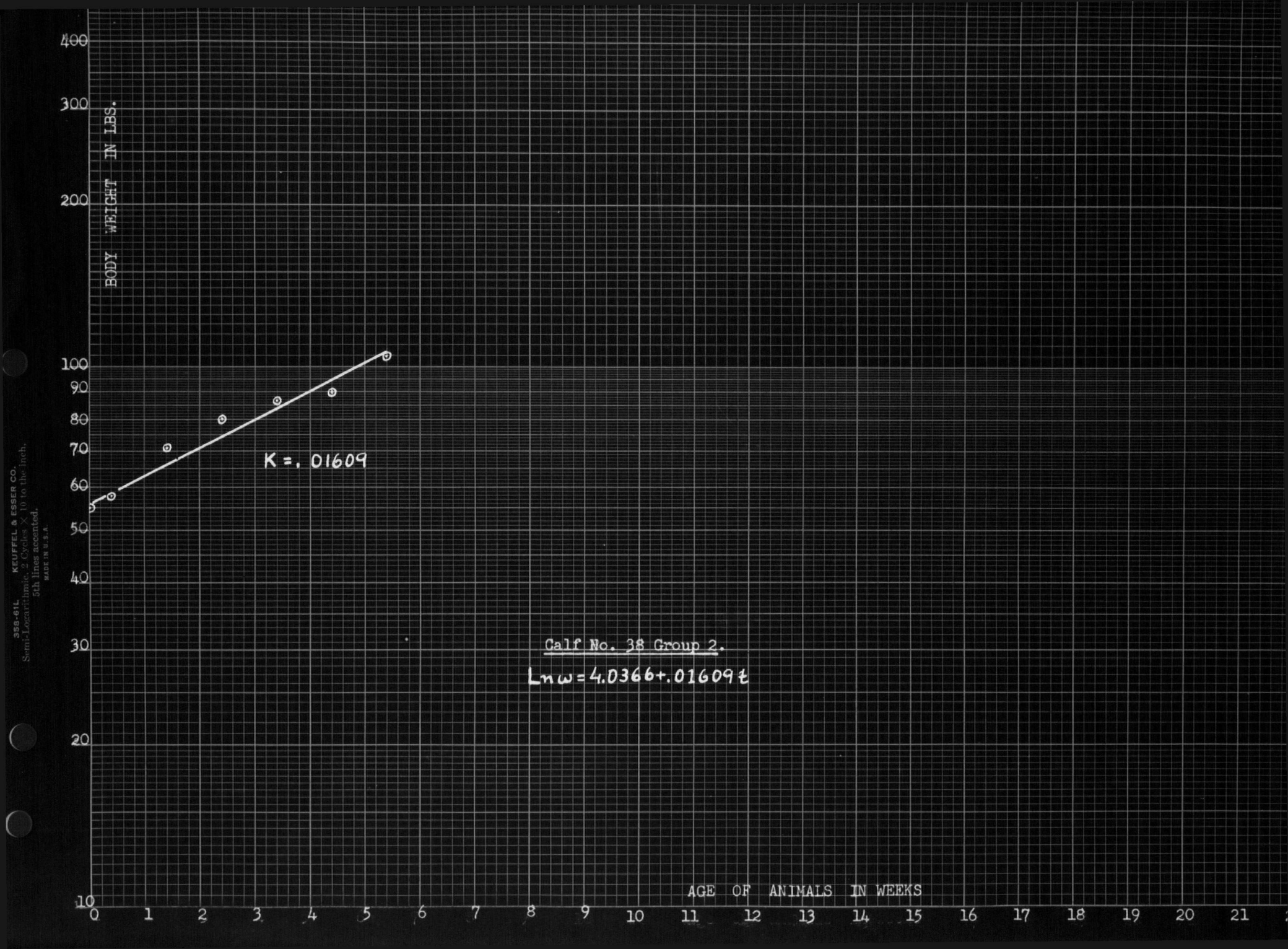

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K = .01217
Calf No. 30 Group 1.
Ln ω = 3.5352 + .01217 t
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
358-61L KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles × 10 to the inch.
5th lines accented.
MADE IN U.S.A.

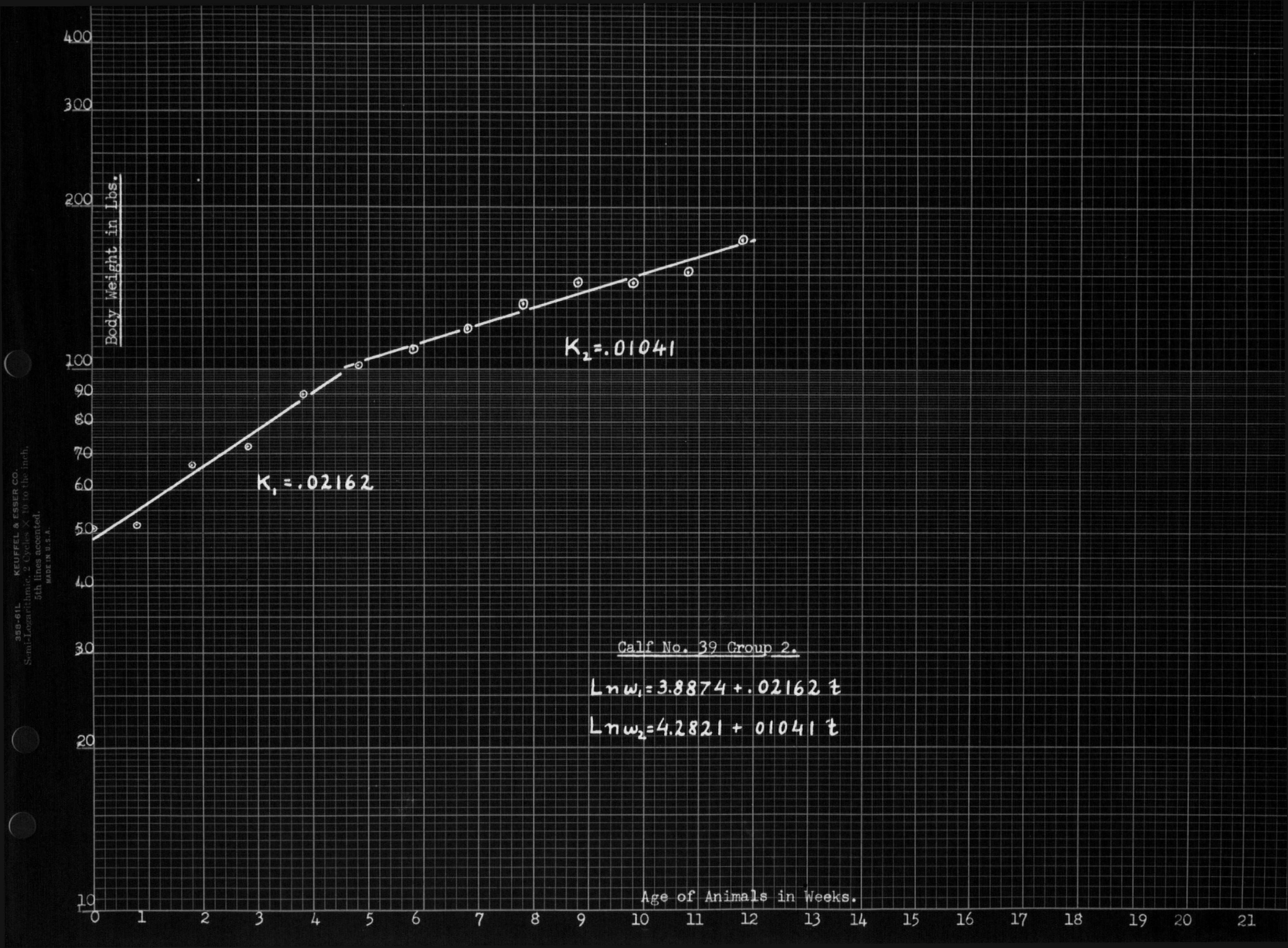

Weight of Animal in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .02774$
$K_2 = .01332$
$K_3 = .00678$
Calf No. 31 Group 1.
$Ln\omega_1 = 4.1309 + .02774\ t$
$Ln\omega_2 = 4.3753 + .01332\ t$
$Ln\omega_3 = 4.8974 + .00678\ t$
Age of Animals in Weeks
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 2

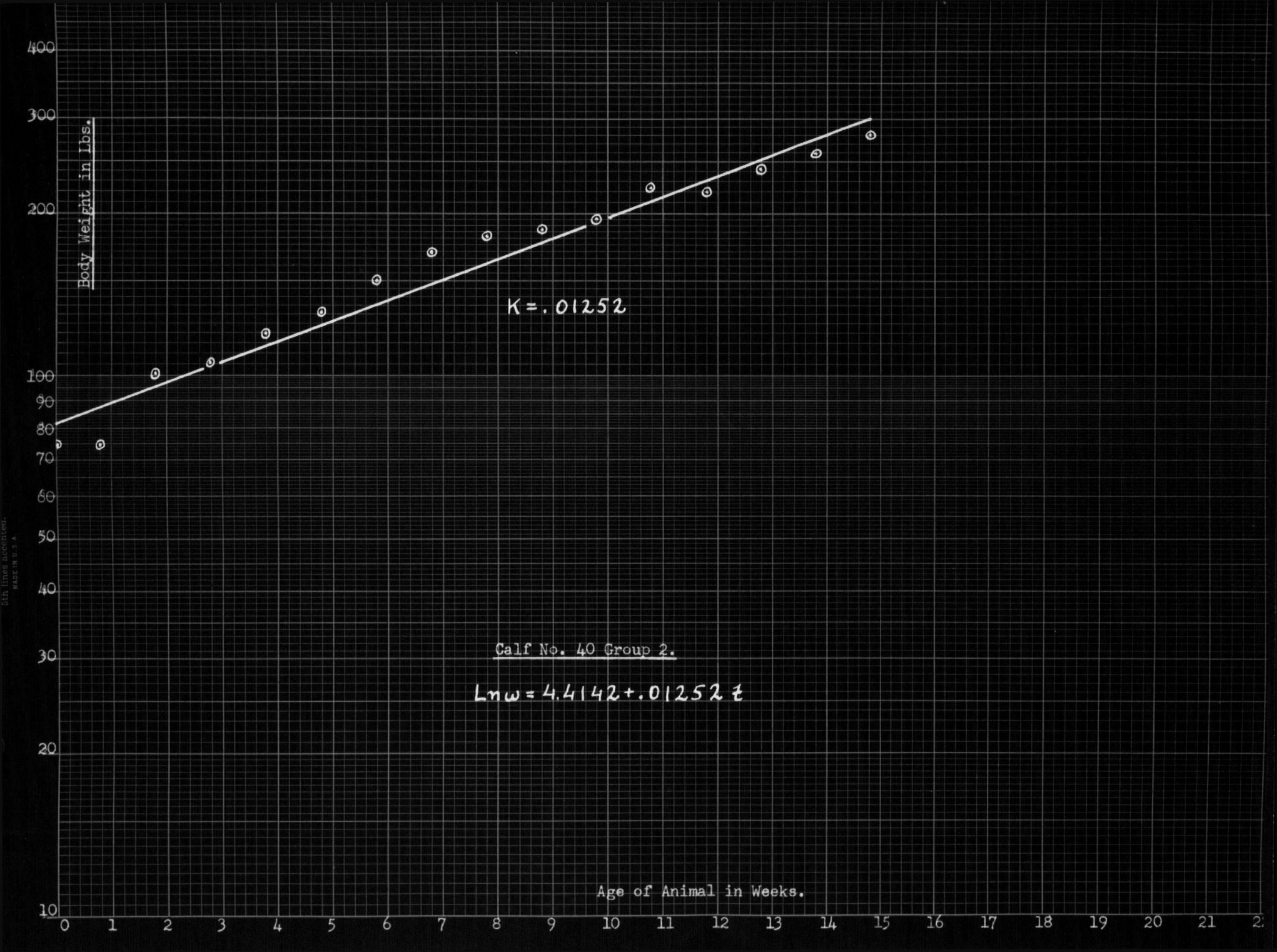

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .02132$
$K_2 = .00889$
Calf No. 33 Group 1
$\ln \omega_1 = 4.0835 + .02132\,t$
$\ln \omega_2 = 4.5359 + .00889\,t$
AGE OF ANIMALS IN WEEKS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

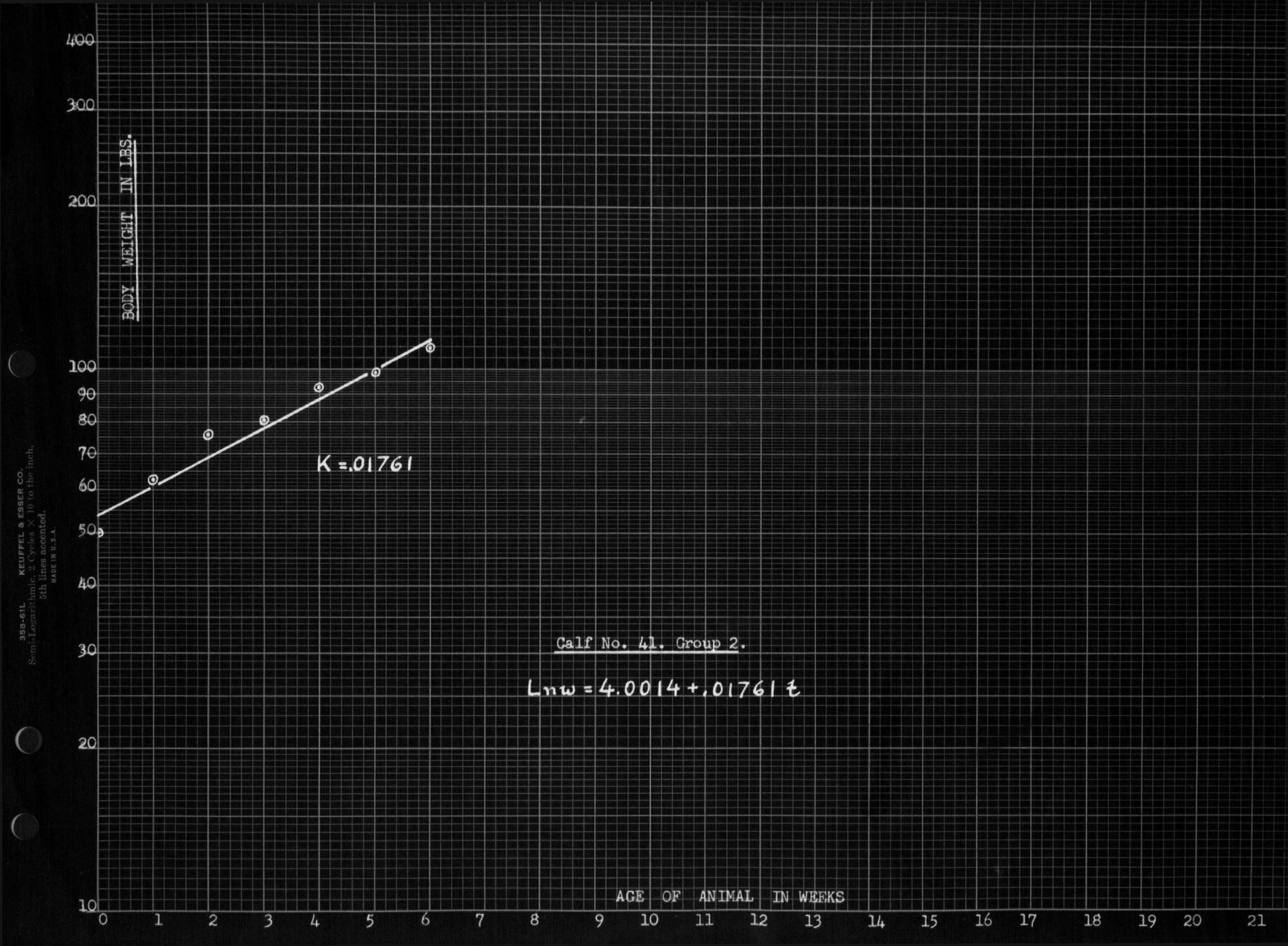


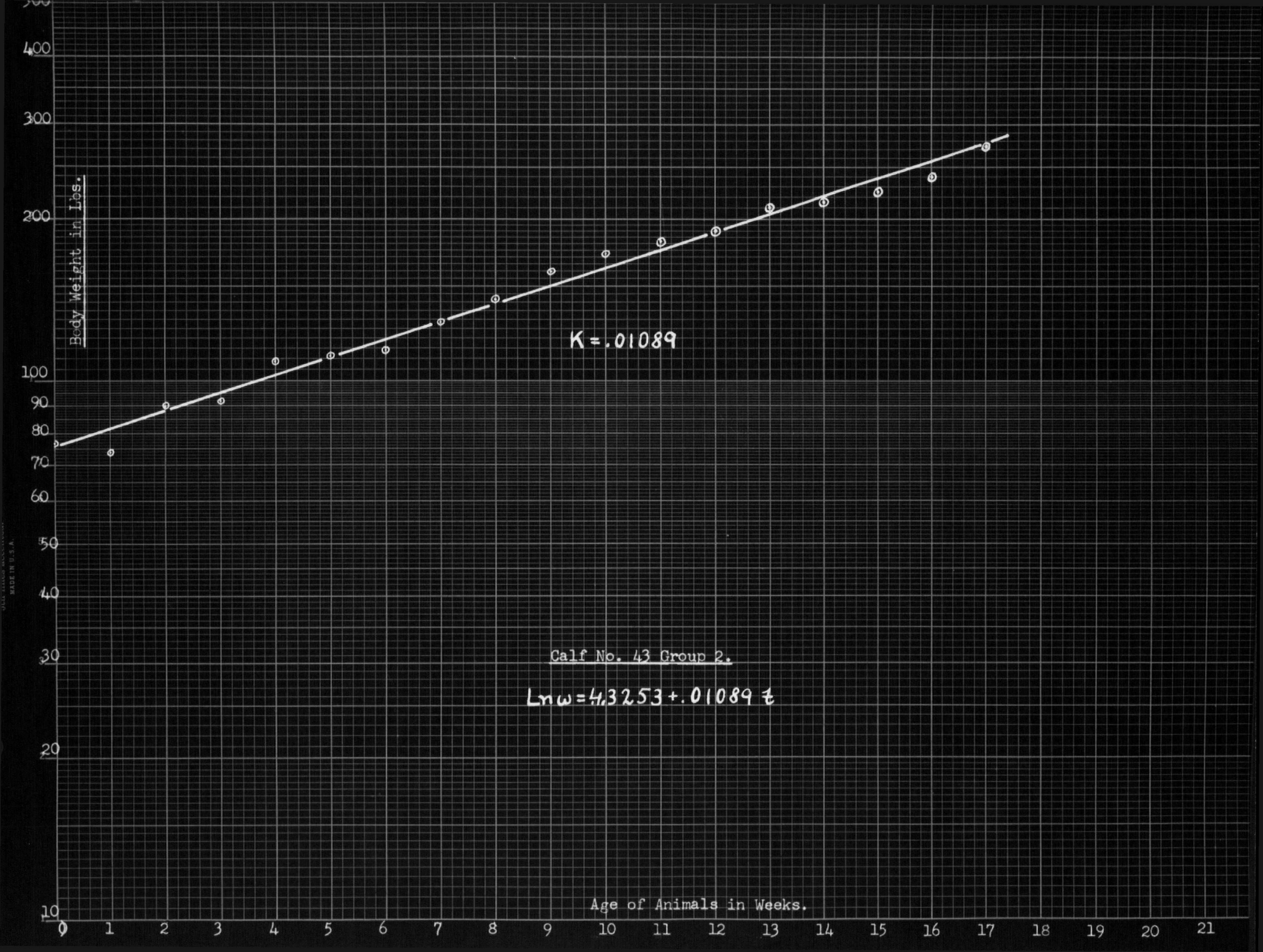

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .01889$
$K_2 = .00931$
Calf No. 36 Group 1
$Ln w_1 = 4.1809 + .01889 t$
$Ln w_2 = 4.5193 + .00931 t$
Age of Animal in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
358-61L KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles X 10 to the inch,
5th lines accented.
MADE IN U.S.A.

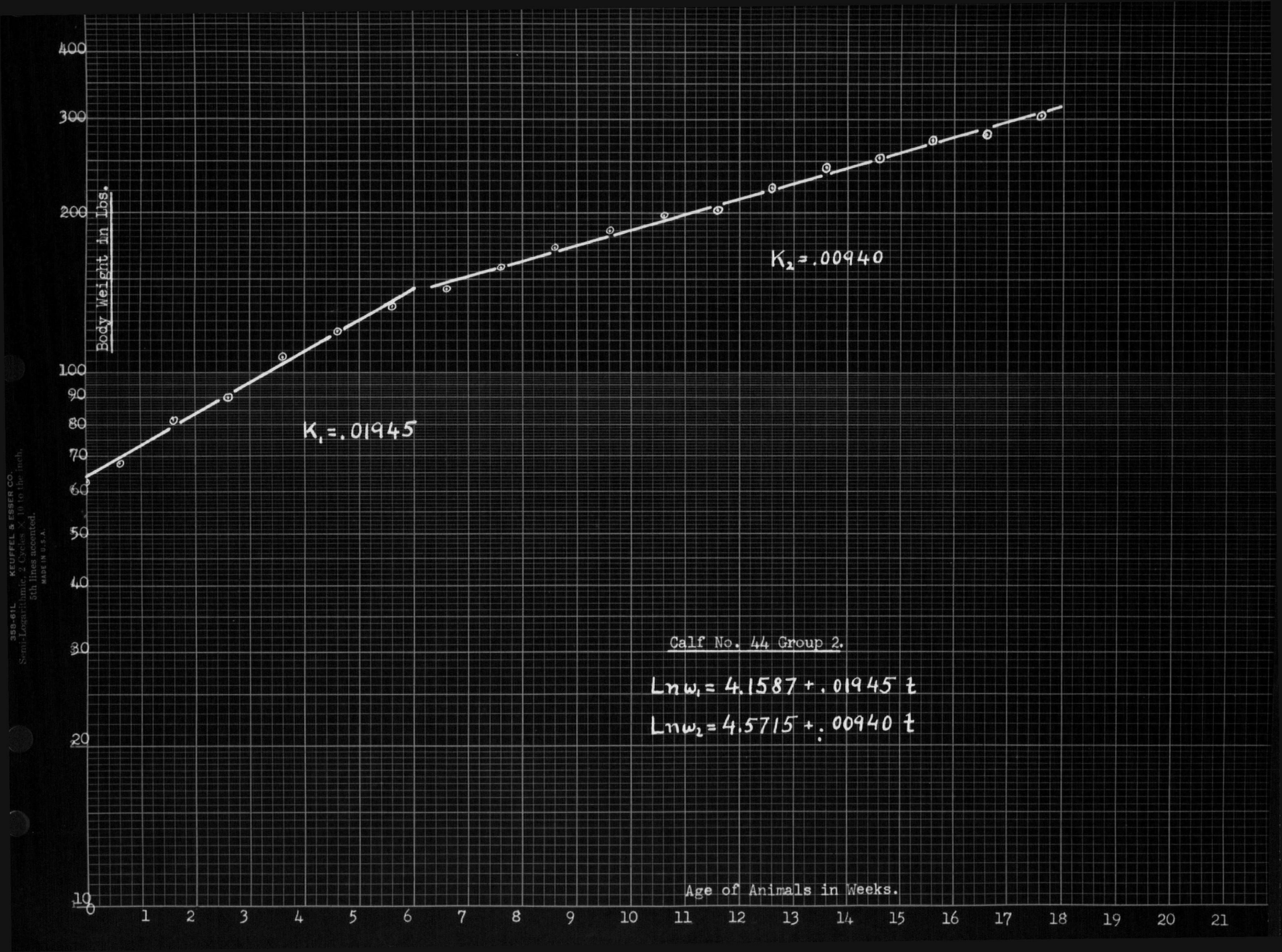

BODY WEIGHT IN LBS.
400
300
200
100
90
80
70
60
50
40
30
20
10
K =. 01609
Calf No. 38 Group 2.
Lnω = 4.0366 + .01609t
AGE OF ANIMALS IN WEEKS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
358-61L KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles × 10 to the inch.
5th lines accented.
MADE IN U.S.A.

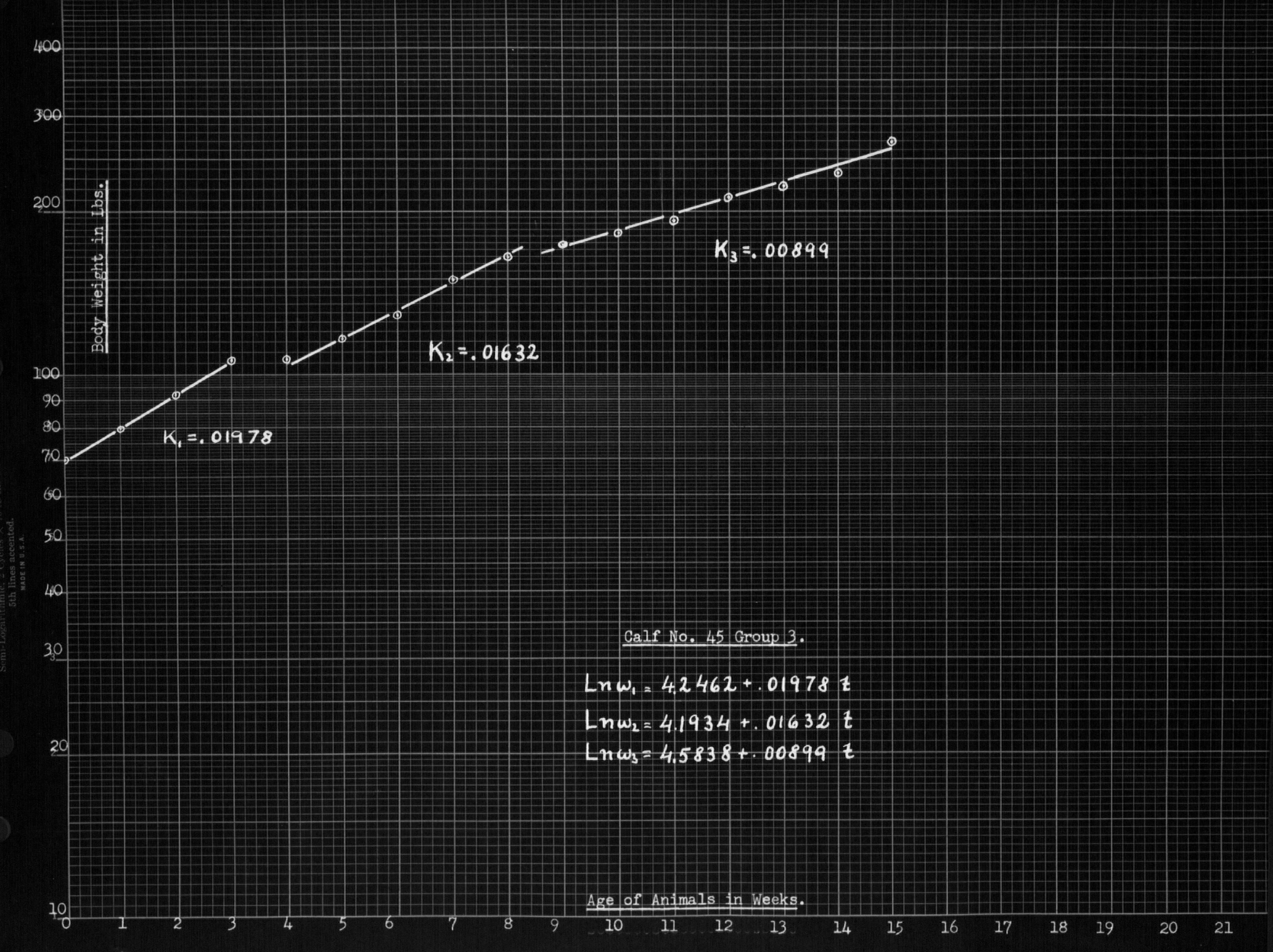

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .02162$
$K_2 = .01041$
Calf No. 39 Group 2.
$Ln\,w_1 = 3.8874 + .02162\,t$
$Ln\,w_2 = 4.2821 + 01041\,t$
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

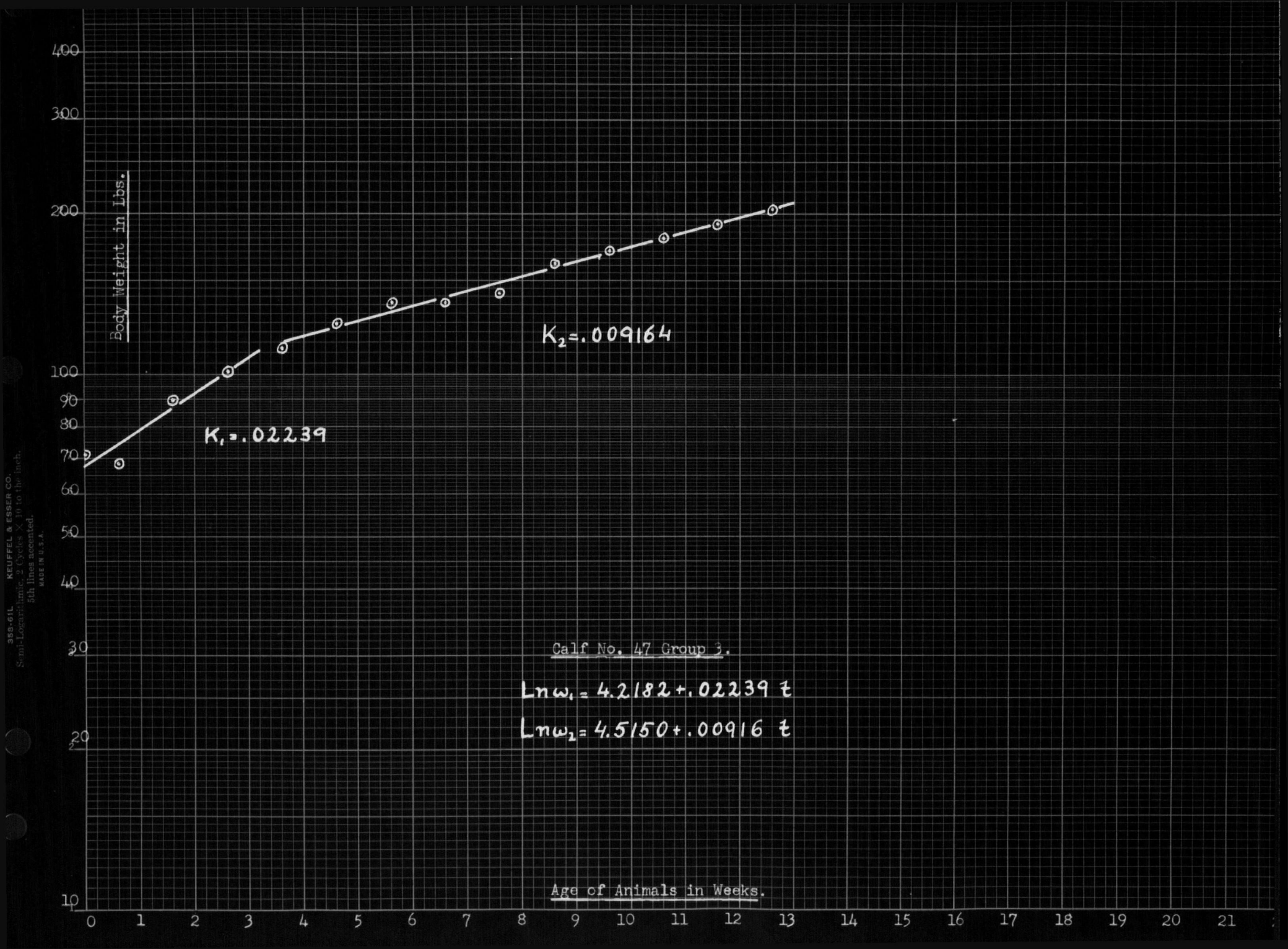

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K=.01252
Calf No. 40 Group 2.
Lnw=4.4142+.01252 t
Age of Animal in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

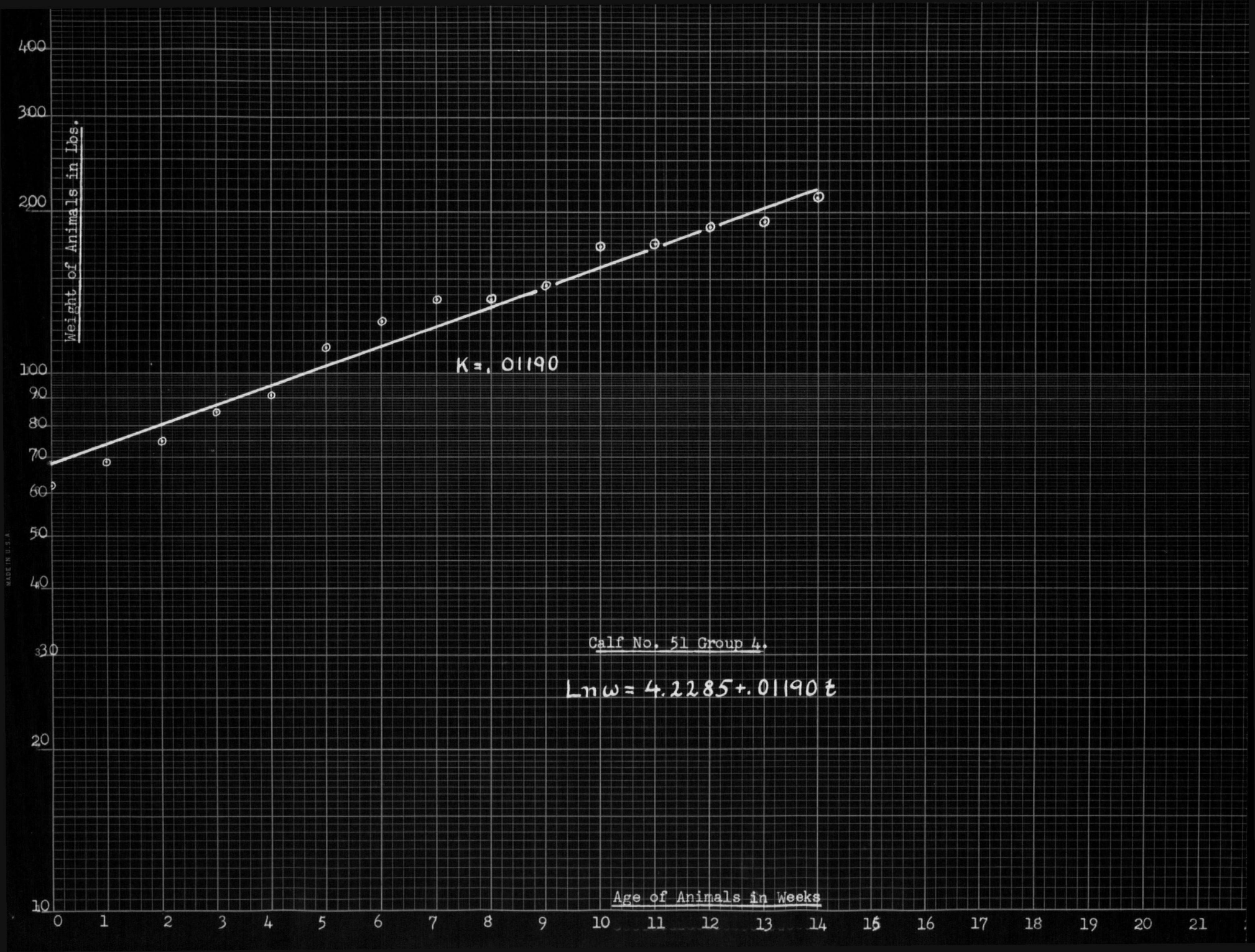

400
300
200
100
90
80
70
60
50
40
30
20
10
BODY WEIGHT IN LBS.
K=.01761
Calf No. 41. Group 2.
Lnw=4.0014+.01761 t
AGE OF ANIMAL IN WEEKS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
358-61L KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles X 10 to the inch.
5th lines accented.
MADE IN U.S.A.

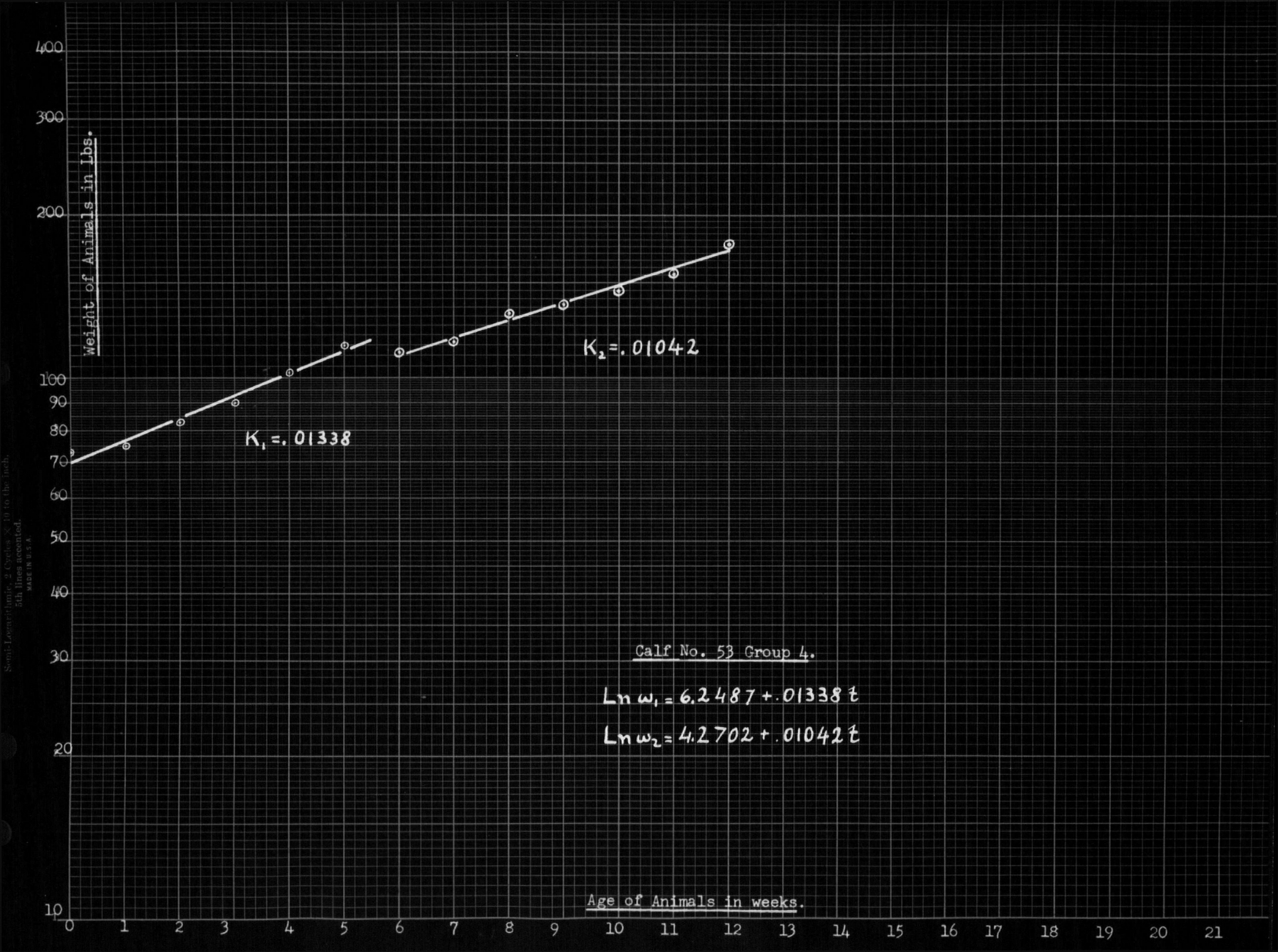

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K=.01089
Calf No. 43 Group 2.
Ln ω = 4.3253 + .01089 t
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

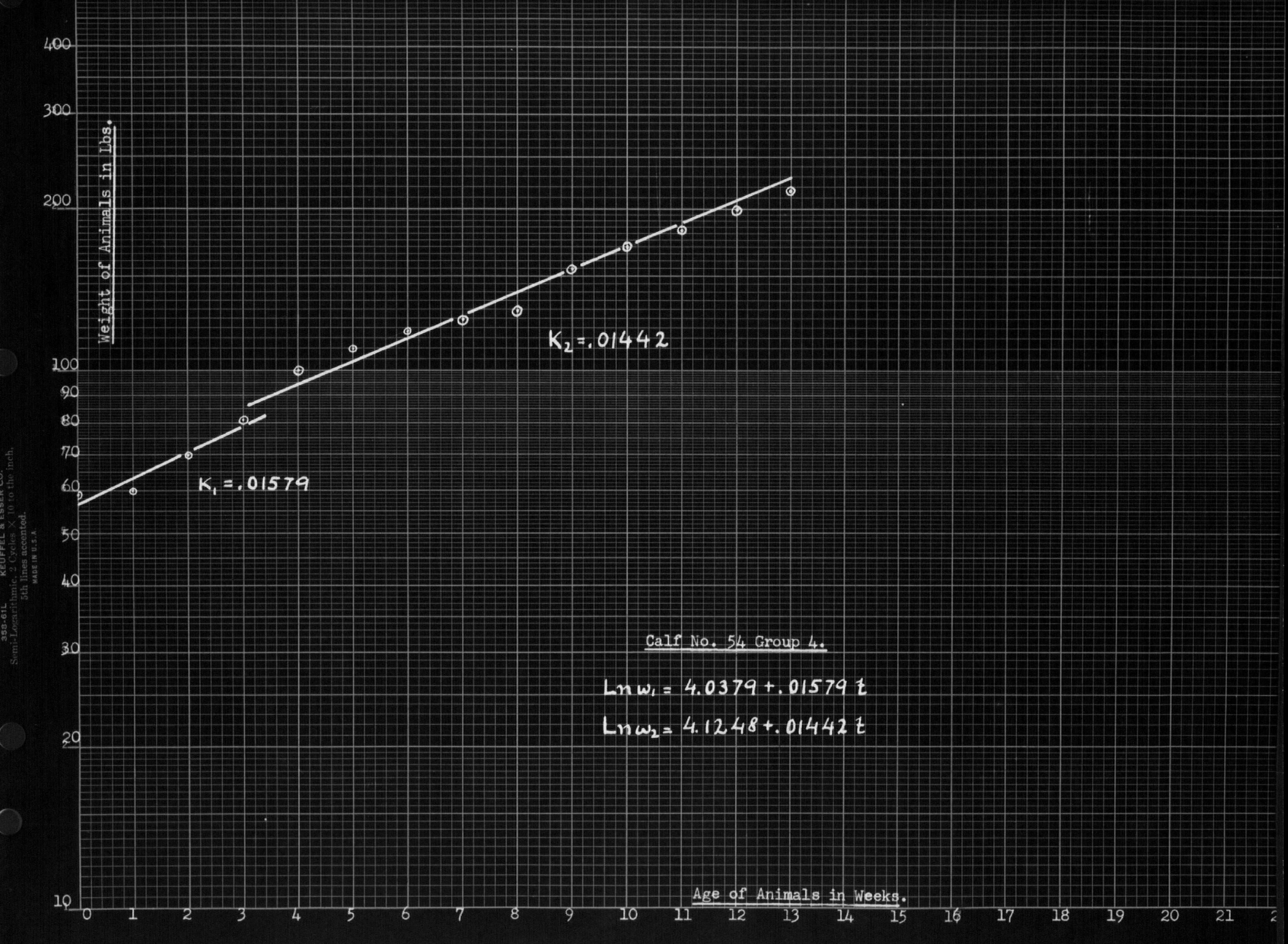

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Age of Animals in Weeks.
$K_1 = .01945$
$K_2 = .00940$
Calf No. 44 Group 2.
$\text{Ln}\, w_1 = 4.1587 + .01945\, t$
$\text{Ln}\, w_2 = 4.5715 + .00940\, t$
358-61L KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles X 10 to the inch.
5th lines accented.
MADE IN U.S.A.

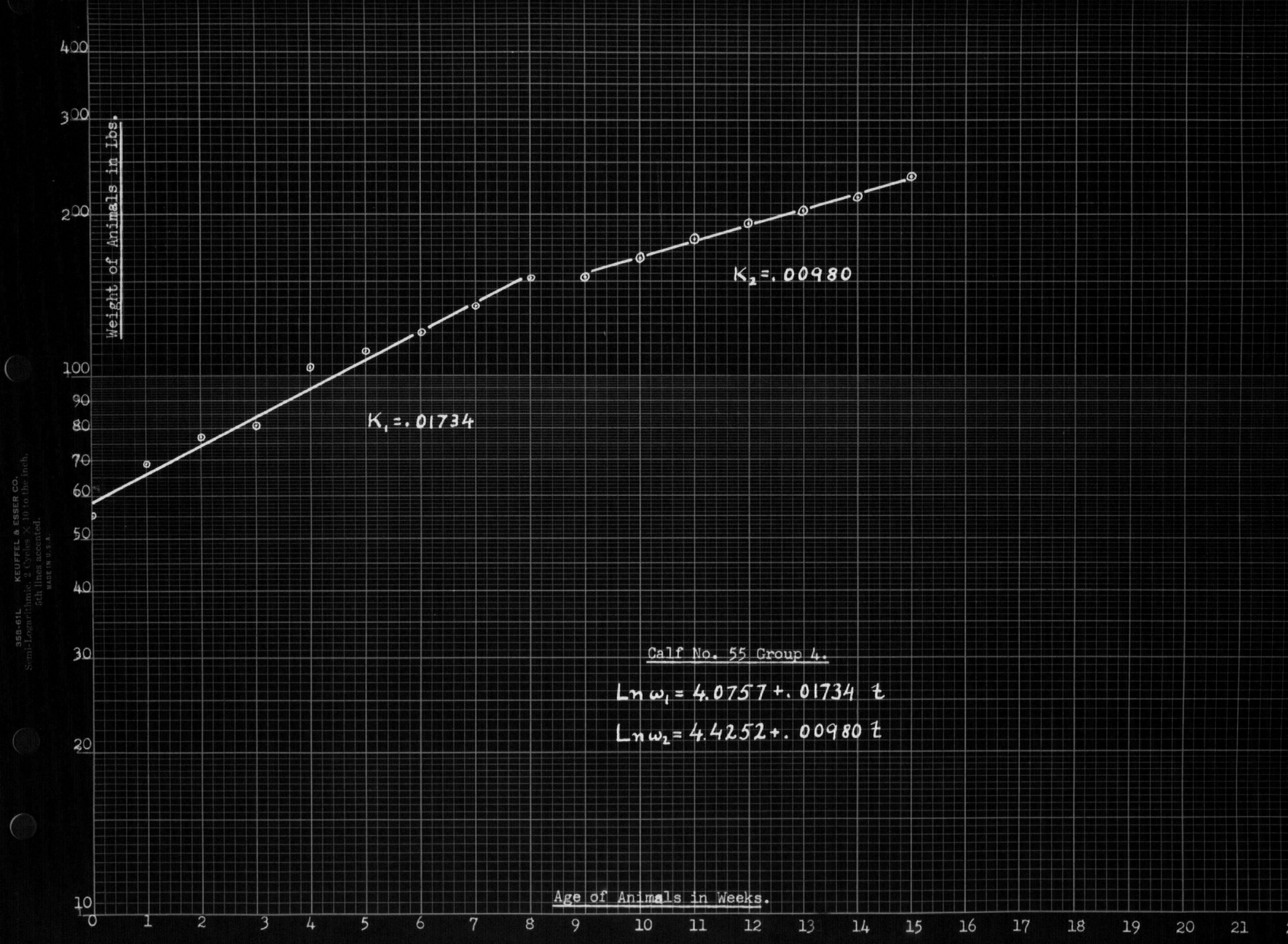

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .01978$
$K_2 = .01632$
$K_3 = .00899$
Calf No. 45 Group 3.
$Ln w_1 = 4.2462 + .01978\ t$
$Ln w_2 = 4.1934 + .01632\ t$
$Ln w_3 = 4.5838 + .00899\ t$
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

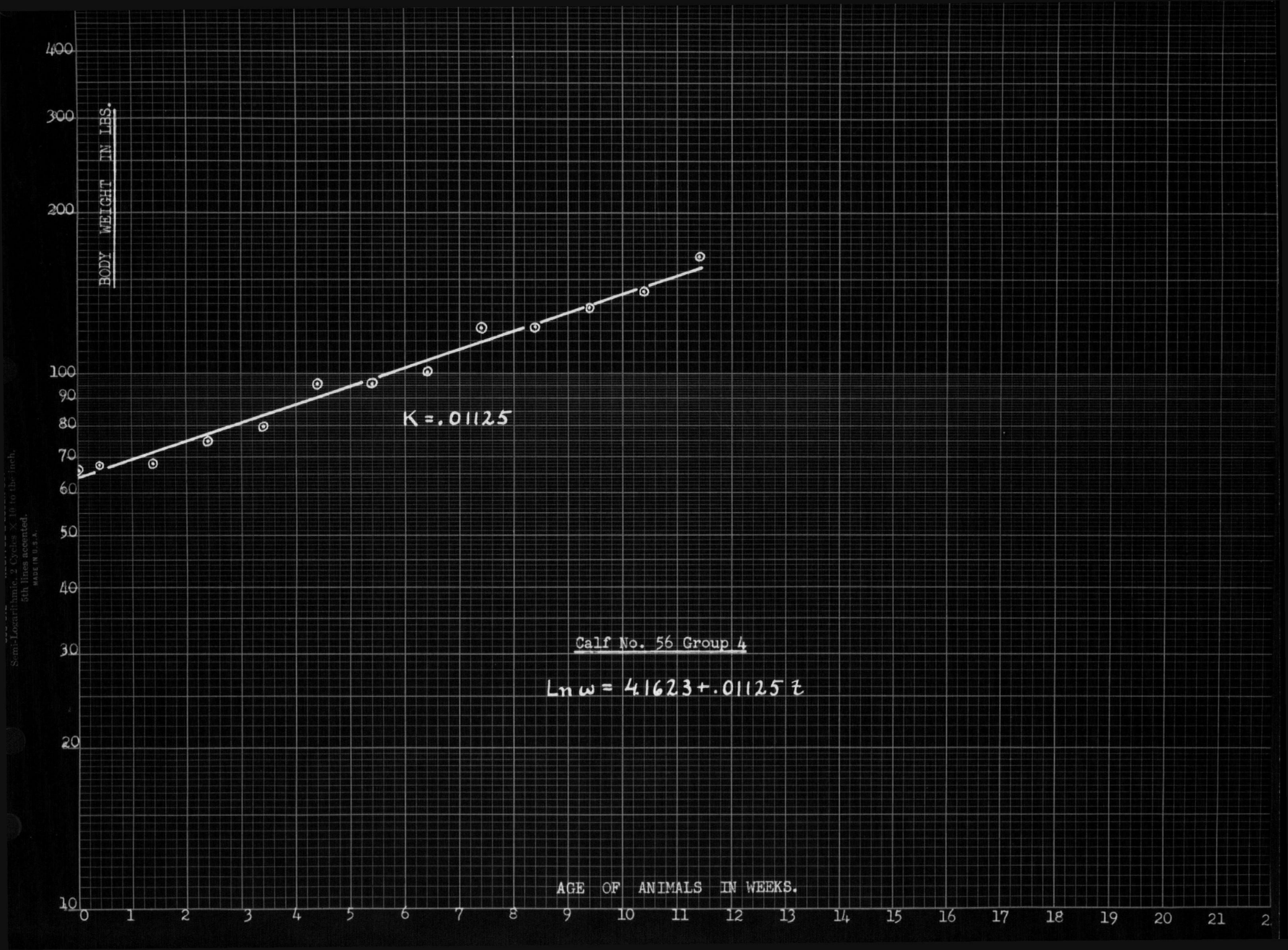

Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K_1 = .02239
K_2 = .009164
Calf No. 47 Group 3.
$Ln\omega_1 = 4.2182 + .02239\ t$
$Ln\omega_2 = 4.5150 + .00916\ t$
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

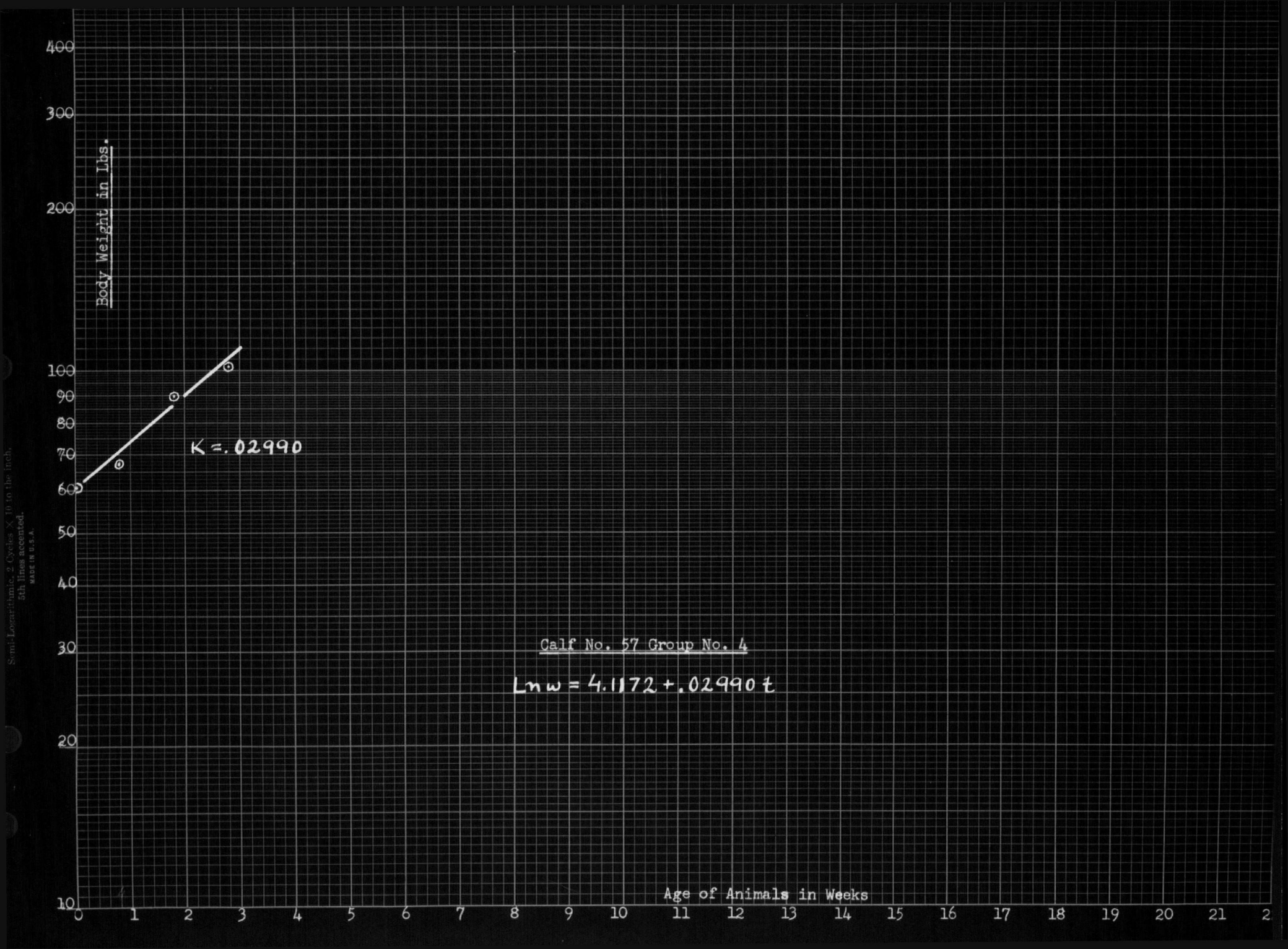

Weight of Animals in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K = .01190
Calf No. 51 Group 4.
Ln w = 4.2285 + .01190 t
Age of Animals in Weeks
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Weight of Animals in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .01338$
$K_2 = .01042$
Calf No. 53 Group 4.
$\text{Ln } \omega_1 = 6.2487 + .01338\,t$
$\text{Ln } \omega_2 = 4.2702 + .01042\,t$
Age of Animals in weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Weight of Animals in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .01579$
$K_2 = .01442$
Calf No. 54 Group 4.
$\text{Ln } w_1 = 4.0379 + .01579\ t$
$\text{Ln } w_2 = 4.12548 + .01442\ t$
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Weight of Animals in lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
$K_1 = .01734$
$K_2 = .00980$
Calf No. 55 Group 4.
$Ln\ \omega_1 = 4.0757 + .01734\ t$
$Ln\ \omega_2 = 4.4252 + .00980\ t$
Age of Animals in Weeks.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


BODY WEIGHT IN LBS.
400
300
200
100
90
80
70
60
50
40
30
20
10
K = .01125
Calf No. 56 Group 4
Ln ω = 41623 + .01125 t
AGE OF ANIMALS IN WEEKS.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21


Body Weight in Lbs.
400
300
200
100
90
80
70
60
50
40
30
20
10
K = .02990
Calf No. 57 Group No. 4
Ln w = 4.1172 + .02990 t
Age of Animals in Weeks
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 2

APPENDIX II

Weight Records of Beef Heifers

TABLE NO. I

WEEKLY BODY WEIGHT RECORD OF BEEF HEIFERS FIRST WINTER PERIOD - 161 DAYS
NOVEMBER 28, 1953 - MAY 6, 1954

Group	Heifer No.	Weeks 1	2	3	4	5	6	7	8	9	10	11	12
	30	433	441	454	453	460	456	457	465	473	470	485	487
	31	528	529	530	528	525	529	528	526	553	553	551	553
I	32	470	471	490	493	488	498	493	490	507	508	513	528
	33	447	447	461	458	463	466	457	460	479	485	484	492
	34	501	506	516	513	525	525	528	541	555	553	557	566
	35	413	419	435	425	433	435	430	423	440	440	441	450
	36	455	450	464	465	470	472	468	473	480	490	504	504
	37	500	518	512	520	518	525	529	530	547	557	564	570
	38	427	440	433	440	440	438	443	439	450	460	449	461
II	39	463	473	485	490	501	505	490	500	512	521	532	531
	40	443	451	463	454	470	478	473	464	470	488	499	508
	41	445	452	466	459	470	470	461	467	470	478	480	478
	42	406	424	421	426	425	430	425	431	445	460	456	470
	43	455	468	473	479	482	475	468	477	483	493	500	500
	44	472	486	499	509	513	532	540	540	547	547	567	561
	45	489	489	500	505	525	535	532	541	545	551	575	565
III	46	488	498	503	509	517	532	550	543	548	560	574	572
	47	439	452	464	463	470	488	488	485	494	496	514	520
	48	413	425	444	440	448	450	459	463	470	473	489	479
	49	451	459	475	487	488	498	494	497	507	511	523	520
	50	426	443	452	450	460	470	466	474	481	484	492	503
	51	440	450	443	462	483	480	490	500	520	522	534	547
	52	430	461	455	450	480	486	495	503	509	514	527	547
IV	53	467	464	473	485	489	498	481	491	518	527	522	548
	54	471	476	484	488	516	532	545	566	583	600	617	630
	55	441	460	448	450	463	468	473	490	510	519	549	550
	56	450	458	434	452	458	456	454	477	483	490	510	523
	57	400	420	413	430	438	438	443	459	472	485	500	496

TABLE NO. I. (CONTINUED)

Group	Heifer No.	Weeks 13	14	15	16	17	18	19	20	21	22	23	24
	30	502	505	495	520	516	540	539	552	563	565	560	575
	31	567	565	561	575	575	589	600	606	615	623	620	610
	32	548	535	527	545	546	554	560	568	578	595	590	591
I	33	502	498	500	521	515	527	535	542	550	555	555	560
	34	585	583	603	600	588	580	598	617	611	623	631	639
	35	453	445	452	460	453	466	460	463	457	480	473	477
	36	520	517	530	540	537	537	556	570	555	582	580	586
	37	589	578	583	593	580	587	603	610	625	631	631	639
	38	478	475	502	506	505	515	535	527	541	548	546	550
	39	557	541	555	560	552	554	565	575	580	578	594	590
II	40	528	532	536	523	526	541	542	553	560	567	573	580
	41	511	498	517	526	515	513	537	542	553	553	550	558
	42	483	481	475	500	496	500	519	526	540	545	551	560
	43	526	511	528	541	525	539	555	550	573	582	572	580
	44	577	586	607	608	610	628	632	630	636	633	650	660
	45	584	586	610	627	615	648	647	641	665	676	685	696
	46	587	595	610	615	596	601	632	627	632	656	659	670
III	47	530	520	544	546	530	550	563	565	563	580	590	590
	48	501	504	505	506	500	530	520	525	542	525	545	554
	49	535	532	548	562	547	581	585	576	598	592	607	615
	50	525	518	537	545	541	555	555	560	586	582	595	600
	51	566	568	583	606	615	628	642	656	651	678	690	699
	52	563	568	570	568	603	606	609	618	632	630	---	---
	53	538	550	550	552	560	556	571	590	587	577	590	606
IV	54	641	660	663	675	679	724	702	720	750	758	780	780
	55	575	570	585	603	610	630	642	655	666	683	699	705
	56	542	544	562	568	573	587	593	603	605	621	630	642
	57	515	510	523	546	543	560	568	580	577	582	605	615

TABLE NO. II.

WEEKLY BODY WEIGHT RECORD OF BEEF HEIFERS - FIRST PASTURE PERIOD - 160 DAYS

Group	Heifer No.	Weeks 1	2	3	4	5	6	7	8	9	10	11
	30	572	590	615	630	654	660	678	655	658	655	674
	31	622	635	655	673	685	713	740	708	702	710	719
	32	602	603	637	645	685	683	708	690	688	685	725
I	33	571	574	602	615	621	635	655	647	652	646	662
	34	630	650	692	690	717	742	745	725	725	750	764
	35	482	475	495	500	515	525	542	525	528	521	536
	36	603	617	642	642	670	695	702	670	690	680	711
	37	660	653	682	688	715	720	735	702	720	695	736
	38	575	585	617	637	660	685	693	682	685	683	696
	39	597	605	620	635	658	660	675	672	690	692	727
II	40	587	565	610	620	633	657	680	645	668	655	663
	41	577	585	610	617	642	642	682	655	678	660	693
	42	570	590	610	612	641	650	662	665	675	690	702
	43	612	615	641	650	672	690	707	675	678	680	696
	44	647	657	680	680	713	745	752	730	740	750	773
	45	702	705	735	733	742	776	792	760	790	787	815
	46	675	682	705	710	732	730	768	725	740	740	763
III	47	585	602	631	625	652	665	675	668	682	665	696
	48	572	572	594	605	627	640	650	630	645	645	663
	49	621	595	630	640	665	670	700	675	680	690	699
	50	595	605	650	645	683	705	730	710	712	705	745
	51	690	681	715	712	741	754	760	745	745	750	747
	53	590	620	640	660	691	710	725	698	718	705	725
IV	54	770	770	792	802	820	835	830	825	828	828	842
	55	707	698	720	731	750	770	780	765	772	770	799
	56	642	640	675	671	682	708	717	698	700	683	715
	57	630	618	645	640	655	660	682	650	640	615	607

TABLE NO. II. (CONTINUED)

Group	Heifer No.	Weeks 12	13	14	15	16	17	18	19	20	21	22
	30	688	687	672	701	695	720	743	737	755	777	786
	31	738	748	746	765	762	792	813	821	831	856	881
	32	725	730	747	763	775	795	822	826	830	847	864
I	33	683	692	697	712	712	725	746	746	746	785	785
	34	788	800	785	793	810	834	852	859	862	894	900
	35	554	575	575	582	587	615	616	628	628	661	631
	36	725	738	720	715	721	740	752	778	798	819	828
	37	758	761	767	790	782	790	827	836	831	879	872
	38	733	741	721	751	760	775	806	812	813	859	866
	39	730	725	735	750	750	775	782	795	795	837	835
II	40	698	705	717	725	720	748	768	774	793	821	817
	41	726	728	715	742	743	765	768	789	787	833	823
	42	718	722	710	720	725	751	773	783	801	822	825
	43	708	730	735	745	746	755	776	791	819	838	846
	44	778	800	800	800	805	821	838	848	832	878	875
	45	838	855	840	865	852	872	904	924	908	956	946
	46	768	775	780	790	796	812	836	848	848	877	886
III	47	718	732	705	735	740	742	769	771	750	777	789
	48	689	695	685	700	703	720	736	747	742	778	765
	49	726	730	741	761	740	771	792	797	786	832	839
	50	760	800	780	790	792	807	818	830	821	866	873
	51	765	760	770	790	785	796	818	825	817	831	825
	53	730	750	750	770	770	800	831	848	859	876	874
	54	838	868	870	880	870	893	867	898	917	917	930
IV	55	802	825	815	828	820	835	854	865	859	899	907
	56	723	750	710	732	738	748	773	803	762	824	809
	57	608	628	635	638	620	658	681	695	672	721	723

TABLE NO. III.

WEEKLY BODY WEIGHT RECORD OF BEEF HEIFERS - SECOND WINTER PERIOD - 210 DAYS

Grp.	Heifer No.	Weeks 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	30	815	795	805	820	832	810	832	831	850	830	815	822	848	843	855
	31	905	890	900	915	928	910	935	953	962	942	970	985	990	982	990
	32	895	860	875	905	880	875	900	900	929	888	884	914	918	920	915
I	33	815	810	795	825	836	820	838	856	879	868	871	879	900	880	890
	34	920	916	920	943	944	923	957	965	978	979	978	987	1009	993	1005
	35	640	655	660	Sold											
	36	835	820	817	835	871	840	860	851	878	870	882	892	913	910	915
	37	890	895	910	Sold											
	38	860	845	850	860	880	875	897	901	939	889	905	925	949	937	955
	39	825	842	845	860	879	861	888	895	909	870	908	929	955	945	963
II	40	810	815	825	835	852	850	880	878	900	872	879	909	928	934	950
	41	840	842	850	855	873	860	886	895	915	875	921	933	965	958	965
	42	810	826	850	855	864	868	886	891	923	885	920	932	961	951	955
	43	850	850	880	885	911	885	926	937	969	942	973	990	1019	1008	1015
	44	895	920	925	958	965	960	1002	998	1030	1021	1045	1085	1085	1079	1105
	45	970	994	999	1015	1025	1010	1060	1074	1100	1082	1100	1138	1150	1150	1150
	46	910	930	940	965	970	946	987	1002	1036	1029	1042	1073	1077	1082	1100
III	47	790	818	825	845	859	858	895	913	943	928	939	979	981	998	1010
	48	780	794	800	825	824	821	858	877	896	888	885	900	913	921	920
	49	855	867	865	Sold											
	50	875	890	885	915	934	927	970	980	999	998	1005	1040	1042	1057	1065
	51	855	865	860	880	905	885	905	917	940	952	958	972	1000	1020	1015
	53	880	875	875	880	892	905	902	923	956	956	979	986	1011	1024	1048
	54	925	962	965	985	996	1016	1016	1048	1082	1070	1091	1105	1121	1145	1160
IV	55	910	920	928	940	953	941	960	970	1010	1008	1010	1029	1060	1060	1070
	56	800	813	815	815	842	842	846	868	888	900	911	912	930	950	965
	57	750	740	750	755	765	748	783	774	828	820	820	836	861	870	875

TABLE NO. III. (CONTINUED)

Grp.	Heifer No.	Weeks 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	30	852	858	835	835	836	862	795	832	845	808	830	831	829	857	846
	31	1015	1014	995	1000	1006	991	900	900	915	887	875	892	869	881	890
	32	900	922	915	910	925	932	940	936	945	918	931	960	933	953	950
I	33	905	909	895	908	930	901	920	930	930	896	891	850	839	870	810
	34	1012	1030	1010	1025	1025	1005	1015	1030	1030	999	1004	915	944	926	910
	36	929	940	940	940	945	931	930	935	955	930	920	935	827	833	840
	38	959	981	955	979	1000	988	1020	1005	1025	1017	1035	1060	1058	1072	1058
	39	972	999	978	1005	1038	1002	1030	1026	1030	1008	1035	1052	1060	1080	1015
	40	957	980	975	1000	1041	1003	1030	1032	1045	1041	1045	981	969	980	942
II	41	1000	1015	1000	1020	1039	1030	1082	1070	1110	1083	1105	1127	1134	1160	1130
	42	965	990	985	1002	1038	1020	1055	1045	1075	1052	1100	1106	1085	1128	1092
	43	1045	1065	1050	1060	1109	1090	1100	1105	1110	960	1017	1013	1010	1027	1020
	44	1113	1136	1140	1167	1182	1156	1190	1214	1110	1106	1100	1128	1102	1120	1120
	45	1154	1200	1205	1218	1250	1217	1230	1260	1280	1140	1175	1177	1171	1220	1195
	46	1121	1149	1150	1172	1193	1180	1210	1065	1100	1100	1117	1143	1137	1145	1123
III	47	1020	1048	1065	1083	1101	1086	1110	1131	1140	1143	1162	1178	1142	1075	1063
	48	943	956	965	987	1000	988	995	1017	1040	1021	1021	948	953	981	978
	50	1072	1129	1120	1149	1177	1140	1152	1180	1200	1185	1196	1218	1195	1251	1105
IV	51	1029	1037	1050	1075	1099	1064	1100	1106	1130	1131	1158	1159	1086	1096	1094
	53	1060	1057	1090	1107	1138	1109	1139	1144	1170	1172	1185	1178	1228	1102	1102
	54	1144	1187	1180	1212	1244	1234	1245	1265	1289	1294	1296	1286	1300	1229	1220
	55	1071	1095	1100	1092	1123	1108	1130	1153	1158	1160	1060	1086	1106	1116	1084
	56	970	1004	995	1021	1042	1027	1050	1052	1075	1062	1087	1057	1096	1096	1010
	57	890	915	920	938	967	936	950	972	985	1000	1015	1004	1030	1008	1007

TABLE NO. IV.

WEEKLY BODY WEIGHT RECORD OF BEEF HEIFERS - SECOND PASTURE PERIOD - 77 DAYS

Group	Heifer No.	Weeks 1	2	3	4	5	6	7	8	9	10	11
	30	842	890	940	940	950	965	965	937	971	960	972
	31	935	900	910	961	955	929	958	960	970	970	1000
	32	964	990	1020	1045	1022	1030	1043	1043	1043	1042	1062
I	33	838	865	915	938	918	927	930	908	917	922	930
	34	977	960	1015	1008	1022	1000	1017	1035	1025	1038	1042
	36	878	860	910	913	905	908	925	914	917	910	945
	38	1084	1090	1140	1134	1153	1059	1088	1072	1076	1070	1092
	39	1010	995	1040	1038	1016	1018	1037	1019	1030	1010	1020
II	40	975	955	1000	1000	1000	996	998	990	1006	1008	1005
	41	1140	1165	1220	1221	1122	1125	1140	1141	1123	1150	1155
	42	1130	1155	1185	1189	1210	1192	1206	1208	1192	1210	1229
	43	1031	1040	1060	1078	1086	1076	1074	1071	1073	1072	1084
	44	1126	1150	1175	1146	1182	1173	1171	1152	1163	1160	1166
	45	1189	1205	1250	1257	1257	1217	1205	1193	1208	1192	1212
	46	1147	1170	1205	1196	1215	1212	1206	1200	1202	1205	1225
III	47	1078	1080	1115	1093	1106	1081	1098	1085	1056	1060	1098
	48	946	970	1020	995	1012	1005	1015	992	1000	1010	1018
	50	1079	1105	1150	1134	1150	1157	1165	1141	1142	1150	1155
	51	1076	1080	1110	1138	1113	1122	1111	1081	1103	1080	1102
	53	1073	1090	1150	1135	1141	1155	1152	1107	1161	1130	1135
	54	1211	1220	1260	1246	1232	1251	1260	1239	1228	1225	1246
	55	1082	1105	1120	1123	1138	1125	1141	1138	1107	1130	1155
	56	1032	1050	1090	1090	1088	1107	1090	1040	1045	1032	1065
	57	1021	1032	1085	1068	1068	1075	1092	1075	1066	1082	1020

TABLE NO. V.

WEEKLY BODY WEIGHT RECORD OF CALVES

Calf No.	Date of Birth	Weight	Sex	March 19	March 26	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 20
30	Mar. 16.	31	F	30	39	44.5	49	53	61	64	66	70	78
31	Mar. 17.	62	F	68	82	99	112	122	133	140	152	180	187
46	Mar. 24.	70	M	Died									
44	Mar. 29.	63	F			68	82	90	107	120	133	144	158
43	Apr. 3.	77	M				74	90	92	108	111	114	129
45	Apr. 8.	70	F				71.5	80	92	106	106	116	129
55	Apr. 16.	55	M					55.5	69	77	81	104	111
40	Apr. 18.	75	M						75	101	106	120	131
48	Apr. 22.	61	F	Died									
33	Apr. 22.	59	F						59	68	81	95	108
34	Apr. 22.	63	M						63	73	82	105	111
36	Apr. 25.	67	F							71	81	100	109
51	Apr. 25.	62	F							69	75	85	91
54	May 1.	59	F								60	70	81
47	May 3.	71	M								69	90	101
53	May 6.	73	F								73	75	83
39	May 9.	51	F									52	67
50	May 10.	81	M	Died									
56	May 11.	67	M									68	68
41	June 17.	50	F										
38	June 21.	55	F										
57	July 25.	61	F										

TABLE NO. V. (CONTINUED)

Calf No.	Date of Birth	Weight	Sex	May 28	June 4	June 10	June 17	June 24	July 1	July 8	July 15	July 22	July 29
30	Mar. 16	31	F	90	100	109	109	112	130	135	146	158	175
31	Mar. 17	62	F	210	237	245	250	262	281	292	310	320	336
46	Mar. 24	70	M										
44	Mar. 29	63	F	172	185	198	203	223	244	253	272	280	303
43	Apr. 3	77	M	141	160	172	182	190	211	215	226	240	273
45	Apr. 8	70	F	150	165	174	183	192	212	222	235	250	270
55	Apr. 16	55	M	120	135	152	153	166	180	193	202	215	235
40	Apr. 18	75	M	150	170	183	188	196	225	221	242	260	282
48	Apr. 22	61	F										
33	Apr. 22	59	F	123	136	147	148	162	180	183	198	205	226
34	Apr. 22	63	M	130	150	160	165	175	168	198	215	230	257
36	Apr. 25	67	F	125	140	149	145	160	180	188	203	208	226
51	Apr. 25	62	F	112	125	137	138	146	173	175	188	192	211
54	May 1	59	F	100	110	118	124	129	155	170	183	200	218
47	May 3	71	M	112	125	136	136	142	163	171	180	192	203
53	May 6	73	F	90	102	115	112	117	132	137	145	156	177
39	May 9	51	F	72	90	102	109	119	133	145	145	152	175
50	May 10	81	M										
56	May 11	67	M	75	85	96	96	101	122	122	133	142	166
41	June 17	50	F				50	63	76	81	93	98	110
38	June 21	55	F					58	71	80	87	90	105
57	July 25	61	F										68

APPENDIX III

Weekly Feed Consumption Records of Beef Heifers

Table No. I. Dry Lot - Phase I

Table No. II. Dry Lot - Phase II.

TABLE I.

WEEKLY FEED CONSUMPTION RECORD OF BEEF HEIFERS

NOVEMBER 28, 1953 to MAY 6, 1954

GROUP NO. I. (7 ANIMALS)

Week No.	Hay Per Animal	Concentrate in Lbs.	Hay Per Group	Concentrate in Lbs.
1	65.		455.	
2	65.		455.	
3	65.		455.	
4	65.		455.	
5	70.		490.	
6	80.		560.	
7	85.		595.	
8	90.		630.	
9	90.		630.	
10	98.		686.	
11	98.		686.	
12	98.		686.	
13	98.		686.	
14	98.		686.	
15	103.		721.	
16	103.		721.	
17	103.		721.	
18	103.		721.	
19	108.5		759.5	
20	108.5		759.5	
21	108.5		759.5	
22	108.5		759.5	
23	109.			
161 days	2,120. Lbs.		14,840. Lbs.	

TABLE I. (CONTINUED)

GROUP NO. II. (7 ANIMALS)

Week No.	Hay Per Animal in Lbs.	Concentrate Per Animal in Lbs.	Hay Per Group	Concentrate Per Group in Lbs
1	52.5	14.	367.5	98.
2	52.5	14.	367.5	98.
3	52.5	14.	367.5	98.
4	65.	14.	455.	98.
5	52.5	14.	367.5	98.
6	52.5	14.	367.5	98.
7	52.5	14.	367.5	98.
8	56.	14.	392.	98.
9	56.	14.	392.	98.
10	56.	16.1	392.	112.7
11	63.	16.1	441.	112.7
12	67.2	16.1	470.4	112.7
13	67.2	16.1	470.4	112.7
14	67.2	16.1	470.4	112.7
15	67.2	16.1	470.4	112.7
16	67.2	17.5	470.4	122.5
17	67.2	17.5	470.4	122.5
18	67.2	17.5	470.4	122.5
19	67.2	20.3	470.4	142.1
20	67.2	20.3	470.4	142.1
21	67.2	20.3	470.4	142.1
22	68.	23.5	476.	164.5
23	68.	23.5	476.	164.5
161 days	1,460. Lbs	383. Lbs	10,220. Lbs	2,681. Lbs.

TABLE I. (CONTINUED)

GROUP NO. III. (7 ANIMALS)

Week. No.	Hay Per Animal in Lbs	Concentrate Per Animal in Lbs	Hay Per Group in Lbs.	Concentrate Per Group in Lbs.
1	52.5	22.4	367.5	156.8
2	52.5	22.4	367.5	156.8
3	52.5	22.4	367.5	156.8
4	56.	24.5	392.	171.5
5	56.	24.5	392.	171.5
6	56.	25.6	392.	179.2
7	56.	25.6	392.	179.2
8	56.	26.6	392.	186.2
9	56.	26.6	392.	186.2
10	56.	26.6	392.	186.2
11	63.	28.7	441.	200.9
12	67.2	28.7	470.4	200.9
13	67.2	28.7	470.4	200.9
14	67.2	28.7	470.4	200.9
15	67.2	28.7	470.4	200.9
16	67.2	30.8	470.4	215.6
17	67.2	30.8	470.4	215.6
18	73.5	32.9	514.5	230.3
19	73.5	32.9	514.5	230.3
20	73.5	32.9	514.5	230.3
21	73.5	35.	514.5	245.
22	73.7	35.	516.	245.
23	73.6	35.1	515.1	245.7
161 days	1,467. Lbs	654. Lbs	10,269. Lbs	4,578. Lbs

TABLE I. (CONTINUED)

GROUP IV. (7 ANIMALS)

Week No.	Hay Per Animal in Lbs	Concentrate Per Animal in Lbs	Hay Per Group in Lbs	Concentrate Per Group in Lbs
1	14.	63.	98.	441.
2	14.	63.	98.	441.
3	15.	50.	105.	350.
4	14.	63.	98.	441.
5	14.	66.5	98.	465.5
6	14.	66.5	98.	465.5
7	20.	66.5	140.	465.5
8	28.	70.	196.	490.
9	28.	70.	196.	490.
10	28.	84.	196.	588.
11	28.	88.2	196.	617.4
12	28.	92.4	196.	646.8
13	28.	92.4	196.	646.8
14	28.	92.4	196.	646.8
15	28	85.4	196.	597.8
16	28	96.6	196.	676.2
17	28	100.8	196.	705.6
18	28	100.8	196.	705.6
19	28	100.8	196.	705.6
20	28	100.8	196.	705.6
21	28	109.2	196.	764.4
22	28	108.7	196.	761.1
23	28	108.7	196.	761.
161 days	553. Lbs	1,840. Lbs	3,871. Lbs	12,880. Lbs.

TABLE II

WEEKLY FEED CONSUMPTION RECORD OF BEEF HEIFERS

OCTOBER 15, 1954 to MAY 14, 1955

GROUP I. (6 ANIMALS)

Weeks	Hay Per Animal in Lbs	Concentrate Per Animal in Lbs	Hay Per Group in Lbs.	Concentrate Per Group in Lbs.
1	123.2		739.2	
2	124.6		747.6	
3	127.4		764.4	
4	124.6		747.6	
5	130.2		781.2	
6	130.2		781.2	
7	127.4		764.6	
8	130.2		781.2	
9	130.2		781.2	
10	133.		798.	
11	130.2		781.2	
12	133.		798.	
13	133.		798.	
14	134.4		806.4	
15	133.		798.	
16	134.4		806.4	
17	134.4		806.4	
18	134.4		806.4	
19	134.4		806.4	
20	134.4		806.4	
21	134.4		806.4	
22	134.4		806.4	
23	133.		798.	
24	134.4		806.4	
25	134.4		806.4	
26	134.4		806.4	
27	134.4		806.4	
28	134.4		806.4	
29	134.4		806.4	
30	134.4		806.4	
210 days	3,959.2 Lbs		23,755.2 Lbs.	

TABLE II. (CONTINUED)

GROUP II. (6 ANIMALS)

Weeks	Hay Per Animal in Lbs	Concentrate Per Animal in Lbs	Hay Per Group in Lbs.	Concentrate Per Group in Lbs.
1	93.1	38.5	558.6	231.
2	93.1	38.5	558.6	231.
3	93.1	38.5	558.6	231.
4	95.2	39.2	571.2	235.2
5	95.2	39.2	571.2	235.2
6	97.3	39.9	583.8	239.4
7	95.2	39.2	571.2	235.2
8	97.3	39.9	583.8	239.4
9	97.3	39.9	583.8	239.4
10	100.8	40.6	604.8	243.6
11	97.3	39.9	583.8	239.4
12	98.7	40.6	592.2	243.6
13	100.8	40.6	604.8	243.6
14	102.2	41.3	613.2	247.8
15	102.2	41.3	613.2	247.8
16	102.5	41.3	615.	247.8
17	104.3	42.	625.8	252.
18	106.4	42.7	638.4	256.2
19	104.3	42.	625.8	252.
20	106.4	42.7	638.4	256.2
21	107.8	43.4	646.8	260.4
22	106.4	42.7	638.4	256.2
23	109.9	43.4	659.4	260.4
24	107.8	43.4	646.8	260.4
25	109.9	43.4	659.4	260.4
26	109.9	43.4	659.4	260.4
27	109.9	43.4	659.4	260.4
28	109.9	43.4	659.4	260.4
29	109.9	43.4	659.4	260.4
30	109.9	43.4	659.4	260.4
210 days	3,074. Lbs	1,242.1 Lbs	18,444. Lbs	7,452.6 Lbs.

TABLE II. (CONTINUED)

GROUP III. (6 ANIMALS)

Weeks	Hay Per Animal in Lbs.	Concentrate Per Animal in Lbs.	Hay Per Group in Lbs.	Concentrate Per Group in Lbs.
1	63.7	77.7	382.2	466.2
2	63.7	77.7	382.2	466.2
3	65.1	79.1	390.6	474.6
4	65.1	79.1	390.6	474.6
5	65.8	80.5	394.8	483.
6	67.2	81.9	403.2	491.4
7	65.8	80.5	394.8	483.
8	68.6	83.3	411.6	499.8
9	70.	84.7	420.	508.2
10	71.4	86.1	428.4	516.6
11	70.0	84.7	420.	508.2
12	71.4	86.1	428.4	516.6
13	72.8	87.5	436.8	525.
14	72.8	87.5	436.8	525.
15	72.8	87.5	436.8	525.
16	74.2	88.9	445.2	533.4
17	74.2	88.9	445.2	533.4
18	76.3	91.7	457.8	550.2
19	76.3	91.7	457.8	550.2
20	77.7	93.1	466.2	558.6
21	79.1	93.8	474.6	562.8
22	77.7	93.1	466.2	558.6
23	77.7	93.1	466.2	558.6
24	77.7	93.1	466.2	558.6
25	77.7	93.1	466.2	558.6
26	77.7	93.1	466.2	558.6
27	77.7	93.1	466.2	558.6
28	77.7	93.1	466.2	558.6
29	77.7	93.1	466.2	558.6
30	77.7	93.1	466.2	558.6
210 days	2,183.3 Lbs	2,629.9 Lbs	13,099.8 Lbs	15,779.4 Lbs

TABLE II. (CONTINUED)

GROUP IV. (6 ANIMALS)

Weeks	Hay Per Animal in Lbs	Concentrate Per Animal in Lbs	Hay Per Group in Lbs.	Concentrate Per Group in Lbs.
1	31.5	114.1	189.	684.6
2	31.5	116.2	189.	697.2
3	31.5	116.2	189.	697.2
4	31.5	116.2	189.	697.2
5	31.5	118.3	189.	709.8
6	32.2	118.3	193.2	709.8
7	32.2	118.3	193.2	709.8
8	32.9	119.7	197.4	718.2
9	33.6	121.8	201.6	730.8
10	34.3	123.9	205.8	743.4
11	34.3	123.9	205.8	743.4
12	34.3	123.9	205.8	743.4
13	35.	126.	210.	756.
14	35.	126.	210.	756.
15	35.7	128.1	214.2	768.6
16	35.7	128.1	214.2	768.6
17	36.4	130.2	218.4	781.2
18	37.1	132.3	222.6	793.8
19	37.1	132.3	222.6	793.8
20	37.8	134.4	226.8	806.4
21	38.5	135.8	231.	814.8
22	37.8	134.4	226.8	806.4
23	38.5	135.8	231.	814.8
24	38.5	135.8	231.	814.8
25	39.2	137.9	235.2	827.4
26	39.2	137.9	235.2	827.4
27	39.2	137.9	235.2	827.4
28	39.2	137.9	235.2	827.4
29	39.2	137.9	235.2	827.4
30	39.2	137.9	235.2	827.4
210 days	1,069.6 Lbs	3,837.4 Lbs	6,417.6 Lbs	23,024.4 Lbs

APPENDIX IV

Ingredients of the Concentrate Ration

Proximate Composition of Roughage and Concentrate

TABLE I

FORMULATION OF CONCENTRATE PELLETS

Supplement "A" - fed to Pens III and IV		Supplement "B" - fed to Pen II	
Refuse Screenings	1500 pounds	Refuse Screenings	1600 pounds
Dehydrated Grass	300 "	Dehydrated Grass	100 "
Molasses	160 "	Molasses	100 "
Salt	20 "	Salt	20 "
Bone Meal	20 "	Whale Meal	180 "
	2000 Pounds		2000 Pounds

TABLE II

PROXIMATE COMPOSITION OF CONCENTRATE AND HAY

Constituent	Hay	Concentrate Pellets	
		Supplement "A"	Supplement "B"
Protein	11.8	11.1	17.0
Fat	0.9	4.5	4.4
Fibre	27.6	16.2	15.1
N.F.E.	34.2	45.8	44.0

TABLE III

CONCENTRATE PELLETS

Constituents	Pounds per Ton
Refuse Screenings	1800
Molasses	100
Salt	25
Whale Soluble	50
Calcium Carbonate	25
	2000

TABLE IV

PROXIMATE COMPOSITION OF CONCENTRATE AND HAY

Constituent	Hay	Concentrate Pellets
Protein		
Fat		
Fibre		
N.F.E.		

APPENDIX V

TABLE I

NET ENERGY VALUE OF 1 POUND OF GAIN

USED IN CALCULATIONS

Body Weight of Animal Lbs.	N.E.Value of 1 Lb of Gain Cal.
100 - 500	1,500
500 - 750	2,000
750 - 1000	2,600

TABLE II

TOTAL NET ENERGY COST OF ANIMAL GROWTH

Group	Feeding Period	Number of Days	Birth Weight Lbs	Final Wgt Lbs	Total Gain Lbs	Average daily Gain	Maintenance N.E.Cost Therms	N.E. Value of Gain Therms	Total N. E. Cost Therms
I	Summer	210	75	550	475	2.26	1,480	712.5	2,192.5
	Winter	210		1000	450	2.14	2,326	1,150.	3,476.
	Total	420		1000	925	2.2	3,806	1,862.5	5,668.5
II	Summer	210	75	475	400	1.9	1,224.3	600.	1,824.3
	Winter	210		800	325	1.55	1,695.1	650.	2,345.1
	Summer	126		1000	200	1.58	1,693.	520.	2,213.
	Total	546		1000	925	1.69	4,612.4	1,770.	6,382.4
III	Summer	210	75	425	350	1.67	1,175.1	525.	1,700.1
	Winter	210		570	145	.69	1,465.2	290.	1,755.2
	Summer	175		875	305	1.74	1,507.	610.	2,117.
	Winter	133		1000	125	.94	1,465.3	325.	1,790.3
	Total	728		1000	925	1.27	5,612.6	1,750.	7,362.6
IV	Summer	252	75	375	300	1.19	1,096.5	450.	1,546.5
	Winter	168		400	25	0.15	909.5	37.5	947.
	Summer	175		650	250	1.43	1,124.	500.	1,624.
	Winter	175		675	25	0.14	1,460.5	65.	1,525.5
	Summer	210		1000	325	1.55	1,610.	845.	2,455.
	Total	980		1000	925	0.94	6,200.5	1,897.5	8,098.

TABLE III

MONETARY EVALUATION OF MAINTENANCE AND GROWTH COST OF FOUR ANIMALS RAISED IN DIFFERENT ENVIRONMENTS

AMOUNT OF FEED REQUIRED, ITS COST, PASTURE EXPENDITURE AND LABOUR COSTS *

Group	Amount of Feed in Pounds		Cost of Feed and labour in $	Total $
I	Creep feed	500	12.50	
	Concentrates	2,520	50.40	
	Hay	2,520	12.60	
	Pasture		15.00	
	Labor during winter		5.00	95.50
II	Creep feed	400	10.00	
	Concentrates	1,890	37.80	
	Hay	2,688	13.44	
	Pasture		25.00	
	Labor during winter		5.00	91.24
III	Hay	6,412	32.04	
	Concentrates	665	13.30	
	Pasture		30.00	
	Labor during winter		10.00	85.34
IV	Hay	5,477	27.40	
	Pasture		45.00	
	Labor during winter		10.00	82.40

* Values used for calculation

Net energy value of feeds: 1 Lb of Hay 450 Cal.
1 Lb of Concentrate 850 "

Price of feeds: 1 ton hay $10.00
1 ton creep feed 50.00
1 ton concentrate 40.00

Pasture expenditures: (Labor, taxes, etc)
$15.00 per animal per season

Labor during winter - feeding period: $5.00 per animal

TABLE IV

CALCULATION OF DRY MATTER INTAKE

w	Log w x	D.M.	Log D.M. y	xy	x^2
900	2.9542	18.33	1.26316	3.731627	8.727297
900	2.9542	21.45	1.33143	3.933311	8.727297
1100	3.0414	21.74	1.33726	4.067143	9.250114
1100	3.0414	24.02	1.38057	4.198866	9.250114
1300	3.1139	24.03	1.38075	4.299517	9.696373
1300	3.1139	27.41	1.43791	4.477477	9.696373
	18.2190		8.13108	24.707941	55.347568

$N = 6$

$\Sigma XY = a\Sigma X + b\Sigma X^2$

$\Sigma Y = an + b\Sigma X$

$24.707941 = 18.2190_a + 55.347568b$

$8.131080 = 6\,a + 18.219000b \quad \times 3.0365$

$24.707941 = 18.2190a + 55.347568b$

$24.690024 = 18.2190a + 55.321994b$

$.017917 = .025554b$

$b = .7011$

$8.131080 = 6a + 12.77406$

$a = -.77383$

$\text{Log D M} = \log .77383 + .7 \log w$

$\text{Log D M} = \log .22617 + .7 \log w$

$\text{D M} = .\text{X}168 \times w^{.7}$

$\text{D M} = .\text{X}17\ w^{.7}$

W_1 =	500 Lbs.	D M =	13.17 Lbs.
W_2 =	700 Lbs.	D M =	16.67 Lbs.
W_3 =	900 Lbs.	D M =	19.89 Lbs.
W_4 =	1100 Lbs.	D M =	22.88 Lbs.
W_5 =	1300 Lbs.	D M =	25.72 Lbs.
W_6 =	1500 Lbs.	D M =	28.40 Lbs.

TABLE V

DRY MATTER REQUIREMENT OF ALL ANIMALS ON PASTURE

(WEIGHT GIVEN IN LBS)

Pasture Period	Average body wgt of all animals	Number of animals on pasture	Grazing season Days	Number of Animal days	Dry Matter requirement per animal per day ($DM=.17w^{.7}$) in Lbs.	Pasture acres	D.M.Requirement per all groups per season Ton	D.M. Requirement per 1 acre of pasture Ton
No. I	728	27 Heifers 1 Bull	160	4,480	17.14	14	38.40	2.743
No. 2	1062	24 Cows 1 Bull 19 Calves	77*	1,925**	22.32	14	42.96***	3.07

* one half of the grazing period (Experiment terminated).
** calves not included
*** Calculated for 154 days - (whole grazing period)

TABLE VI

SUMMARY OF RATE OF GAIN DATA FOR THE FOUR FEEDING PERIODS:

A - in pounds

B - in percentage of body weight (Kx100)

A.

Group	Period 1. Weanling Winter	Period 2. Yearling Summer	Period 3. Yearling Winter	Period 4. Two Year Old Summer
I	0.73	1.41	0.55	1.31
II	0.83	1.53	1.30	0.76
III	1.04	1.46	1.73	0.52
IV	1.51	1.08	1.62	0.36

B.

Group	Period 1. %	Period 2. %	Period 3. %	Period 4. %
I	.140	.301	.064	.277
II	.162	.296	.150	.123
III	.192	.270	.179	.201
IV	.271	.223	.177	.123