

August 1, 1948

To the Committee on Graduate Study:

I am submitting to you a thesis written by Grover William Stringer entitled "Feeding Thyroprotein to Lactating Ewes for Early Lamb Production." I recommend that it be accepted for nine quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

Sam L. Hansard
Major Professor

We have read this thesis
and recommend its acceptance:

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Accepted for the Committee

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Dean of Graduate School

FEEDING THYROPROTEIN TO LACTATING EWES FOR
EARLY LAMB PRODUCTION

A THESIS

Submitted to
The Committee on Graduate Study
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

Grover William Stringer

August 1948

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G. W. Stringer

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INTRODUCTION

It has been long recognized that the secretion of the thyroid gland is largely responsible for the regulation of general body metabolism. With this knowledge, investigations soon demonstrated that by feeding thyroid materials, a temporary increase in milk production could be obtained.

Recently a material of great thyroid potency was developed by the process of adding iodine to milk casein. With the perfection of this process, supply and price have been more favorable and much experimental work has been done with the administering of thyroprotein to milk producing animals.

Many workers noted increases in milk and milk fat production when administering thyroprotein either orally and or by injection. They found that it caused a definite increase in metabolism as indicated by an increase in heart rate, temperature, and respiration rate. This increase in metabolism brought about many changes, including marked losses in body weight. Consequently, controversy soon arose as to whether this increased milk and milk fat production would compensate for the detrimental effects associated with the higher rate of metabolism. This question remains unanswered at the present time.

Acknowledgments have been made that a definite correlation exists between the relative market grade of

lambs and their condition. Therefore, it appeared feasible that by feeding thyroprotein to lactating ewes, milk production could be stimulated, thereby improving the finish and consequent market grade and prices of the lambs produced.

Due to the fact that thyroprotein is available commercially and that little work has been done with its administration to sheep, this study has been conducted in an effort to determine its practicability for use in the production of milk fed spring lambs.

In view of the possibility that such studies will help to explain some of the many effects of thyroprotein feeding on sheep, it is believed that this information will be of general interest to both the investigator and the sheep farmers. The data for this report were obtained from this study.

OBJECTIVES

Earlier studies have indicated that the feeding of thyroprotein has a profound effect on all animals. However, relatively few workers have used the sheep in their experimental investigations. This experiment was initiated

(1) To evaluate the effects of adding thyroprotein to the ration of lactating ewes upon the daily and total gains and the market grade of lambs; (2) To determine the effects of thyroprotein on ewe weight, pulse rate, respiration, temperature, and feed consumption when maintained on pasture and in dry lot; and (3) To determine the relative cost of producing spring lambs in dry lot and on temporary pasture under Tennessee conditions.

LITERATURE REVIEW

The feeding of pure thyroxine or desiccated thyroid to animals has been limited because of the small supply and the prohibitive costs. However, recently Herman (1944) reported a material of great thyroid potency developed by iodinating milk casein. This thyroidal substance was first called thyrolactin, then thyroprotein and is now prepared commercially as "protamone."

Turner (1943) stated that when hormones were administered orally they usually lost their activity in the digestive tract. However, the hormone of the thyroid gland proved to be an exception to this rule, because it was attached to the protein globulin. The active physiological agent thyroxine, is an amino acid closely related to tyrosine, one of the building blocks from which protein is formed. When the thyroglobulin of the thyroid gland enters the digestive tract, it is broken down into the constituent amino acids with the thyroxine ready to be absorbed into the blood stream.

As related by Reece (1944), Graham was the first to observe the thyroid gland as having a profound influence on the level of milk and milk fat secretion of cows. He later identified this active principal of the thyroid gland as the hormone thyroxine.

Graham (1934) has stated that the thyroid gland is not essential for initiation of milk secretion, but pointed out that the feeding of thyroprotein raised the plane of nutrition greatly. This was supported by Espe (1946). However, Epse (1946) found a decrease of as much as 75 percent in milk production upon thyroidectomy in the cow. Ralston, et. al. (1940) in an experiment with goats, found that the removal of the thyroid gland caused a marked drop in milk yield, but the administration of two milligrams per day of thyroxine for eleven days re-established normal milk and fat production. The decreased milk production was reportedly due to the shock of the operation and to a lowering of metabolic activity as shown by the decreased heart activity. A specially prepared thyroxine solution injected subcutaneously in the neck region caused an increase in heart beat and milk and fat production. These goats showed a range from twelve respirations per minute to 140 per minute, which would indicate a marked rise in metabolic activity in response to thyroxine activity.

Experiments by Herman (1938) demonstrated that by feeding two ounces daily of desiccated thyroid, milk production was increased 18 percent, and the butter-fat yield 35 percent. By injecting subcutaneously, three milligrams daily of thyroxine an increase of 11 percent

in milk and 22 percent in fat was obtained, while the injection of ten milligrams daily raised the milk yield 23 percent and the fat yield 37 percent. Archibald (1945) found that by feeding fifteen grams of thyroprotein daily to a group of eighteen cows, the fat content of the milk was not consistent, and there were wide variations in the milk yield.

Turner (1940) implied that surplus skim milk may become the agent with which the cow can be injected to stimulate the production of more milk. For many years it has been known that when iodine is mixed with protein under certain conditions, it becomes chemically united with the free proteins and free iodine is no longer present. Fresh skim milk can be used as the protein source. To it is added finely powdered iodine. The casein is then precipitated by adjustment of the pH to its isoelectric point. Reineke (1943) also explained the possibility of forming preparations with high thyroidal activity by the simple iodination of casein and other proteins.

Reineke, et. al. (1942), and Moore and Sykes (1947), and many other investigators have been able to prepare thyroprotein by the iodination, under special conditions, of casein, skim milk and other proteins rich in tyrosine. Reineke (1946) prepared this synthetic hormone to contain

3 to 4 percent thyroxine. Reineke (1942) stated that commercial preparations containing as much as 7 percent iodine, compared to 65 percent for thyroxine, showed nearly equal potency to thyroxine when used on tadpoles, but only about 40 percent as effective on guinea pigs. Experiments indicated that optically iodinated milk proteins would stimulate increased milk productions when fed for short periods to lactating cows and goats. When fed to goats in declining lactation at the rate of five to ten grams daily, thyrolactin stimulated increases in milk production averaging 10.5 percent. The heart rate was accelerated an average of 8.2 percent per minute. Thyrolactin fed in amounts of fifty to 100 grams daily to nine cows in a total of fourteen individual trials resulted in an average increase of 8.59 percent in milk yield.

Ralston, et. al. (1940) postulated that the feeding of protamone during the peak of performance might cause a decline in milk production, and further adds that thyroxine caused tissue to compete with the mammary gland for milk precursors.

Turner (1943) suggested that beyond the peak of production the thyroid secretion was not at optimum, and the addition of protamone holds the cow at a higher level of production. Turner (1945) furthermore stated that some

cows appeared to have an inherent thyroxine secretion rate below the level of their optimum capacity for producing milk.

Blaxter (1946) stated that in cases where cows were fed a constant dose of twenty grams of iodinated casein regardless of body weight, the stimulation of milk production tended to be greater for the lighter breeds. Also heifers did not increase in yield so markedly as did mature cows, and during the experimental period the heifers lost more weight than the mature cows. The average increase in the heart rate of the treated cows was 10.2 beats per minute. The increase was smaller in the heifers than in the mature cows.

Results of experiments showing a failure to respond during the last half of lactation were explained by Ralston, et. al. (1940) as possibly due to a smaller number of working alveoli, and to a reduced flood flow.

Hibbs and Kraus (1947) with experiments on the feeding of protamone to dairy cows, stated that the increase in milk production was dependent on the feed intake of the cow.

According to Moore (1946), in experiments where thyroprotein was administered to dairy cows for a period of eight months, receiving T.D.N. in accordance with Morrison's feeding standard, marked losses in body weight

were noted, and after considerable loss in body weight, milk declined at a fairly rapid rate. This loss in body weight and decline in milk production could be checked by increasing the T.D.N. intake by 25 percent. Booth, et. al. (1947) found a loss in body weight despite an increase in food intake. It was also noted that the heart rate declined, but like weight and production, was increased by 25 percent intake of feed. However, to the contrary, Sykes, et. al. (1947) stated that thyroprotein increased the heart rate to about the same extent whether the animals were on a high or low level of feed intake.

Reece (1944) carried on an experiment with cows for a period of seven months. He fed ten grams daily of thyroprotein, and received a 1400-pound gain in milk for the total lactation, 1000-pounds of which he contributed to the use of thyroxine. In an experiment extending over a sixteen-months period he found, that eight months after the feeding was started, milk production was as high as it had been previous to the trial. He demonstrated that protamone feeding stimulated varying degrees of increases in milk production. In one experiment the cow demonstrating the greatest increase in milk production showed the least increase in fat content of her milk, and the cow giving the smallest increase in milk production showed the greatest

increase in fat content of her milk. There was a slight loss in body weight but the loss was not severe. All cows showed increases in heart rate with the increase varying from eight to fourteen beats per minute.

As for the time it takes for an animal to return to normal after being fed thyroprotein, Reineke and Turner (1942) stated that following a three-day feeding trial production returned to normal within a week. However, Van Landingham, et. al. (1944) are of the opinion that the cows did not reach their peak in a four-week feeding period, and their study showed that following this period of feeding the production was very slight in the next four weeks.

Booth, et. al. (1947) concluded that duration of response was from six to fifteen weeks, but Reece (1947) suggested that from the standpoint of milk and fat production, thyroxine should not be withdrawn until the cow is ready to be dried off. He further stated that the decrease in milk and fat production, following thyroprotein withdrawal, was dependent on the stage of lactation.

Booth, et. al. (1947) seemed to think that greater response could be obtained from feeding thyroxine to the older cows.

In comparison with the oral requirements of ruminants and non-ruminants, studies indicated that thyroprotein

was being utilized less efficiently by ruminant animals than by the non-ruminants. Turner and Reineke (1944) carried out an experiment with sheep for a period of two weeks, using loss in body weight as an indication of response, and found that only about 5 percent as much thyroprotein is required when administered subcutaneously as when given orally by capsule. However, no difference was noted in the effectiveness of thyroprotein given by mouth or directly into the true stomach. From this it was concluded that the apparent low rate of absorption of the thyroprotein from the digestive tract was not due to inactivation in the rumen, but to its poor utilization and low digestibility in the ruminant alimentary system.

At the present time sufficient investigations have not been made to warrant a decision as to whether synthetic thyroprotein can become of any practical value to the dairy man, or any livestock man. Before this decision can be made, the effect upon the general health of the animal must be studied.

The total effects of these increases in physiological functions upon the well being of the animal has not been determined. However, Ralston, et. al. (1940) found that feeding large doses of thyroprotein to goats for an extended period of time produced definite injury to the heart. To date no long range experiments have been

conducted to determine the effects upon the productive life of the cow. However, Lush and Lacey (1932) reported the productive life of cows to be approximately 3.5 years, indicating very few cows die from old age.

Hibbs, et. al. (1947) suggested that the greatest use of synthetic thyroprotein may be in the feeding of hypothyroid animals to bring them to normal level of production. Turner (1945) stated that some cows may have a low supply of thyroxine and need some for greater production. Espe (1946) has stated that thyroproteins are effective orally, which makes them more practical than other synthetic hormones.

Blaxter (1948) did some work with the feeding of iodinated casein to sheep. He found there was no change in the methane production, which suggested that alimentary fermentation had not been affected by feeding the iodinated casein, also, that the respiratory rate was highly variable and directly related to the environmental temperature. He further reported that two grams of thyroprotein had a decidedly stimulating effect on pulse rate, oxygen, and resting metabolism, and markedly accelerated the basal metabolism of the sheep.

Spielman (1944) reported that thyroxine acts as a stimulator of the energy metabolism of the body. It

regulates the burning of the nutrients, starches, sugars, and fats by the cells of the body, also that it increases the heart action and circulation of the blood. He further stated that the feeding of thyroprotein in excessive amounts would cause undesirable effects such as hyperirritability and loss in body weight.

In an experiment with eleven cows being fed fifteen grams of iodinated casein daily for varying periods of time and under various conditions, Booth, et. al. (1947) state that increases in milk and butterfat production were obtained, but all cows lost weight and had increased heart rates.

Moore and Sykes (1947) emphasized the lack of knowledge of the effect of thyroxine on the life span, and on the relationship, from an economic standpoint, between the amount of additional feed required to produce this additional milk.

The use of thyroprotein must necessarily be limited until definite effects of its use are more thoroughly understood. Seath, et. al. (1945) stated that it was highly questionable if the increased results were worth the chance of possible injury to milk cows.

Booth, et. al. (1947) stated that several factors should be considered before feeding iodinated casein. In

many cases there was loss in body weight, even when extra nutrients were fed, and often there was a drop in production below normal after the feeding of thyroprotein had been discontinued.

Van Landingham, et. al. (1947) state that the increased heart rate and respiration observed at first seems to approach normal after several months feeding.

However, under carefully controlled conditions, taking into account the status of each animal to be treated, it may be shown that increased milk production mediated by iodinated casein can profitably be realized.

EXPERIMENTAL

The experimental animals included twenty-eight lactating ewes and their lambs. Purebred Hampshires, Southdowns, and crossbred Southwest ewes were selected from the University of Tennessee farm flock.

Ewes in Dry Lot

Twelve uniform ewes and their lambs were selected from the University farm flock directly following lambing. Their weights, respiration, pulse rate and rectal temperatures were checked for three consecutive days during the fourteen-day period following lambing, and then once weekly thereafter throughout the experimental period.

The lambs were weighed at birth, ear tagged and branded a number with paint to correspond with the number of the ewe for ready identification. All lambs were docked when ten days of age and their weights checked each week. Observations and gains were recorded.

When the lambs were fourteen days of age, these twelve ewes were divided into three uniform lots based on weight, lambing date, condition, age and other indications of probable outcome. Each lot consisted of two Hampshires, one Southdown, and one Southwest ewe and their lambs. One set of twins and three single lambs were included in each lot.

Lot I, consisting of four ewes and their lambs, received daily a ration balanced in accordance with Morrison's Standard. (Table I)

Lot II, consisting of four ewes and their lambs, received Morrison's Standard nutrient requirements plus a 25 percent increase, plus one and one-half grams of thyroprotein (protamone) in capsules daily. (Table I)

Lot III, consisting of four ewes and their lambs, received Morrison's Standard nutrient requirements plus one and one-half grams of the thyroprotein daily. (Table I)

Ewes on Pasture

Sixteen ewes and their lambs were selected and divided into two uniform lots. They were checked, prepared for the experiment, and managed as discussed for the dry lot groups.

When the lambs were fourteen days of age, these sixteen ewes were grouped into eight pairs. One ewe from each pair (total of eight ewes) were entered into Lot IV, and received daily thereafter one and one-half grams of the thyroprotein in a capsule. The other eight ewes were entered into Lot V, and did not receive thyroprotein.

These sixteen ewes with their lambs had free access to good temporary pasture during the day and were returned

to the barn each evening and separated into their respective lots for feeding and routine check. Each lot received throughout the experimental period a supplemental feeding of one-half pound of grain mixture per ewe per day and equal amounts of alfalfa hay. The ewes were kept in lots during the night and turned on pasture early each morning.

Methods, Feeds and Pasture

The thyroprotein was prepared for administering by placing 1.5 grams of "protamone" into a capsule and these were administered to the ewes daily with a balling gun. A stethoscope was used for checking the heart rate, and flank movements were counted for respiration. A rectal thermometer was used for checking body temperatures.

The grain mixture fed consisted of equal parts of whole yellow corn #2, and oats. Alfalfa hay was fed throughout the experiment to all lots. (Table I) The chemical analyses for these feeds are included in Table III.

A mineral supplement, consisting of a mixture of equal parts of bone meal and salt, was fed ad libitum. Fresh water was available to the ewes at all times.

The pasture used was a succulent, growthy mixture of excellent quantity and quality. It consisted of an

eight-acre plot seeded to a mixture of oats, orchard grass, and volunteer Italian rye grass.

Blood ascorbic acid determinations were made on the ewes according to the method of Roe and Kuether (1943), and results presented in Table II.

DISCUSSION OF RESULTS

This experiment was conducted in order to study the possible value of adding thyroprotein to the ration of lactating ewes. The criteria of measurements used in this study were: gains and market grade of lambs; ewe weight, respiration, pulse rate, temperature, and feed consumption on pasture and in dry lot; and the cost of producing spring lambs in dry lot and on temporary pasture.

All of the ewes on experiment, whether receiving thyroprotein or not, did well throughout the 105 days and showed no outward indications of any changes with the exception of one ewe in lot III. This particular ewe receiving thyroprotein plus Morrison's standard ration, went off feed around the eleventh week of the experimental period and died shortly thereafter. Upon autopsy by the college veterinarian, gross degeneration of the liver, spleen and small intestine were noted. However, there was no conclusive evidence that this tissue degeneration was due to the feeding of thyroprotein.

It was observed from time to time during the experiment that the ewes receiving thyroprotein consumed more water and mineral mixture than the ewes not receiving thyroprotein. Therefore, a check was made on these observations for a two-week period. It was found that

lots II and III did consume considerably more water than the controls in lot I, and that lot III, receiving thyroprotein plus Morrison's standard ration, consumed approximately two times as much mineral mixture as either lot I or II. Lot II receiving thyroprotein plus 25 percent extra feed consumed the same amount of mineral mixture as the controls.

As shown in Table I and Figure 1, each group of ewes maintained a fairly constant weight throughout the experiment. All of the groups on dry lot lost some weight, with lot III which received Morrison's standard ration plus thyroprotein, losing more weight than the other dry lot groups. This is in agreement with the findings of both Seath et. al. (1945) and Booth et. al. (1947), who fed thyroprotein to dairy cows and found marked losses in body weight. The group receiving thyroprotein with Morrison's standard ration plus 25 percent extra feed lost approximately the same amount of weight as did the control group. This is in agreement with the work of Moore (1946), who found that 25 percent extra feed practically eliminated the loss in body weight, due to the feeding of thyroprotein to lactating dairy cows.

Table I and Figure 1 show the gain or loss in body weight of the ewes in the pasture groups (lots IV and V).

TABLE I

SUMMARY SHEET PRESENTATION OF DATA FROM THE THYROPROTEIN ("PROTAMONE")
STUDY WITH LACTATING EWES

Lot	No. of Ewes	No. of Lambs	Daily Feed Consumption Per Ewe			Total Feed Consumed Per Lot		
			Corn lbs.	Oats lbs.	Alfalfa lbs.	Corn lbs.	Oats lbs.	Alfalfa* lbs.
I Controls (Morrison's Standard)	4	5	0.75	0.75	3.0	315	315	1260
II Morrison's Std. / 25 % / Thyroprotein	4	5	0.94	0.94	5.0	394.8	394.8	2100
III Morrison's Std. / Thyroprotein	4	5	0.75	0.75	3.0	315	315	1260
IV Pasture Thyroprotein	8	10	0.25	0.25	0-2 ^a	210 ^b	210 ^b	1264 ^b
V Pasture Controls	8	10	0.25	0.25	0-2 ^a	210 ^b	210 ^b	1264 ^b

^aFed according to amount the ewes would consume.^bLots IV and V were on pasture 105 days.^{*}The feed weigh-back of alfalfa were as follows: Lot 1, 4.5 lbs; lot 2, 15.1; lot 3, 6.2; lot 4, 33.0; and lot 5, 38.0 lbs.

Market Grades of Lambs												Average	Average
High		Choice		Low		High		Good		Low		Daily	Total
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Gain Per	Gain of
Lamb	Lambs												
								3	60	2	40	0.39	40.8
		1	20	1	20	2	40	1	20			0.47	49.3
				2	40	1	20	1	20	1	20	0.42	44.2
4	40	4	40	2	20							0.54	56.4
3	30	4	40	3	30							0.55	57.4

Average Market Wt. of Lambs	Average Gain or Loss in Weight Per Ewe	Thyroprotein Fed Per Ewe Daily (Gms)	Total Thyroprotein Fed Per Ewe (Gms)	Total Thyroprotein Fed Per Lot (Gms)	Feed Cost Per cwt. of Lamb ^d Produced
57	-7.25	None	None	None	\$26.71
65.8	-7.5	1.5	157.5	630	31.99
59.3	-9	1.5	157.5	630	22.98
72.5	-3.5	1.5	157.5	630	9.20 ^c
73.2	48.6	None	None	None	9.02 ^c

^cPasture \$0.25 per ewe per month.^dThe cost of "protamone" was not included in these figures.

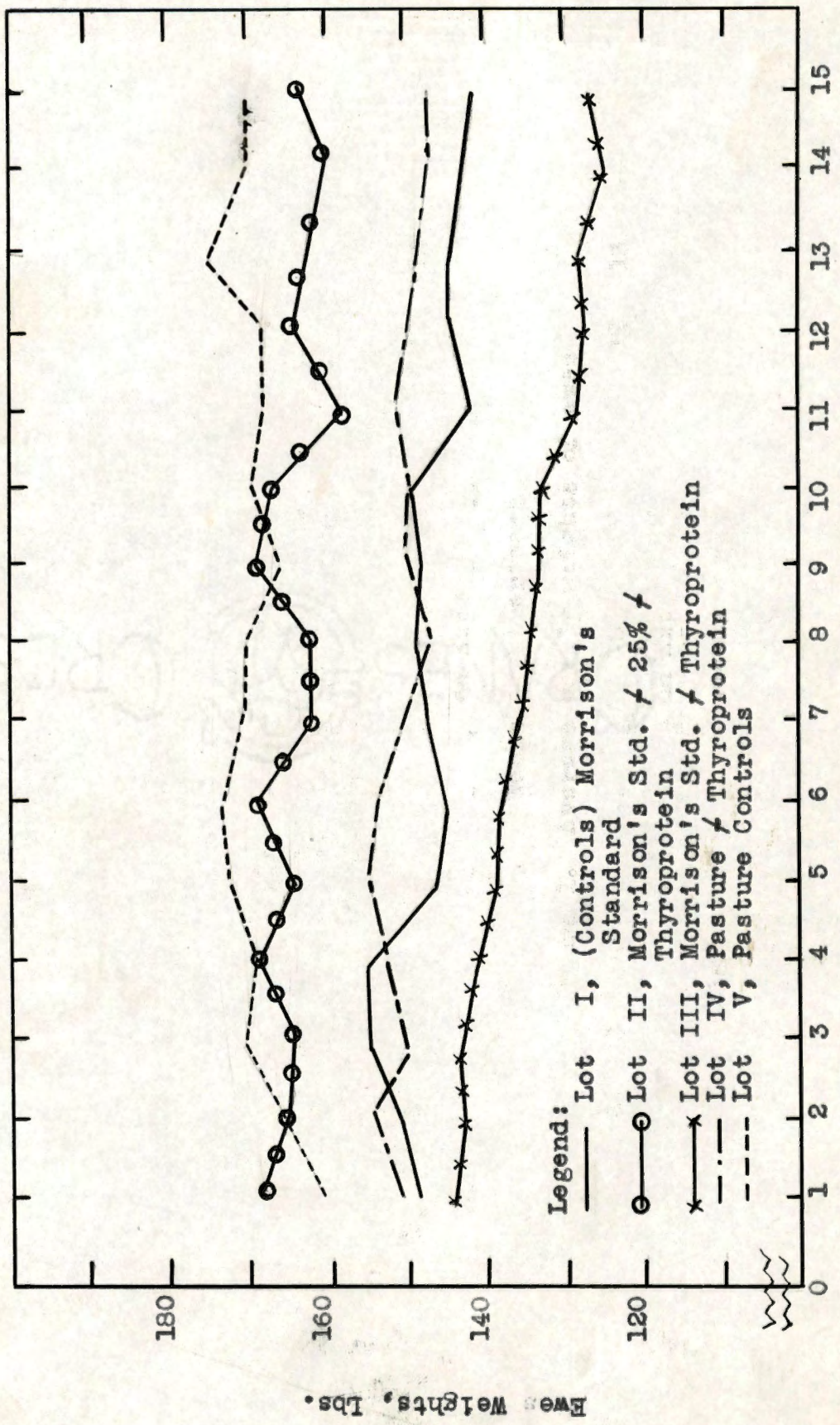


Figure 1. Average weekly weights of ewes

Lot IV, receiving thyroprotein on pasture, lost some weight during the course of this study. Whereas, lot V, the pasture controls not receiving thyroprotein, gained slightly. This was the only group of ewes to gain in weight during the experimental period and is similar to the work of Moore (1946), who reported marked losses in body weight of dairy cows that were fed thyroprotein. Moore (1946) also stated that this loss in body weight could be checked by increasing the total digestible nutrient intake by 25 percent above that recommended by Morrison's standards. Our results were in agreement with his findings, (Table I). The 25 percent (lot II) extra feed gave practically the same results as lot I so far as body weight maintenance of the ewe was concerned.

The average weekly respiration rate of the ewes in the different lots is presented in Figure 2. There were sharp changes in the respiration rate from week to week, which seemed to be brought about to a certain extent by environmental temperature changes. This association was particularly noticeable on hot humid days. The controls (lot I) tended to maintain a lower respiration rate than any of the other lots; whereas, lot III was higher than lot II. Our findings concerning the respiration rates are in agreement with Blaxter (1948), who fed thyroprotein

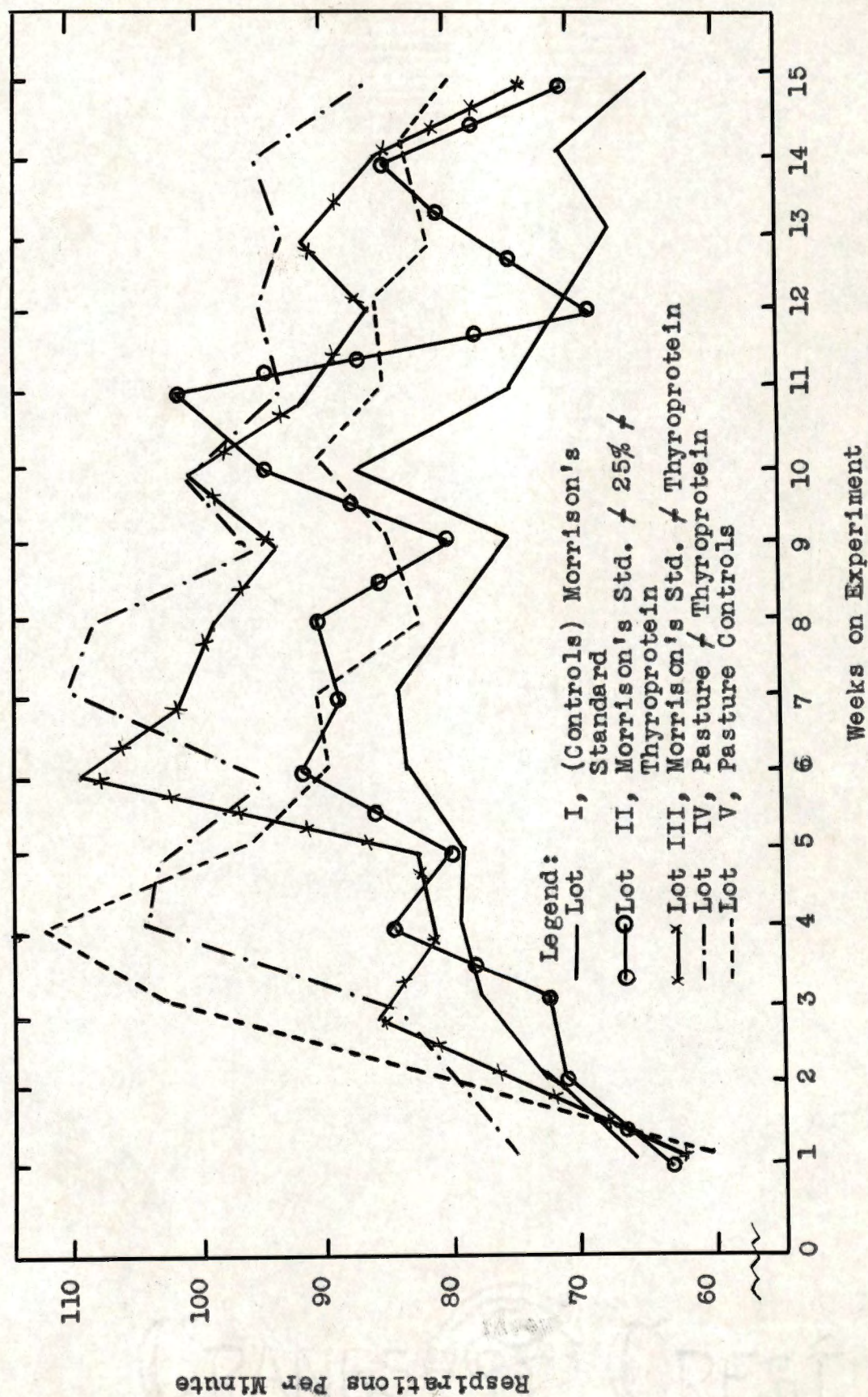


Figure 2. Average weekly respiration rates of ewes

to sheep and reported that thyroprotein markedly accelerated the respiration rate of ewes. He also found that the respiratory rates were highly variable, and that they were definitely related to environmental temperatures. The extra feed fed to lot II appeared to have a tendency of keeping the respiration rate more nearly like the controls (lot I).

The pasture groups receiving thyroprotein (lot IV) showed a higher respiration rate throughout most of the experimental period than did the pasture controls (lot V). This is demonstrated graphically in Figure 2. Van Landingham et. al. (1947) made the statement that the increased respiration observed at first seemed to approach normal after several months of feeding thyroprotein to dairy cows. This study is for the most part in agreement with his findings (Figure 2).

The average weekly pulse rates of the ewes in the different groups are presented in Figure 3. Similiar to the respiration rate just discussed, the pulse rate of the different groups varied markedly from week to week. This weekly pulse rate seemed to follow no definite pattern except for the fact that the rates of the controls were somewhat lower than that of the remaining lots throughout the greater part of the experiment. The extra feed

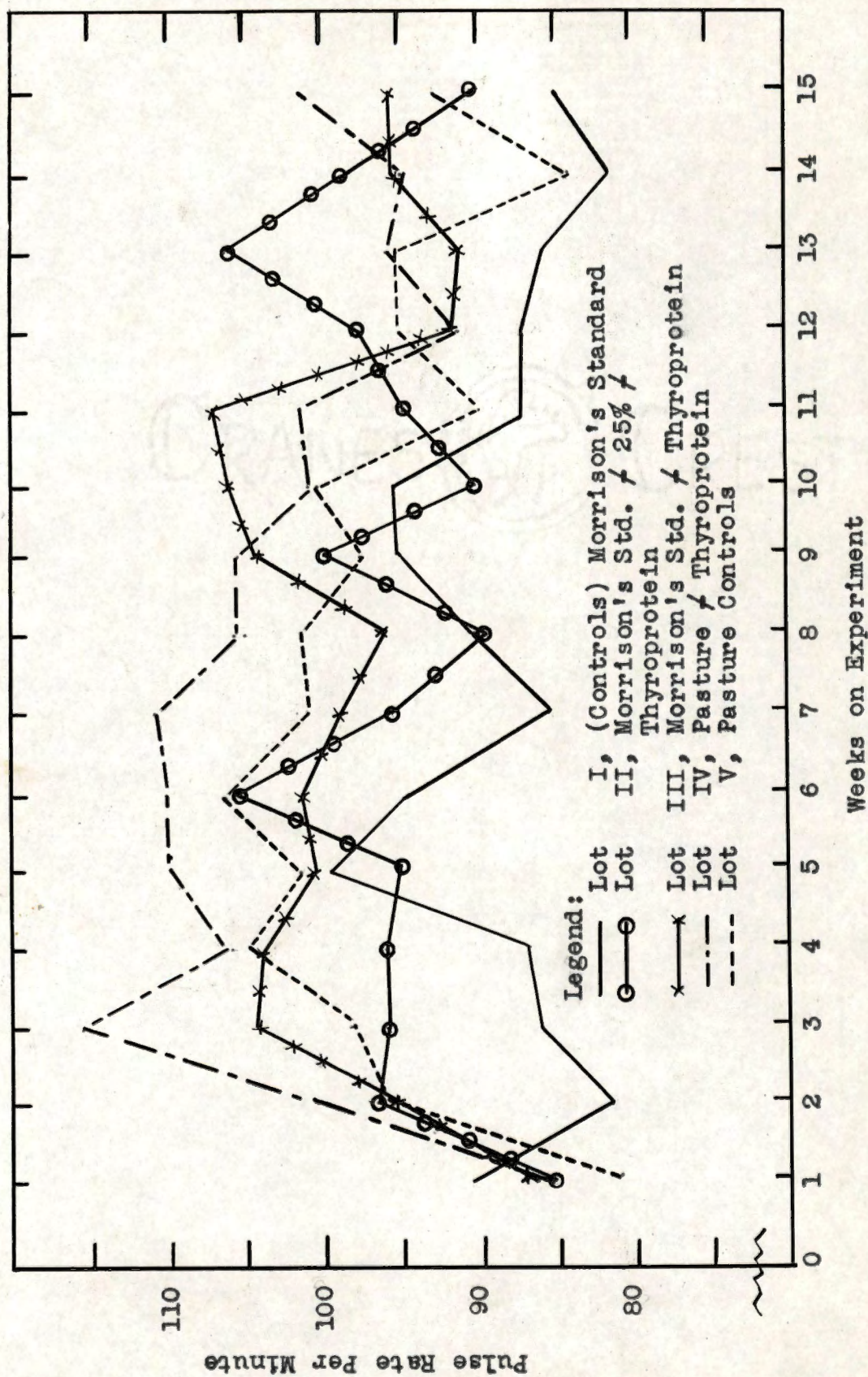


Figure 3. Average weekly pulse rates of ewes

consumed by lot II appeared to have no significant effect on the pulse rate of these ewes. This is not entirely in agreement with Moore (1946), who reported the feed intake to have an effect upon the pulse rate of dairy cows being fed thyroprotein. However, this is in agreement with the findings of Sykes et. al. (1947), who fed thyroprotein to dairy steers and found that thyroprotein increased the heart rate to about the same extent whether the steers were on high or low levels of feed intake.

There were considerable differences in the pulse rates of the pasture fed groups (lots IV and V). As illustrated in Figure 3, the ewes receiving thyroprotein maintained a higher pulse rate than the control group. It is indicated that regardless of feed intake the feeding of thyroprotein will cause an increase in pulse rate.

This study agrees with Blaxter (1948) in his work with sheep when he reported the body temperature to remain fairly constant during the period of administration of four grams of iodinated casein. The weekly average body temperatures of the ewes in the different lots is illustrated in Figure 4. There seemed to be no significant difference in the body temperatures between the groups receiving thyroprotein and the controls. There was considerable variation from week to week, but none of the lots followed any definite pattern. From the findings in this study

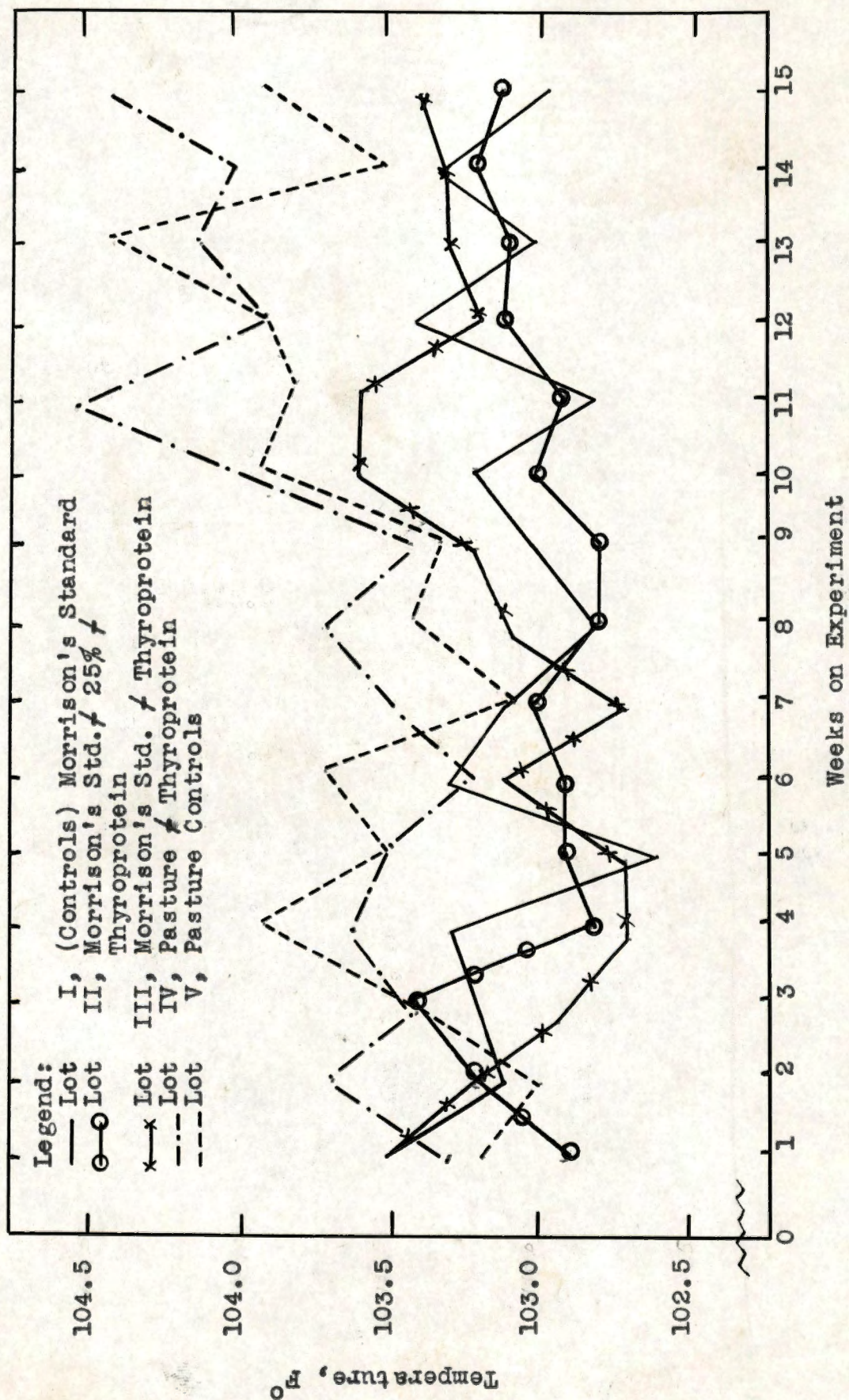


Figure 4. Average weekly body temperatures of ewes

it could not be concluded that the feeding of thyroprotein either caused an increase or decrease in body temperatures of lactating ewes.

Blood ascorbic acid determinations were made on all of the experimental ewes at the termination of the experiment. The method of Roe and Kurther (1943) was used and the results presented in Table II. The wide variation in individual ewes within the lots made the difference between lots insignificant even at the 5 percent level.

At the termination of the experimental period the lambs were graded on foot and placed in their respective market grades by a disinterested faculty committee. The number and percent of lambs placed in each of these grades is shown in Table I. There was an overall range in the market grades from high choice through low good. None of the lambs graded lower than low good. It is significant that the lambs from the control group of ewes graded lower than the other groups fed in dry lot. The lambs from the ewes in the lot receiving thyroprotein plus 25 percent extra feed above Morrison's standard ration, graded higher than any of the groups in dry lot. These grades ranged from medium choice through medium good. However, the group receiving Morrison's standard ration plus thyroprotein, graded considerably higher than lot I,

TABLE II

EFFECTS OF THYROPROTEIN FEEDING UPON THE BLOOD
ASCORBIC ACID IN LACTATING EWES

Group	Ewe Number	Coleman Reading	Mg Percent Ascorbic Acid	Group Mean
I Controls (Morrison Standard)	40	71.8	.760	.697
	804	78.0	.560	
	104-96	76.0	.620	
	84-61	69.0	.850	
II (Morrison $\neq$ 25%) $\neq$ Thyroprotein	761	78.0	.560	.523
	789	81.5	.465	
	307-60	87.0	.480	
	131-65	77.0	.590	
III (Morrison $\neq$ Thyroprotein	134-50	74.0	.685	.723
	20	74.0	.685	
	980	74.0	.800	
IV Pasture $\neq$ Thyroprotein	978	75.8	.630	.657
	600	71.8	.755	
	144-147	72.0	.750	
	989	74.0	.685	
	119- 91	71.0	.780	
	32	81.0	.465	
	207	72.2	.750	
V Pasture Controls	59	75.6	.635	.644
	-224	77.5	.575	
	70	77.0	.590	
	136-77	79.5	.610	
	824	73.8	.695	
	478-860	72.0	.750	
	145	75.0	.655	
	489	83.0	.710	

but below those receiving the extra feed. The better finish of these lambs could justly be attributed to an increased milk supply produced by the ewes receiving thyroprotein. This is in agreement with Reece (1944) and Herman (1938), who reported increases in milk production when thyroprotein was administered to dairy cows during lactation. From these results it can be stated that the feeding of thyroprotein stimulated milk production in the ewes, which was reflected in the lambs by their increased finish and resulting market grade.

The lambs from the ewes in the pasture lots graded higher than those in the dry lot groups (Table I). All of these lambs graded choice, ranging from high choice through low choice. The control lot had only one less (grade) choice lamb than the pasture group that received thyroprotein. This difference therefore was not sufficiently great to be of any statistical significance.

The average daily gains, total gains, and market weights of the lambs are shown in Table I. The growth curves illustrating the average weekly gains of the lambs in each lot is shown in Figure 5. In the control dry-lot group of ewes the lambs made fewer pounds of daily gains, and total gains, and the consequent market weights, as well as the grades, were less for the lambs in this lot than in

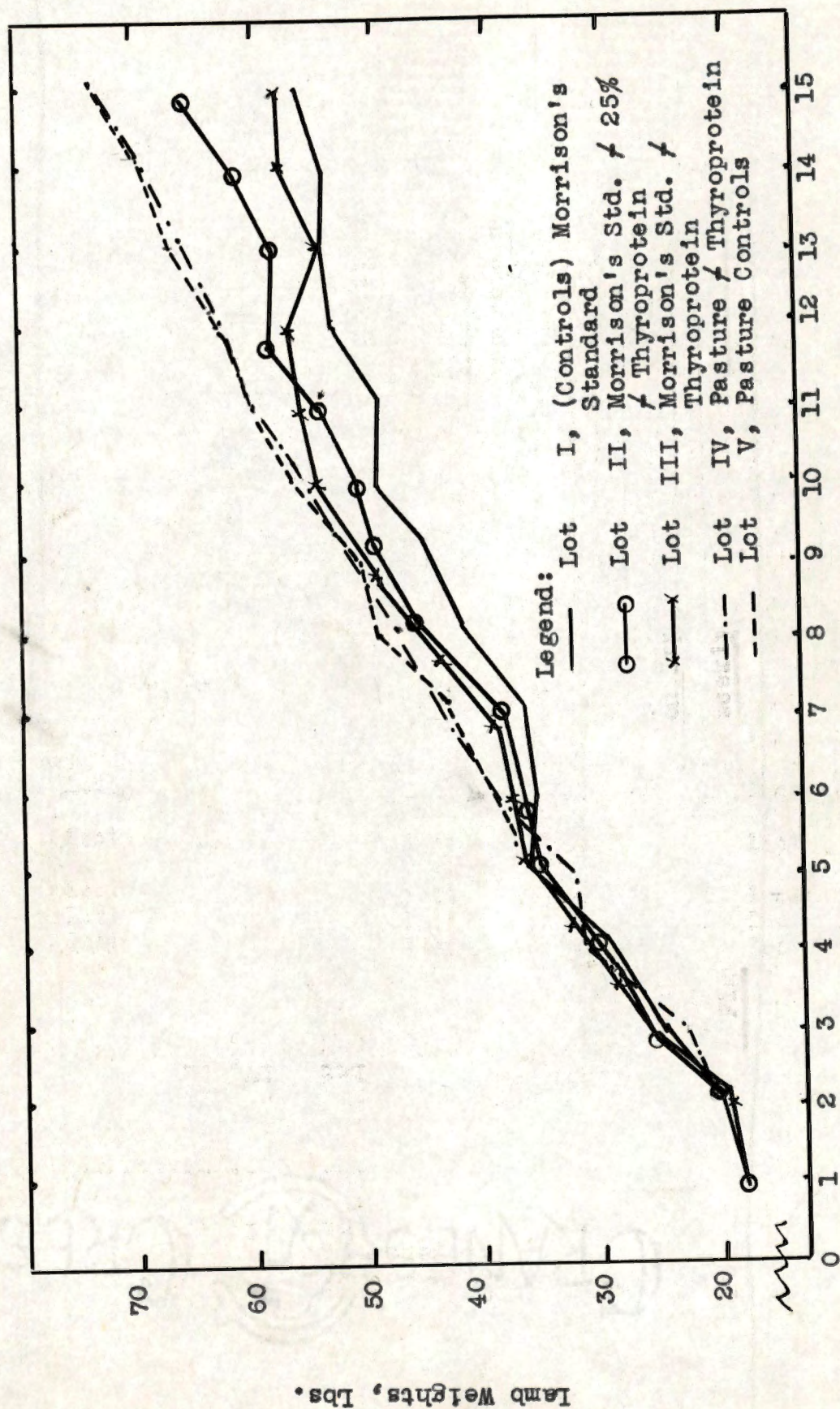


Figure 5. Average weekly gains of lambs

any of the other lots. The lot receiving thyroprotein plus 25 percent extra feed made the most rapid daily gains of any of the lambs in the dry lot groups. The total gains were higher, and a higher market weight was attained at the termination of the experiment. Lot III received the same amount of feed as the controls (lot I), plus thyroprotein (Table I). However, the lambs in lot III made considerably faster gains than the control lot. Consequently, the total gains for the period and the market weights were higher for lot III than for lot I. It is illustrated in Figure 5, by the average weekly lamb weights, that the ewes receiving thyroprotein maintained a more constant rate of milk production. Whereas, in the control dry-lot group of ewes, there was a noticeable decline in milk production at the sixth and tenth week of the lactation cycle. It therefore appears feasible that the thyroprotein fed to the ewes in dry lot stimulated milk production, which in turn caused faster daily gains of the lambs and produced heavier lambs more quickly for the early spring market. Hibbs and Kraus (1947) concluded that the feeding of thyroprotein to dairy cattle caused an increase in milk production which was proportional to the feed consumption. Our work is in agreement with this as is indicated by lot II, which received thyroprotein plus 25 percent extra

feed, and produced heavier lambs than did the ewes receiving thyroprotein on less feed. However, our findings in the pasture lots studied indicated that thyroprotein feeding to ewes on good pasture did not significantly affect production as measured by lamb growth (Table I, Figure 5). These lambs in the pasture groups gained more rapidly throughout the entire experimental period and attained a heavier market weight than did the lambs in dry lot.

The cost of producing spring lambs is probably the biggest factor confronting the present day sheep man. The greater part of the lamb cost is attributed to the cost of feeding the ewe. The feed cost per hundred pounds of lamb produced in dry-lot and on pasture is shown in Table I. The lambs from the ewes in lot II receiving thyroprotein plus 25 percent extra feed cost considerably more per hundred pounds of lamb produced than did either lot I or III. Those lambs from the ewes in lot III, receiving thyroprotein but no extra feed, cost \$3.73 less per hundred pounds of lamb produced than did lot I, which did not receive thyroprotein. In this case it appeared definitely profitable to feed thyroprotein to ewes receiving the regular amounts of feed. However, the labor, cost of administering the drug, and the possible effect that the thyroprotein may have on the health of the ewe must be studied more thoroughly before definite recommendations

can be made. The cost of producing spring lambs on pasture was approximately the same whether or not the ewes received thyroprotein.

SUMMARY AND CONCLUSIONS

This study indicated that the feeding of thyroprotein (protamone) caused a decrease in body weight and an increase in respiration and pulse rate.

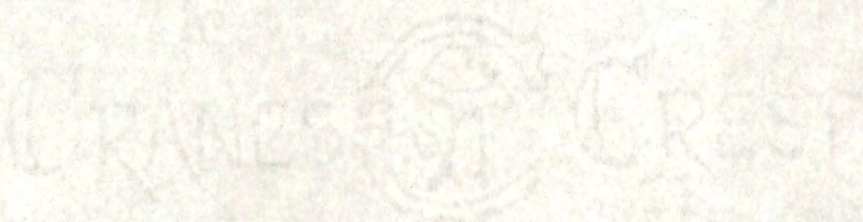
Evidence was presented to indicate that the market grades of lambs were increased when thyroprotein was fed to lactating ewes in dry lot; however, this was not true when fed to ewes on good pasture.

The feeding of thyroprotein had little if any effect on body temperature. Neither did it have a statistical effect upon the blood ascorbic acid content of the ewes. The effects of thyroprotein feeding were more clearly exemplified when fed to ewes on a limited supply of feed than when they had free access to good winter pasture.

Based on cost of gains, winter pasture proved to be superior to dry lot for producing spring lambs.

When ewes were fed in dry lots, data indicated that thyroprotein reduced the cost of producing spring lambs. However, when ewes have access to abundant pasture, the data shows that there is probably no value in feeding thyroprotein to lactating ewes for spring lamb production.

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A P P E N D I X

TABLE III

CHEMICAL ANALYSIS OF FEEDSTUFFS USED IN THE
THYROPROTEIN EXPERIMENT

Constituents Determined	Corn Percent	Oats Percent	Alfalfa Hay Percent
Moisture	12.20	13.92	10.62
Ash (Mineral Matter)	1.10	3.03	8.13
Crude Protein % N X 6.25	7.19	9.11	17.17
Crude Fat (Ether Extract)	4.29	5.93	2.17
Crude Fiber	4.29	5.93	26.70
Nitrogen Free Extract	73.60	58.38	35.21
Calcium (Ca)	.010	.085	1.731
Phosphorus (P)	.112	.168	0.154

TABLE IV

RATIONS FED EWES IN THYROPROTEIN STUDY

Lot	No. of Ewes	Corn	Oats	Alfalfa Hay
I Controls (Morrison's Standard)	4	3	3	12
II Morrison's Standard / 25 % / Thyroprotein	4	3.75	3.75	20
III Morrison's Standard / Thyroprotein	4	3	3	12
IV Pasture / Thyroprotein	8	2	2	0-16 ¹
V Pasture Controls	8	2	2	0-16 ¹

¹Fed according to amount they would consume.

TABLE V

THYROPROTEIN FED EWES DURING THE 105
DAY EXPERIMENTAL PERIOD

Lot	No. of Ewes	No. of Lambs	Thyroprotein Fed Per Ewe Daily, Gms.	Total Thyro- protein Fed Per Ewe, Gms.	Total Thyro- protein Fed Per Lot, Gms.
I					
Controls					
(Morrison's Standard)	4	5	None	None	None
II					
(Morrison's Standard / 25%)	4	4	1.5	157.5	630
III					
Morrison's Standard / Thyroprotein	4	5	1.5	157.5	630
IV					
Pasture / Thyroprotein	3	10	1.5	157.5	630
V					
Pasture Controls	8	10	None	None	None

TABLE VI
GAINS OF EWES AND LAMBS DURING THE 105
DAY EXPERIMENTAL PERIOD

Lot	No. of Ewes	No. of Lambs	Average Gain or Loss Per Ewe, lbs.	Average Daily Gain Per Lamb, lbs.	Average Total Gain Per Lamb, lbs. (105 Days)
I Controls (Morrison's Standard)	4	5	-7.25	0.39	40.8
II Morrison's Standard / 25% / Thyropotein	4	5	-7.5	0.47	49.3
III Morrison's Standard / Thyropotein	4	5	-9	0.42	44.2
IV Pasture / Thyropotein	8	10	-3.5	0.54	56.4
V Pasture Controls	8	10	8.6	0.55	57.4

TABLE VII

MARKET GRADES OF LAMBS AT TERMINATION OF THE
EXPERIMENTAL STUDY

Lot	Choice			Good		
	High	Med.	Low	High	Med.	Low
I						
Controls						
(Morrison's						
Standard)						
No. Graded					3	2
% Grade					60	40
II						
Morrison's						
Standard / 25%						
/ Thyroprotein						
No. Graded		1	1	2	1	
% Grade		20	20	40	20	
III						
Morrison's						
Standard /						
Thyroprotein						
No. Graded			1	2	1	1
% Grade			20	40	20	20
IV						
Pasture /						
Thyroprotein						
No. Graded	4	4	2			
% Grade	40	40	20			
V						
Pasture						
Controls						
No. Graded	3	4	3			
% Grade	30	40	30			

TABLE VIII

EFFECTS OF THYROPROTEIN UPON THE COST OF PRODUCING SPRING LAMBS
ON DRY LOT AND ON PASTURE

	Lot I Controls (Morrison's Standard)	Lot II Morrison's Standard 25% Thyro- protein	Lot III Morrison's Standard Thyro- protein	Lot IV Pasture Thyro- protein	Lot V Pasture Controls
Number of Ewes	4	4	4	8	8
Number of Lambs	5	5	5	10	10
Average Daily Gain Per Lamb	0.39	0.47	0.42	0.54	0.55
Average Total Gain	40.8	49.3	44.2	56.4	57.4
Average Market Weight	57	65.8	59.3	72.5	73.2
Total Feed Consumed					
Corn, lbs.	315	394.8	315	210 ¹	210 ¹
Oats, lbs.	315	394	315	210	210
Alfalfa, lbs.	1260	2100	1260	1260	1264
Cost Per cwt. of Lamb Produced	26.71	31.99	22.98	9.20 ²	9.02 ²

¹ Lots IV and V were on pasture 105 days.

² Pasture \$0.25 per ewe per month.