THE EFFECT OF AMBIENT TEMPERATURE ON THE WINTER FEED INTAKE OF BIGHORN SHEEP

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INTRODUCTION

The concept of winter range has preoccupied the thinking of biologists for many years. Intrinsic in this concept are data describing population size, sex ratios, age classes, carry-over, distribution, vegetative types and yield.

However, little or no data have been collected regarding feed intake, proportion of feed types ingested, apparent digestibility, the relation of feed quality to intake, the effect of snowfall on nutritional status, the efficiency of the feed habits of individual animals and the influence of ambient temperature and topography on feed intake.

The study of the winter nutrition of any wild ungulate must involve at least three factors:

(a) the quality of the feed
(b) the quantity which is ingested
(c) the influence of environmental variables.

RESULTS

Many authors have substantiated the progressive decline of nutrients (crude protein, gross energy, phosphorus) in winter range forage, with seasons (Figure 1). Summer range forage contains a greater quantity of nutrients than does winter range forage, but nutrient decline proceeds in a similar manner (Figure 2), correlating with the phenological stage.

During the period October through March most ungulates subsist on winter range forage of a relatively poor quality (low crude protein, high crude fibre). At this time modifications in temperature, snowfall and range availability are extremely critical.

Feeding trial measurements during the winter months indicate that a decline in quality produces dramatic changes in digestibility and nutrient intake (Table 1). Conventional trials generally utilize large changes in nutrient content over short time intervals. This tends to separate the balance between nutrient content and digestibility.

Conversely, in the natural state, qualitative changes occurring throughout the winter appear to be minor. Of singular importance is the length of time spent on each low quality diet.

Therefore, minor changes in nutrient content of overwintering feed, over longer time intervals correlate well with degrading rumen condition and resultant digestibility.

Description of Diet	Quality of Diet Crude Protein	Feed Intake gm/day/group	Apparent Digestibility %	Digestible Protein gm/day/group	Age Status of Animal
Mainly Agropyron	5.87	998.18	50.6	20.53	Adult
Mainly Agropyron	4.78	910.83	38.16	-2.72	Adult
Mainly Agropyron	3.44	850.92	58.99	10.06	Yearling
Mainly Agropyron	3.22	681.54	55.94	5.48	Yearling

Table 1: The change in digestibility for the adult and yearling animals as a unit, in relation to level of feeding and quality of the diet.

Subsequently, a comparison of the adult ewe group as a unit while on diets differing in quality (CP content) indicates that feed intake declines throughout the year in response to declining dietary quality, without improvements in digestibility or nutrient intake (Table 1). In this instance digestibility and DCP paralleled declines in feed intake and dietary quality in contrast to the following experiment where digestibility increased as feed intake declined. Results were similar when tested with the yearling animals (Table 1).

Examination of the seasonal feed intake for a migratory and nonmigratory group of sheep (with body weight standardized-Feed Intake/Kg. B.W.) indicates that it also correlates with the natural decline in forage quality (Figure 3).

Within each group (adult and yearling sheep) it was noted that certain individuals ingested higher quantities of feed which in turn lowered the apparent digestibility of that feed. The following data test the idea that this combination of feeding and digestibility is nutritionally superior and will promote greater survivorship among individuals of this type. Blaxter and Wilson (1962) show that the apparent digestibility of hay of a given nutritional quality fell with increasing intake.

In my study, feed intake for the individual adult ewes on the standard ration 36-57 (Table 2) ranged from 767.61 to 1209.84 grams per day. This increase was accompanied by a decline in digestibility from 86.1 to 78.9 percent respectively. However, the animal with the higher feed intake, despite the lowered digestibility, acquired 197.29 grams of DCP/day while the one with the lower feed intake acquired 134.77 grams of DCP/day.

This relationship was similar when the ewe group was maintained on alpine forage. Again the greatest DCP intake (107.03 gm./day) was associated with the highest feed intake (1321 gm./day). The relationship was confirmed with the yearling group (Table 2).

Body weight differences were minimal during the comparison of individuals on any of the described rations, and should not produce significant differences in feed intake among individuals of a group.

These data indicate that individuals which ingest high quantities of summer or winter range feed, while sacrificing efficiency of digestion, still benefit in terms of nutrient intake.

A comparison of the two different experiments suggests that, although dietary quality determines the change in feed intake, apparent digestibility, DCP, etc., individuals which have a higher feed intake on any particular quality diet will benefit by receiving a greater nutrient intake.

Feed Intake and Ambient Temperature. The influence of minimum ambient temperature on air dry (10 percent moisture) feed intake during the critical winter period of 1969-70 was examined using low quality forage (3.3 percent CP) available to the animals during that season. The test was standardized by holding forage quality constant and expressing feed intake on a body weight basis.

Description of Diet	Feed Intake gm/day/animal	Apparent Digestibility %	Digestible Protein Intake gm/day/animal	Age Status of Animal
Ration 36-57	767.61	86.1	134.77	
	1198.48	83.2	190.20	Adult
	1209.84	78.9	197.29	
Alpine Forage	579.76	68.1	48.19	
	1034.98	65.1	88.77	Adult
	1321.00	61.6	107.03	
Alpine Forage Early Cut	1104.03	77.29	142.65	Yearling
	1422.96	70.46	170.85	
Alpine Forage Later Cut	1249.23	75.28	111.49	Yearling
	1343.60	71.45	118.06	

Table 2: The change in digestibility for individuals of the adult and yearling groups, as affected by level of feeding.

As shown in Figure 4, feed intake/kilogram body weight increased sharply with declining ambient temperature and declined gradually with increasing ambient temperature. Thus, feed intake increased 30 percent for the control group while ambient temperature declined from 19 F to -11 F (30 F).

An inverse relationship between feed intake/Kg BW and ambient temperature for both groups of sheep is evident in Figures 5 and 6 as ambient temperature increased. Consequently, feed intake/kilogram body weight can be predicted from ambient temperature during the critical winter period for the control group according to the equation $Y = 18.95 - .2728\ x \pm 12.97$. The relationship is significant at the .01 level ($p = .007$). Similarly, this relationship is described by the equation $Y = 24.42 - .1868\ x \pm 11.14$ for the experimental group. It is significant at the .05 level ($p = .0317$). The slope of the lines does not appear to be significantly different ($F = .949$, $p = .352$) as both groups responded similarly. Within the described range of ambient temperature, feed intake changes .27 gm/Kg BW for each 1^{o}F change in temperature for the control group and .18 gm/Kg BW for the experimental group.

Feed intake began to respond to minimum ambient temperature at 32 F (Figure 7). During the period November 18-22 when ambient temperature was 27-38 F, feed intake was 1187.83 grams/day; 118.16 grams/day or 9.1 percent less than when the average temperature was 25 F during November 23-28. This change in feed intake was reflected also in crude protein intake which was 6.94 grams/day less and gross energy intake 509.27 Kcal/day less. Forage quality remained constant during this period and body weight was approximately stable.

Extremes in temperature were experienced in late December 1968 (-50 F) and January 1969 (Figure 8). Feed intake increased markedly from 750 grams/day prior to the cold spell to 1148 gm/day during the period of extreme cold. This is an increase of 397.58 grams/day or 34.6 percent. Crude protein and gross energy intakes showed a similar percentage increase.

During the two-month period of feed intake and ambient temperature measurement shown in Figure 8, forage quality declined slightly. It has previously been shown that the resulting effect would be a decline in feed intake and body weight. The data in this figure indicate that the sharp increase in feed intake is a response to ambient temperature.

Feed intake is significantly related ($p = .0002$) to ambient temperature for the adult ewe group (Figure 9) according to the equation $Y = 854.7 - 17.05\ x \pm 10.77$. Within the temperature range - 20 F to 10 F each 1^{o}F change results in a change in feed intake of 17.1 gm/day.

The relationship between ambient temperature and feed intake/day is excellent prior to and during the cold spell for the control and adult ewe groups, respectively. In Figure 5 (designated as O) and Figure 9 (compensatory points are 1026.5 and 1131.5 gm feed/day at 15 and 17 F, respectively) two points are out of phase with the described relationship and have not been included in the calculation of the equation. These occurred during the rise in temperature after the cold spell when there was a lag of about two weeks before nutrient and feed intake returned to the level it had been at the same ambient temperature before the cold period. This lag was not noticed with the experimental group (Figure 6) which had been on higher quality feed during the summer and was in better condition throughout the winter months than the control group.

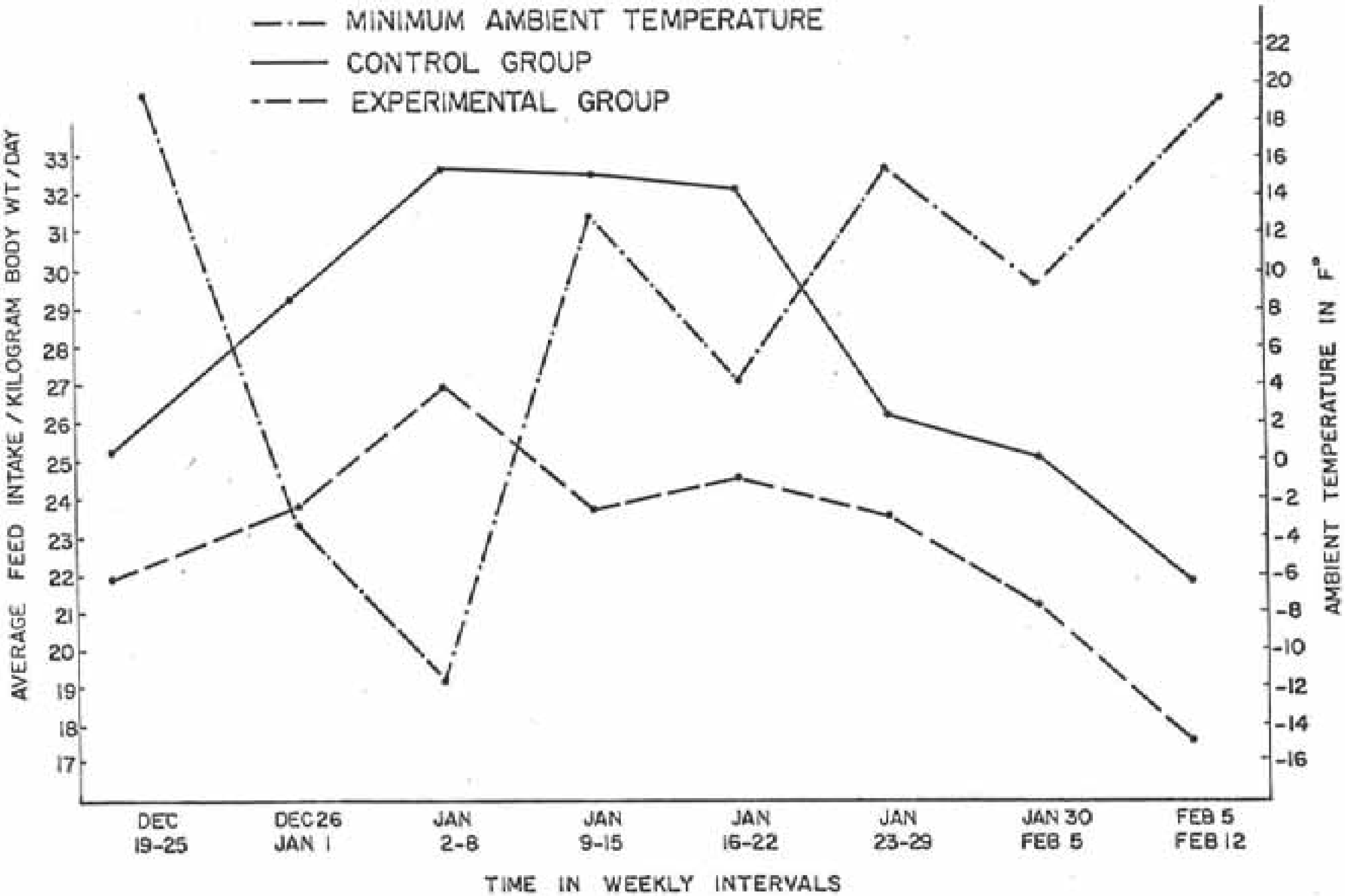


FIGURE 4. Average daily feed intake/kilogram body weight for the control and experimental groups of sheep in relation to changes in ambient temperature during the critical winter period.

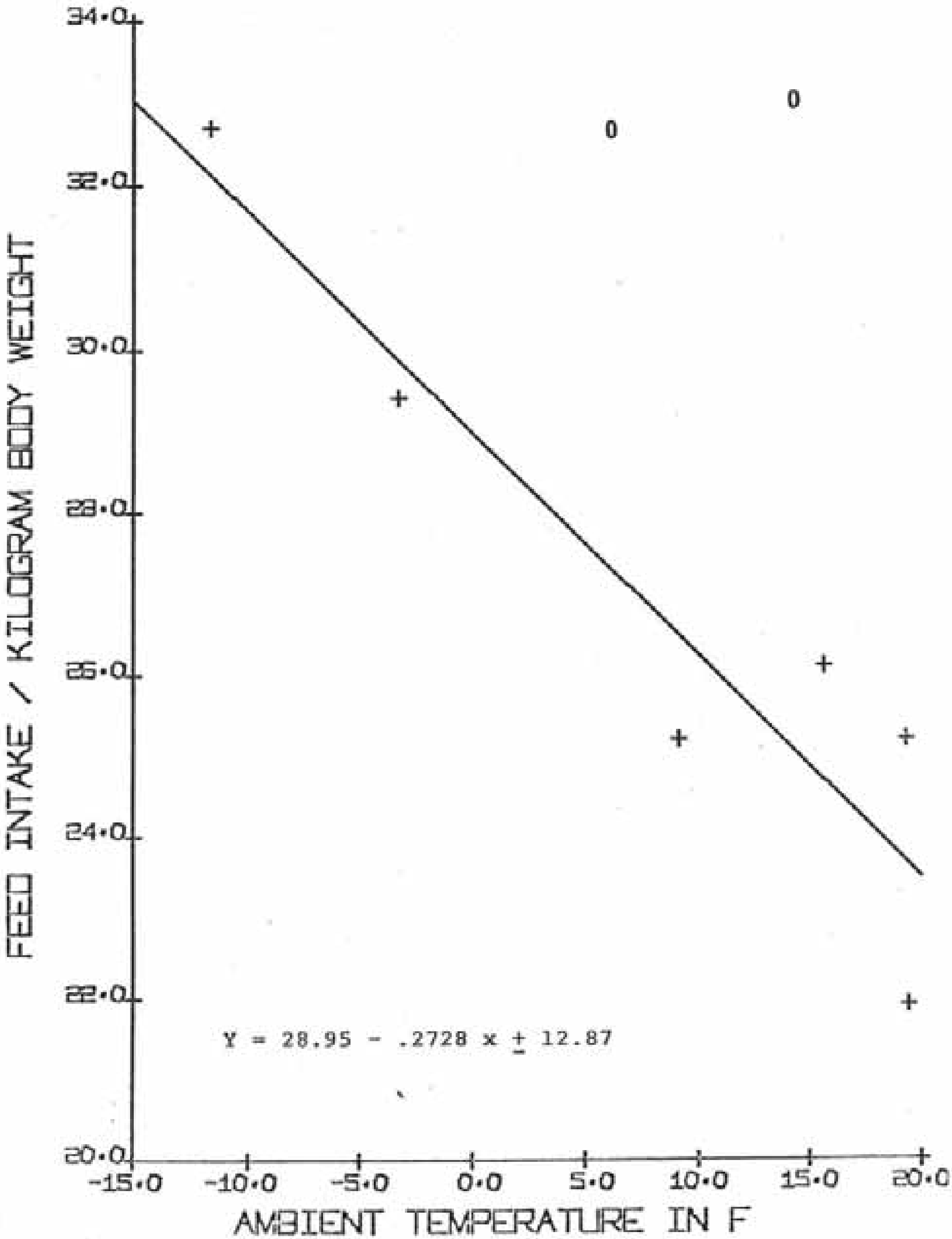


FIGURE 5. The relationship between minimum ambient temperature and feed intake/kilogram body weight for the control group.

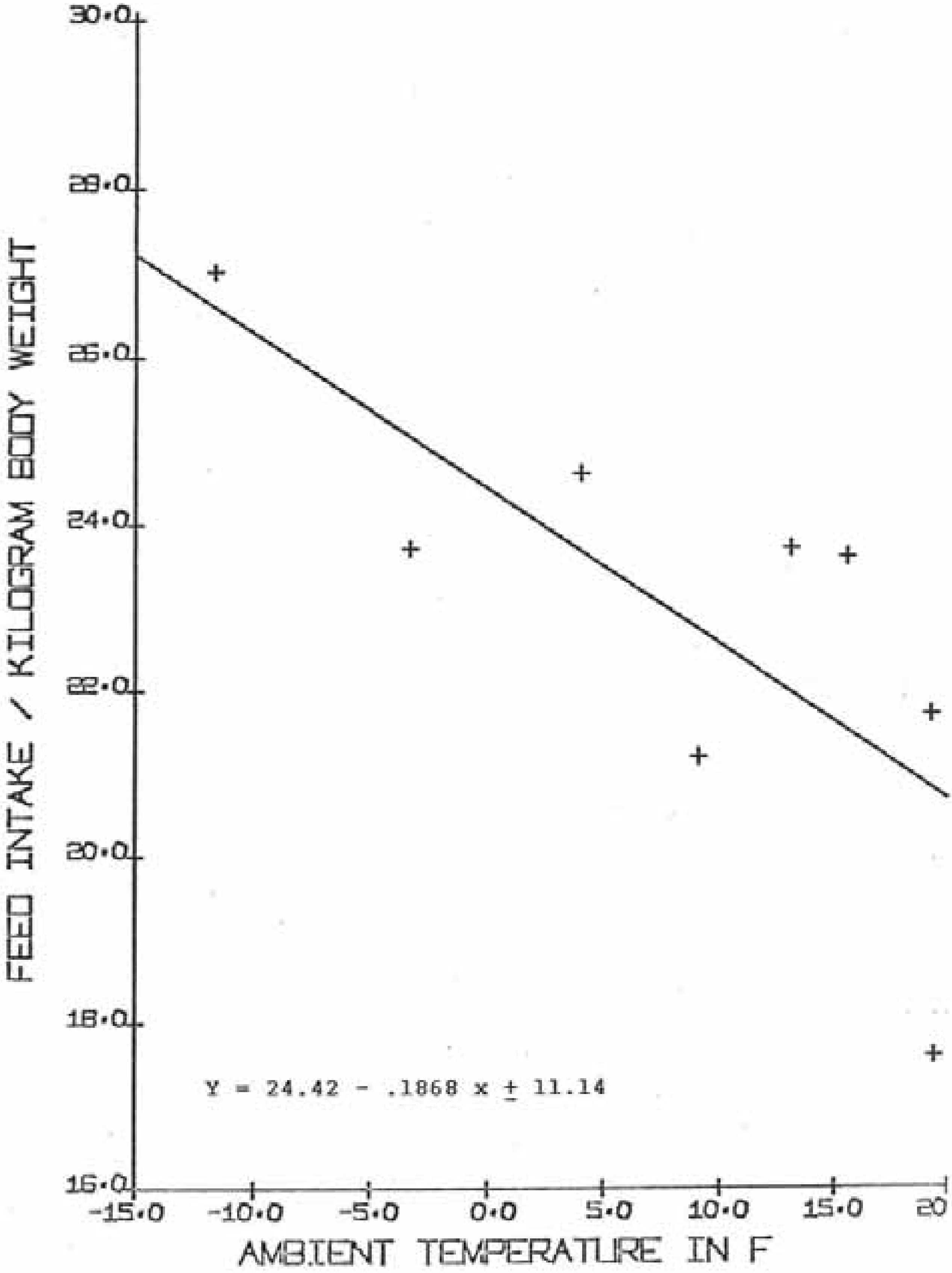
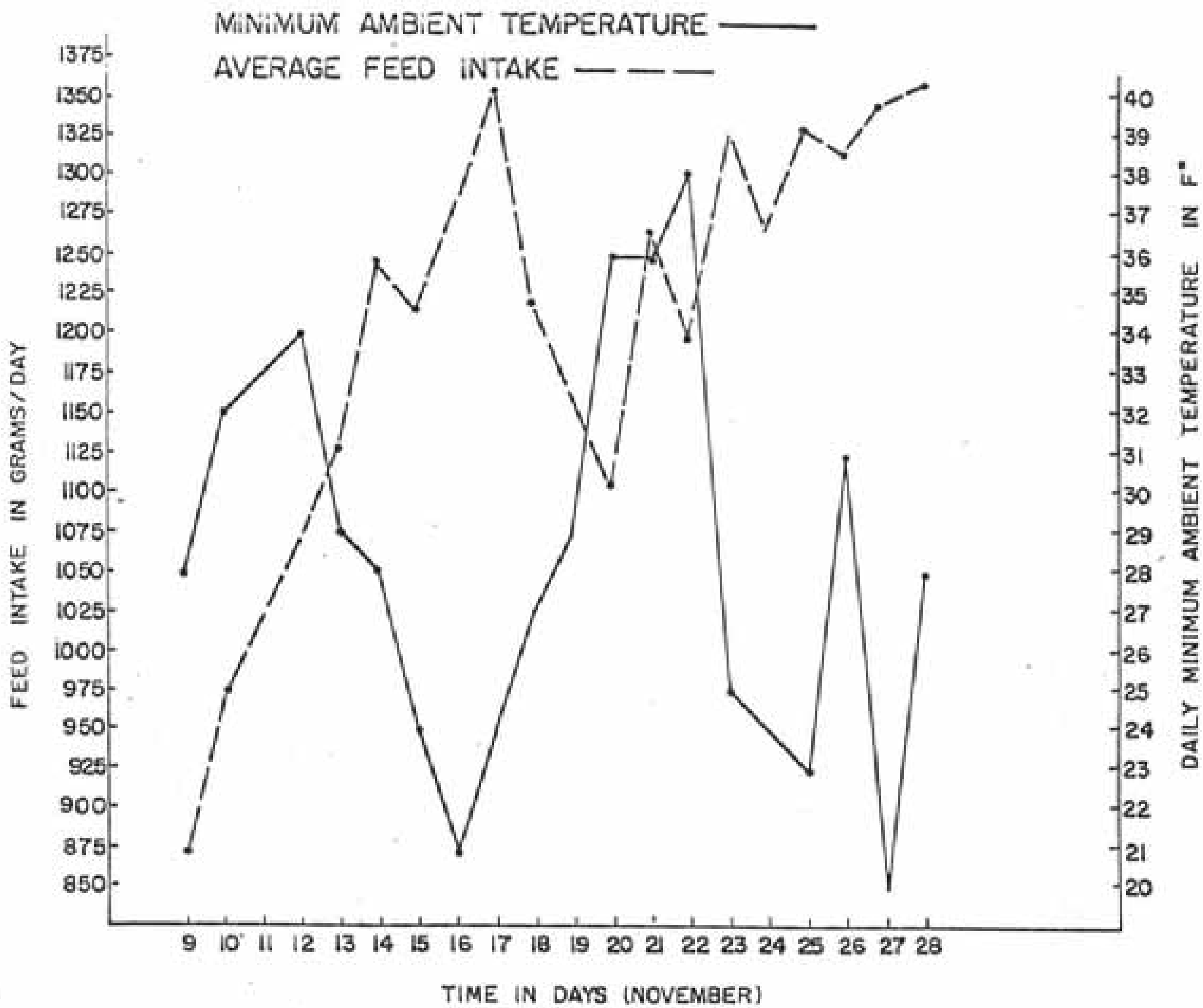


FIGURE 6. The relationship between minimum ambient temperature and feed intake/kilogram body weight for the experimental group.

Figure 7. Changes in minimum ambient temperature and feed intake for the adult ewe group during November 1969.



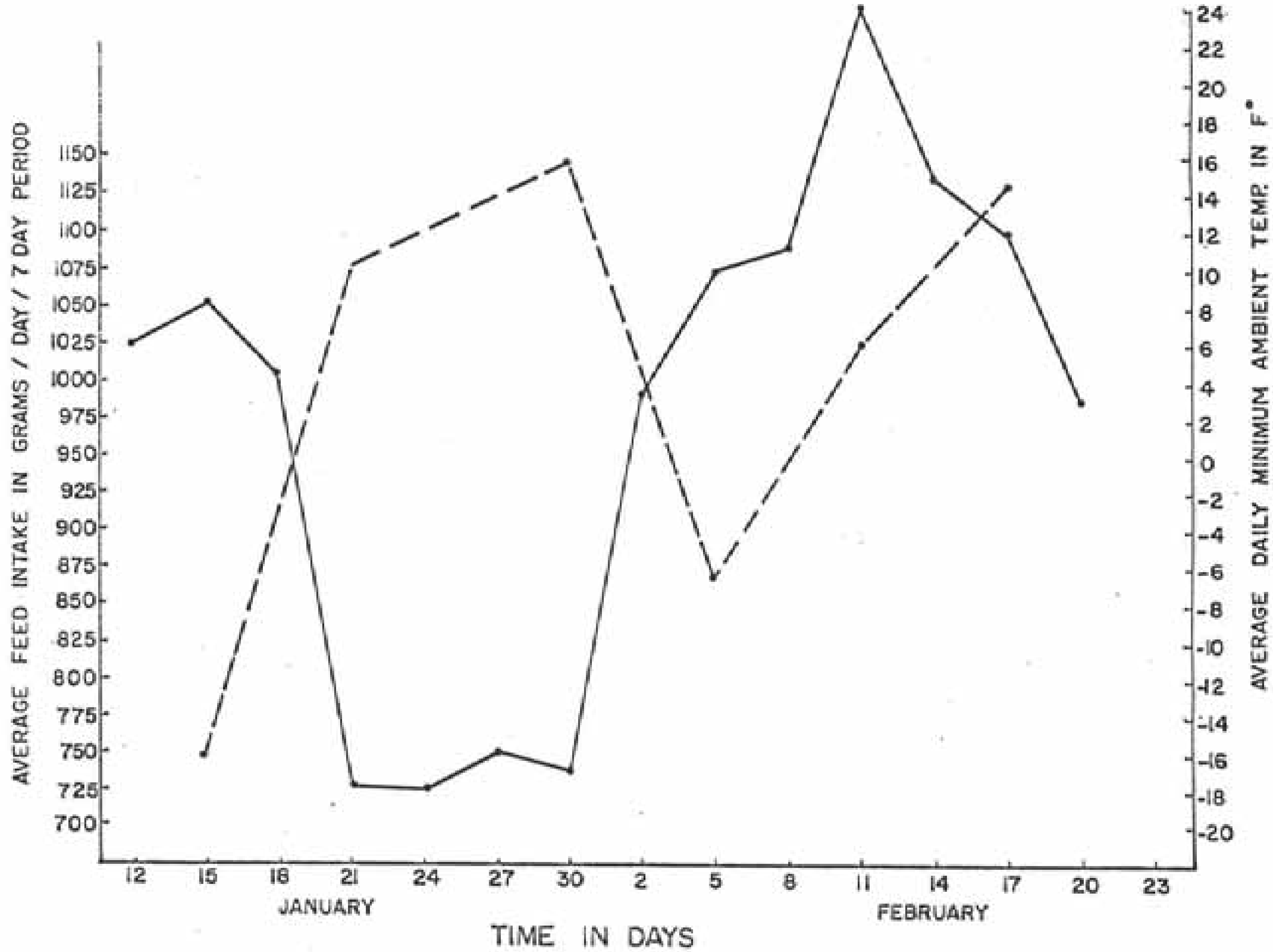


FIGURE 8. Changes in minimum ambient temperature and feed intake

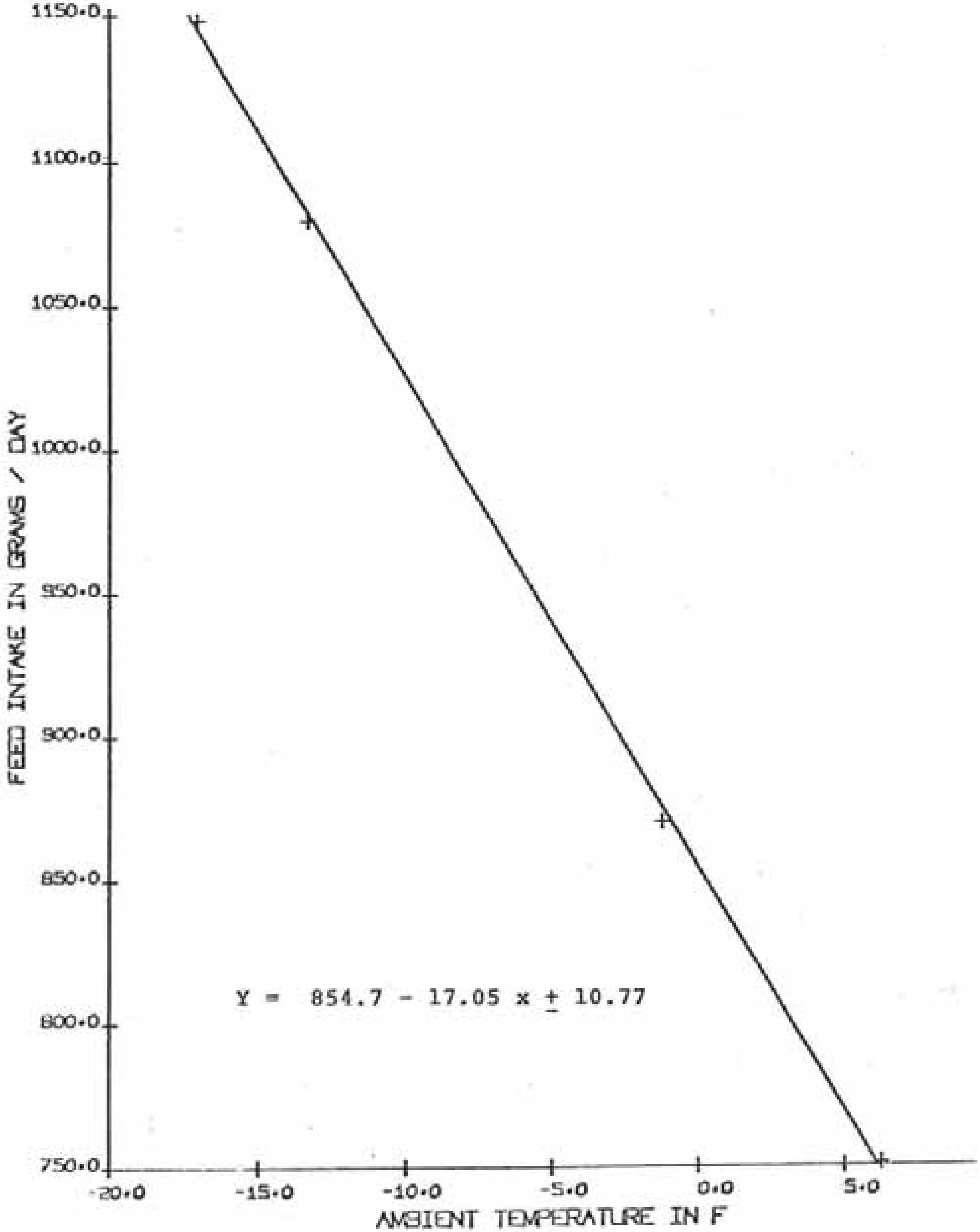


FIGURE 9. The relationship between minimum ambient temperature and daily feed intake for the adult ewe group.