ENERGY AND PROTEIN REQUIREMENTS OF EWES AND THE USE OF NON-PROTEIN NITROBEN BY EWES AND EARLY WEANED LAMBS

by

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ABSTRACT

In order to investigate the nutritional requirements of ewes during late pregnancy and early lactation, two groups of ewes were given 90 gms. Digestible Crude Protein (D.C.P.) during pregnancy and 225 gms. D.C.P./ head/day during early lactation. During the last six weeks of pregnancy ewes in Group II, provided with maintenance + 100% requirement of Digestible Energy (D.E.) made significantly greater liveweight gains ($P<0.01$) than those in Group I and fed maintenance + 50% D.E. During early lactation ewes in Group I, provided with maintenance + 150% D.E. lost significantly less weight ($P<0.05$) than those in Group II which were given maintenance + 100% D.E. There were no significant differences in milk yield and milk composition between the two groups, however pre-weaning lamb growth in Group I was significantly greater ($P<0.05$) than that in Group II. Average daily gain of weaned lambs (weaned at 8 to 10 weeks of age) given pelleted rations containing 20% protein was significantly greater ($P<0.05$) than those given 16% protein but there were no significant differences between lambs fed 20% or 13% and between 16% or 13% crude protein. A higher proportion of single lambs in the group given 13% protein may have accounted in part for the better gain of this group. Results of the digestion trial with these lambs indicated that there were no significant differences ($P<0.05$) in the dry matter digestibility and the protein digestion coefficient of the three types of pellets but the nitrogen retention was greatest in the lambs fed the 20% protein.

The results of the second experiment conducted, to study the effect of non-protein nitrogen in the form of urea on milk yield and milk composition of ewes indicated that there were no significant differences in milk yield, milk composition and milk urea N level of the three groups of ewes fed equal

amounts of supplemental nitrogen, during early lactation, as soybean, soybean + urea and urea alone. Ewes fed soybean or soybean + urea had significantly lower plasma urea nitrogen levels ($P<0.05$) than those supplemented with urea alone. There was no significant difference between the plasma urea nitrogen level of the former two groups of ewes. There were no significant differences in the pre-weaning growth of lambs nursing ewes fed on pellets containing soybean + urea and urea alone but the lambs from ewes fed soybean made significantly slower ($P<0.05$) gain than those from the other two groups. The reason for this slower rate of gain is difficult to explain.

Results of the trial conducted to investigate the use of urea nitrogen in early weaned lambs indicated that the lambs fed on pellets containing soybean made significantly greater gains ($P<0.05$) than those on pellets containing urea as the sole source of supplemental nitrogen. There were however, no significant differences in weight gain of lambs fed on pellets containing soybean or soybean + urea and between soybean + urea or urea alone. There were no significant differences between plasma urea nitrogen level of lambs fed on soybean or soybean + urea containing pellets and these lambs had significantly higher ($P<0.05$) levels of plasma urea nitrogen than those fed on pellets containing urea alone. The variation in the blood urea level of the lambs was thought to be due to variation in protein intake. Results of the digestion trial with lambs showed that there were no significant differences in the protein digestion coefficients and dry matter digestibilities of these types of rations. Pellets providing nitrogen from soybean resulted in greatest nitrogen retention.

Results show that urea did not influence the milk yield or milk composition of the ewes but it was a poor source of nitrogen for early weaned lambs.

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I. INTRODUCTION

The short interval from weaning to mating in sheep production systems involving twice yearly lambing or three lamb crops in twenty four months necessitates the reappraisal of the nutrient requirements of ewes. Normally it is considered that moderate feeding during late pregnancy followed by high-energy feeds in early lactation gives the best results in terms of lambs production and economy. Such a system usually involves a loss of body weight by the ewe during lactation. This being accepted and compensated for prior to rebreeding. It is proposed that good body condition may be attained by feeding at a higher level than normal during late gestation (in excess of the ewes requirements for maintenance and pregnancy) and accepting body weight loss in early lactation. The alternative is to meet the energy and protein requirements in early lactation by high grain feeding in order to maintain body condition. This thesis presents the findings of an experiment which was so designed that one group of ewes received energy and protein to meet the requirements of late pregnancy and then as closely as possible for lactation. The second group received the same total amount of energy during late pregnancy and early lactation but evenly divided over the two periods.

Since the lambs may have to be weaned early in intensive production systems, the protein requirements of early weaned lambs were also investigated.

There is evidence that urea nitrogen can be utilized by the lactating dairy cow without detrimental effects on milk yield and composition. Comparable work with sheep has not been carried out. The results of a further experiment are presented which was conducted to study the effect of urea nitrogen on milk yield and milk composition of ewes. Three groups of ewes were provided equal amounts of supplemental nitrogen, during early lactation, from three different rations containing soybean, soybean + urea and urea alone. The use of urea nitrogen in early weaned lambs was also investigated by feeding the above-mentioned rations for 16 weeks subsequent to weaning at eight weeks of age.

REVIEW OF LITERATURE

II. EWE NUTRITION IN PREGNANCY AND EARLY LACTATION

Considerable importance has been attached to the flushing of ewes before mating and this has become common practice in many countries. Flushing has a significant effect on increasing the number of eggs shed and hence the number of lambs produced (Coop, 1966) but there are other periods when the nutritional status of the ewe is important. The gestation period of the ewe is nearly 21 weeks, during the first 10 weeks of pregnancy foetal weight increase is small. As there is little extra demand from the foetus for nutriment at this time, only a maintenance ration is required for the ewe. De Cleene (1968) stated that in the last four weeks before lambing the foetus nearly doubles its weight. It is during this month that the nutrition of the ewe is important because it can affect the size of the lamb born. Raising the ewe's plane of nutrition to a high level would mean a heavier lamb at birth. This could result in an already large unborn single lamb in increasing its birth weight by an extra pound. The increased weight could make the difference between an easy and a difficult birth and therefore affect total lamb losses. He further stated that subjecting the ewe to a low feeding level during late pregnancy, on the other hand, also should be avoided, as this would mean that the lamb produced would be lighter at birth. A small lamb may be too weak to fend for itself and subsequently die. This is particularly relevant to twin lambs. He stated that although a large proportion of light lambs survive parturition, a great number of these will die in their first week. He pointed out that feeding levels also have an effect on the ewe in addition to the effect on the lamb. Excess feeding during early pregnancy, when very little demand is being made by the foetus on the ewe, results in a build up of excess body fat. This in turn lowers the animal's general fitness. He said that difficulty at parturition is partly a heritable trait but the incidence is higher in animals carrying too much condition when approaching lambing. He further stated that pregnancy toxaemia is a constant threat near the end of gestation when demands on the ewe are reaching a peak. If the amount of carbohydrate the ewe requires is greater than that available through feed intake, then body fat reserves will be catabolized. As a result toxins (acetone, acetoacetic acid and B-hydroxybutyric acid) are produced in liver, rumen epithelium and mammary gland which may cause ewe's death from pregnancy toxaemia. He concluded that it is important to keep the ewes on maintenance rations during early and mid-pregnancy with a gradually rising plane of nutrition over the last few weeks before lambing.

During early pregnancy ewes should be fed to maintain a constant body weight. Coop (1962) stated that under confined conditions (4ft. x 6ft. enclosures) a 45 kg. (100 lb.) sheep requires 0.96 lb. T.D.N. (1920 Kcalories D.E.) or 0.92 lb. digestible organic matter to maintain a constant body weight.

Langlands, Corbett, McDonald and Pullar (1963) estimated that the maintenance requirement of a 100 lb. housed sheep was 0.82 lb. digestible organic matter.

Investigations into the effect of protein intake during the second half of pregnancy on lamb birth weights and ewe milk yield during early lactation have given variable results. Slen and Whiting (1952) fed ewes individually during late gestation and early lactation, rations containing 7, 10 and 13% total protein (3.3, 6.3 and 8.1% digestible crude protein) to study the influence of protein intake on body weight of ewes and birth weight and growth of the lambs. Average daily intakes of digestible crude protein and total digestible nutrients for the three levels of protein during late gestation and early lactation were 0.13 lb. D.C.P. (digestible crude protein) and 1.7 lb. T.D.N. (total digestible nutrients); 0.23 lb. D.C.P. and 1.9 lb. T.D.N.; and 0.29 lb. D.C.P. and 1.9 lb. T.D.N. Results showed that the ewes receiving low protein (7%) ration did not gain as rapidly as the two groups receiving higher levels but there was no difference between groups receiving 10% and 13% total protein. Average body weights of the ewes 6 weeks before lambing were 154, 160 and 160 lb.; 2 weeks before lambing, 160, 168 and 171 lb.; and immediately after lambing, 135, 150 and 152 lb. for 7, 10 and 13% total protein, respectively. Both the single and twin lambs from the ewes receiving the higher levels of protein were significantly heavier than the lambs from ewes receiving the low protein ration. There were no significant differences in birth weights of lambs from ewes receiving the two higher levels of protein indicating that extra protein fed to ewes receiving the highest level of protein was of no additional value in increasing these weights. Many of the lambs from the ewes on the low protein ration were weak at birth, three ewes of the 24 lambing in this group had no milk and another six had insufficient milk to nurse one lamb and none had sufficient milk to raise twin lambs. It was evident from this experiment that 0.13 lb. of digestible crude protein daily during pregnancy was not sufficient to produce a vigorous lamb or sufficient to produce milk for nursing lambs. The single lambs and twin lambs raised as singles in the two higher protein groups were heavier at six weeks of age and at weaning time than lambs raised in low protein groups. All ewes receiving the two higher levels of protein had sufficient milk for one lamb and many had sufficient for twins.

Klosterman, Bolin, Buchanan, Bolin and Dinusson (1953) experimented with ewes of about 120 lb. live weight and found no significant differences in lamb birth weights between intakes of 0.10 and 0.28 lb. digestible crude protein per ewe daily. However ewe mortality was higher on the lower protein intake and milk yield as assessed by the growth of twin lambs was also adversely affected.

Phillipson (1959) concluded that 0.25 lb. digestible crude protein per day should be adequate for the 140 lb. ewe during the last six weeks of gestation.

National Research Council (1968) recommended 0.20 lb. digestible crude protein per day during the last six weeks of gestation for a ewe of 140 lb. live weight or more.

Gardner and Hogue (1963) experimented with ewes to determine the T.D.N. (total digestible nutrients) requirements of pregnant and lactating ewes. The levels of T.D.N. used was that recommended by National Research Council (1957) for 130 lb. ewes during the last 6 weeks of gestation (1.77 lb. T.D.N. per 100 lb. body weight) and for the first 8 to 10 weeks of lactation (2.3 lb. T.D.N. per 100 lb. body weight). The level of T.D.N. tested was as above or 75, 100 or 125% of those values before or after lambing or throughout. The level of protein used was the same as that of N.R.C. (0.23 lb. digestible crude protein during last six weeks of gestation and 0.3 lb. during lactation). Their results showed that varying T.D.N. levels for ewes during the last six weeks of gestation did not affect single lamb birth weights but feeding higher levels significantly increased twin birth weights. Feeding higher T.D.N. levels during gestation significantly increased the average 90 day weight of twin lambs and feeding higher lactation levels to ewes increased the 90 day weights of both single and twin lambs. The results also showed that ewes with single lambs approximately maintained their body weight from six weeks *pre-partum* to one day *post-partum* and to 90 day *post-partum* when fed the present N.R.C. standard whereas ewes with twins required approximately the 125% level. These data indicated that the present N.R.C. - T.D.N.

standard was apparently satisfactory for ewes pregnant with single lambs but increased levels for ewes pregnant with twin lambs seemed advisable.

Wright, Pope, and Phillips (1964) stated that oat straw, maize cobs and low-quality hay as roughages each supplemented with minerals and protein given as pellets were satisfactory for pregnant and lactating ewes.

Various levels of feed energy have been investigated during late pregnancy. Jordan (1966) reported that hay rations providing about 3000 K. calories and high concentrate rations providing 1800 K. calories of digestible energy per ewe daily during summer, nonpregnant dry period of four months resulted in weight losses of about 1 and 5 Kg. respectively. Weight changes were significantly different. During gestation about 3030 and 3930 K. calories (D.E.) per ewe daily were provided by hay and high concentrate rations, respectively. Results indicated that weight gains were not significantly different and averaged 18.8 and 16.5 Kg. per ewe, respectively. He further stated that lamb weights taken at birth and at 30 days of age were not affected by the summer and gestation treatments of their dams, suggesting that all rations were sufficiently adequate to provide ample nutrients for the developing foetus and for milk production.

It has been shown that body weight of ewes markedly affects the weaning weight and to a lesser degree the birth weight of lambs.

Ray and Smith (1966) analyzed birth and weaning weight records of lambs. They declared that age of dam (from 2 to 7 years) did not significantly affect weight of lambs at birth. Twin ram lambs were 0.59 Kg. heavier at birth and 1.8 Kg. heavier at weaning (120 days of age) than twin ewe lambs. There was a 5.63 Kg. increase in weaning weight, when weaned at 120 days of age, with each kilogram increase in birth weight. The greatest response of weaning weight to increase in birth weight occurred in single lambs. The body weight of the ewes markedly affected the weaning weight and to a lesser degree the birth weight of lambs. They stated that selection of heavy replacement ewe lambs for the breeding flock would be desirable (depending upon the extra cost of feeding heavy ewes). As the body weight of ewes increased there was a significant increase in weaning weights of lambs. The heaviest ewes weighing 59.5 to 63.6 Kg. produced lambs that weighed 9% and 20% more at birth and weaning respectively, than ewes in the lightest group weighing 41.4 to 45.5 Kg.

Nedkvitne (1967) conducted trials with ewes fed indoors on hay or silage or both from before mating to 2 to 3 weeks after lambing and in the last 2 or 8 weeks of pregnancy ewes got 0.2 Kg. concentrate daily with 11 to 12% digestible crude protein. Results of the trial showed that the ewes given silage alone or hay with silage produced most offspring. On the whole, the birth weight of lambs was lower among ewes given hay alone than for others. Most deaths were among lambs with very low or high birth weight. Weight gain from birth to weaning was usually least with hay alone and concentrates given for 8 instead of 2 weeks improved birth weight of twins only in the group fed on hay alone. The addition of concentrate to hay or silage resulted in fulfilment of the protein requirements during late pregnancy.

Pregnant ewes being fed on pasture alone should be given a supplement during late gestation to meet the requirements of late pregnancy and for better milk production.

Pogodin (1967) studied the effect of level of nutrition of pregnant ewes, during 150 days of pregnancy fed on pasture alone or with a supplement of 0.5 Kg. barley meal, on weight changes and milk production. Results showed that the average loss of weight during pregnancy was greatest, 17.8% in ewes on pasture alone and least, 10.0% in those given barley meal throughout. Those given the supplement for the last 15, 35, 70 or 100 days lost less weight than those given it for the corresponding periods at the start. Average milk yields during 20 days at the start of lactation, from the third day after lambing when the lambs were removed, were significantly greater in ewes given the supplement for the last 15 to 100 days than those given it only for the first 50 days and than those given no supplement during gestation. It has been shown that lamb birth weights are not affected by the source of protein in the feed of their dams if the dams are supplied with adequate protein level during gestation.

Forbes and Robinson (1967) studied the effect of source and level of dietary protein on the performance of ewes after 10 weeks of gestation. Grass meal was used as a substitute for fresh grass and soybean meal representing a more conventional source of protein was compared with it. Both sources of protein were included at two levels, providing a high (90 g. or 0.2 lb./day) and a low (45 g. or 0.1 lb./day) intake of digestible crude protein. The intake of digestible energy was the same. The level of feeding adopted was 26.7 g. of digestible organic matter per kilogram metabolic weight ($W^{0.73}$)/day. This was equivalent to 100 k. calories of metabolizable energy/kg.($W^{0.73}$) /day where W=live weight in Kg. The dry matter digestibility was not affected by stage of gestation. The percent dry matter digestibility was 67.7% and 58.2% of intake for the diets containing soybean meal and grass meal, respectively. The differences were significant. Lower dry matter digestibility in diets containing grass meal was thought to be due to fine milling. Lamb birth weights were not significantly affected by source or level of dietary protein. Ewes weight gains during the last 8 weeks of gestation were significantly affected by the level of dietary protein. Live weight gains of the ewes were significantly better on higher protein intakes. Source of protein did not have a significant effect on live weight gain of ewes. The low nitrogen retention rate was associated with lowest mean live weight gain and the highest mean net body weight loss. This emphasized the capacity of the ewe to maintain foetal growth during late gestation. Gestation treatments had no effect on the performance of ewes or lambs during the first three weeks of lactation. Robinson and Forbes (1967) carried out an experiment in which protein utilization in the pregnant ewe was studied using the nitrogen balance technique. Eight diets supplying four different intakes of crude protein and two different intakes of energy were each offered to individually penned ewes. The mean crude protein intakes per day were 7.2, 5.5, 4.1 and 3.0 g./Kg.$W^{0.73}$ (W=body weight in Kg.) and the metabolizable energy intakes 134 and 113 K. calories/Kg.$W^{0.73}$. Nitrogen balance was carried out at 10 to 12, 14 to 16 and 18 to 20 weeks of gestation. Results showed that as pregnancy advanced there was a decrease in the intake of metabolizable energy per unit metabolic body weight. This was due mainly to the fact that the intake was based on the live weights of ewes at six weeks of gestation and was not adjusted for increase in body weight as pregnancy advanced. The decreased intake was more pronounced on the low-protein diets. The weight of food left uneaten expressed as a percentage of total food offered increased from under 1% on all diets at 10 to 12 weeks of gestation to 6.4% on the highest protein diet and to 13.0% on the lowest protein diet just before parturition. The intakes of metabolizable energy with the low protein diets were lower but were adequate. There was a significant reduction in dry matter digestibility with decreasing protein intake. The decrease was due to an associated decrease in the numbers of rumen bacteria with low protein diets. There was a significantly higher dry matter digestibility on the high energy diets. This was due to higher proportion of readily fermentable carbohydrate in these diets. With the higher energy intake and higher protein intakes the retention of nitrogen (digested) was significantly increased at all stages of gestation. Retention of nitrogen was not affected by the number of foetuses carried. The mean levels of nitrogen retained on the high and low energy diets were 0.142 and 0.100 g./Kg.$W^{0.73}$ respectively. The mean increase in retention of digested nitrogen per K. calorie increase in metabolizable energy intake was 2 mg. and varied from 1.3 mg. at 10 to 12 weeks of gestation to 2.5 mg. just before parturition. This emphasized the importance of energy intake on nitrogen utilization. They suggested that energy intakes higher than the generally accepted requirement of maintenance plus 25% for late pregnancy may have a beneficial effect on nitrogen retention. The levels of nitrogen retained at mid pregnancy on intakes of 0.50 and 0.15 g. digested nitrogen/Kg.$W^{0.73}$ per day were similar to those obtained for non pregnant ewes on comparable intakes. This indicated that up to mid pregnancy the demand for nitrogen is similar to that of non pregnant animals. Nitrogen retention increased with advancing pregnancy and the retentions at 10 to 12, 14 to 16 and 18 to 20 weeks of gestation were 0.086, 0.114 and 0.163 g./Kg. $W^{0.73}$ per day, respectively. The increase in nitrogen retention was accompanied by a corresponding decrease in urinary nitrogen output. It is clear therefore that increased demand is met by increased efficiency in utilizing absorbed nitrogen rather than by increased absorption. They suggested that this efficiency with which the pregnant animal utilizes digested nitrogen improves as pregnancy advances. The levels of nitrogen retained at maximum efficiency (efficiency of utilization of digested nitrogen) were 0.235 and 0.202 g./Kg.$W^{0.73}$ per day for the high and low energy intakes respectively.

Robinson and Forbes (1968) studied ewe nutrition during late pregnancy and early lactation. During pregnancy the high and low levels of energy used were 150 and 125 K. calories metabolizable energy per Kg.$W^{0.73}$ per day where W=body weight in Kg. and represented 150 and 125% respectively of the maintenance requirement of non pregnant sheep. These levels were equivalent to daily intakes of 3270 and 2725 K. calories/150 lb. ewe. The protein levels used were 110, 82, 55, 27 g. or (0.24, 0.18, 0.12, 0.05 lb.) digestible crude protein daily/150 lb. ewe. The two higher levels of protein intake (0.24 and 0.18 lb.) were used in one experiment and two lower levels (0.12 and 0.05 lb.) were used in another experiment.

During the first three weeks of lactation ewes were given a high energy diet intended to supply 250 K. calories of metabolizable energy/Kg. $W^{0.73}$ day (5450 K. calories/150 lb. ewe) or a low energy diet to supply 175 K. calories metabolizable energy/Kg.$W^{0.73}$ (3815 K. calories/150 lb. ewe). Both these diets also supplied a standard digestible crude protein (D.C.P.) intake of 8.8 g./Kg.$W^{0.73}$ or 192 g. (0.42 lb.)/150 lb. ewe daily.

During gestation, results showed that with each energy level there was a small decrease in dry matter intake with decreasing protein intake. The decrease in metabolizable energy intake was pronounced on the lower energy diets. It was 2825 and 2237 K. calories for the high and low energy diets, respectively. On each energy intake, crude protein intake was 156.5 and 64.5 g/150 lb. ewe per day on the highest and lowest protein diets, respectively.

The difference between the rates of live weight gain on the two energy levels was about 0.06 Kg./day in favor of the higher level. The difference was significant. There was a significant interaction between protein and energy indicating a difference in response to protein intake on each energy intake. On the high energy intake there was no significant difference between protein levels (0.24 and 0.18 lb. D.C.P.) in the first experiment during pregnancy but there was a significant difference between protein levels (0.12 and 0.5 lb. D.C.P.) in the second experiment. There was also a highly significant difference between protein levels between experiments.

There was a highly significant correlation between the ewe weight loss at parturition and the number of lambs born. Ewes giving birth to twins lost an average of 3.2 Kg. more body weight at parturition than those giving birth to singles. Although the mean weight loss on the lowest protein intake during pregnancy was 0.5 Kg. greater than on the highest protein intake, and the difference due to energy intake was 1 Kg., these differences were not significant. The net body weight change of the ewes was calculated from the gain in body weight during the last ten weeks of pregnancy minus the weight loss at parturition corrected to twin births by covariance. There was a net body weight loss on all treatments except the two highest protein intakes with the higher energy intake. There was a highly significant difference in net body weight loss between the high and low energy intakes. There was no significant protein x energy interactions in the mean birth weights and no significant difference due to energy intake. Although there were no significant differences in lamb birth weights between protein intakes within experiments, the birth weight of lambs born from ewes on the lower protein intakes were generally lower than those from higher protein intakes (3.98 and 3.51 vs. 4.61 and 4.59 Kg./lamb). As a result the combined comparison of protein levels between experiments was significant.

There was a significant correlation between the ewe weight change during the first three weeks of lactation and the number of lambs suckled. Ewes suckling twins lost an average 0.11 Kg. more body weight per day than those suckling singles. There was a large variation between ewes within treatments. There were no significant interactions between protein and energy intakes during pregnancy or between treatments during pregnancy and treatments during lactation. There was no significant difference in weight loss between the two energy intakes imposed during pregnancy. The mean losses were 0.15 and 0.16 Kg./day on high and low levels, respectively. The difference in loss of body weight between high and low energy treatments during lactation was not significant. Ewes on the lower levels of protein intake during pregnancy in each experiment tended to lose less weight during lactation than those on the higher levels but the differences were not significant. The difference between combined protein levels between experiments was significant.

Lambs born from ewes on lower protein intakes during pregnancy had on average a slower growth rate (0.26 and 0.23 versus 0.31 and 0.30 Kg./day growth rate for lower and higher protein levels, respectively). The difference in growth rate between protein intakes between the two experiments was significant.

A summary of the results indicates that ewe live weight loss during early lactation, lamb growth rates from birth to three weeks and ewe milk yield at 3 weeks tended to decrease with drecreasing protein intake (156, 119, 90 and 65 g. D.C.P./150 lb. ewe daily) during pregnancy. There was no significant difference in weight loss of ewes between the two energy intakes imposed during pregnancy. Ewes suckling twins produced a greater amount of milk (0.60 Kg./day more) than those suckling singles. There were no significant interactions between protein and energy intakes during pregnancy or between pregnancy x lactation.

Further work carried out on ewe nutrition during late pregnancy and early lactation has indicated that lean ewes have a higher efficiency of food conversion to milk.

Peart (1968) studied the effects of live weight on the milk production of Blackface ewes. Ewes were individually fed a pelleted feed consisting of dried grass meal 66%, maize meal 18%, soybean meal 10%, and molasses 5%, with vitamin and mineral additions. The feed contained 66 g. digestible organic matter (D.O.M.) per 100 g. as determined _in vivo_ and _in vitro_. At six weeks, _pre-partum_ the first and second group of ewes were given 14 g. D.O.M./Kg. live weight. The third group received 9.2 g. D.O.M./Kg. During the last 6 weeks of pregnancy the mean total daily food intake of ewes in the first and second group increased from 912 to 1182 g. D.O.M. and that of third group increased from 736 to 980 g. D.O.M. Immediately after parturition and throughout lactation feed was rationed to the ewes according to their individual _post-partum_ live weights. During lactation the ewes were fed 9.2 g. D.O.M./Kg. based on their immediate _post-partum_ live weights, plus an allowance for a predicted level of milk production. All groups of ewes make similar live weight gains in late pregnancy and mean birth weights of the lambs were also similar. Ewes in the first and second group were fed 0.5 and ewes in the third group 0.25 g. D.O.M./g. of predicted milk production. The ration was increased after first and second weeks of lactation, then maintained at a constant level for the remainder of lactation. The mean daily milk production of ewes in first and third group was similar and the yield of each of these groups was significantly greater than that of ewes in the second group. The mean total milk production of ewes, during 10 weeks of lactation, suckling twin lambs was 127, 108, and 142 Kg. for the first, second and third group, respectively. The mean live weight changes of ewes in the first and third group were similar during lactation. The mean daily live weight gain of twin lambs in the first, second and third group was 279, 275 and 284 g, and of singles, 318, 300 and 319 g., respectively. The evidence indicated that ewes in lean body condition have a higher efficiency of food conversion to milk.

There are breed differences in milk production. Slen, Clark and Hironaka (1963) made a comparison of milk production and its relation to lamb growth in five breeds of sheep namely Suffolk, Hampshire, Rambouillet, Canadian Corriedale and Romnelet ewes. Their results indicated that ewes nursing twins yielded significantly more milk than those nursing singles and Suffolks yielded significantly more than other breeds. Of ewes nursing twins Suffolks and Corriedales yielded most. Single lambs gained more live weight than twins and those gains were highly correlated with milk consumption. Protein and fat content did not differ between breeds.

III. EARLY WEANING AND FEEDING OF LAMBS

Clark (1954) stated that early weaning confers great flexibility in stock management, especially in respect to shearing, pasture utilization and weed control.

Wardrop (1960) has shown that, at about 8 weeks of age, grazing lambs can digest forage with the efficiency of an adult. This indicated the minimum age at which lambs can be weaned on to pasture.

Baird, McCampbell, Neville, Coirdia, Bizzell and Sell (1960) found that most of the milk production of ewes had ceased by 15 weeks after lambing and Clark (1961) stated that for ewes nursing twins the milk production of the first week of lactation was approximately double the production of the eighth week.

Dickson (1959) suggested that after two months of age, grass becomes the dominant factor in the lamb's feed. This also indicates that lambs can be weaned easily at 8 weeks of age but some workers have shown that early weaned lambs do not gain as much, when weaned on to pasture, as unweaned lambs. Different responses to early weaning have been reported. Stage of maturity of the pasture is an important factor for early weaning. Many workers have pointed out that lambs weaned at 8 to 10 weeks of age should have at least 12 to 14% crude protein in their feed during first 3-4 weeks after weaning.

Baird *et al* (1960) weaned lambs at an average age of 76 days and an average weight of 45 lb., on to winter temporary pastures of wheat and rye grass. Early weaning did not stimulate forage consumption of lambs. Average daily gain for unweaned and weaned lambs was 0.57 and 0.51 lb., respectively. So early weaned lambs made slower gains than the unweaned controls in this experiment. They also stated that early weaned lambs had 46% less worms at slaughter than the lambs weaned later (764 vs. 1407).

Brothers and Whiteman (1961) studied the influence of early weaning on creep-fed milk lambs when weaned on weight or age basis. All lambs and their dams were on wheat pasture and the lambs were creep-fed. In the first year the average weight of lambs at weaning was 54 lbs. and average weaning age was 76 days. The weaned lambs made an average daily gain from weaning to market weight (90 lb.) of 0.52 lb. and lambs not weaned gained 0.54 lb./day. This difference was not significant. In another experiment during the following year the average weight of lambs at weaning was 46 lb. and average weaning age was 62 days. The weaned lambs gained 0.47 lb. and the lambs not weaned, 0.52 lb./day. This difference was significant. This showed that early weaned lambs (about 9 weeks old) made slower gains than late weaned (about 11 weeks old) lambs. Cannon (1960) stated that fat lambs weaned at eight weeks of age may average a minimum of 2.5 lb. less in carcass weight than suckling lambs when both types have been under extremely good nutritional conditions. Under such conditions grading was not affected by weaning. Wardrop (1960) reported that lambs weaned at 7, 10, 13 or 18 weeks of age and grazing high protein pastures grew equally well and there were no significant differences between their carcass weights, grades and dressing percentages. However, when grazing pastures in the pre-flowering and flowering stages of growth, lambs weaned at 8 weeks of age did not grow as well as unweaned controls. Their carcass weights were also lower and it was suggested that the differences were primarily due to an inadequate protein. They stated that stage of maturity of the pasture is very important factor for early weaning. They pointed out that the milk intake of the 10-week old grazing lamb is about 1.6 lb./day which is equivalent to 2.3 lb. of S.E. (starch equivalent) and 0.6 lb. of digestible crude protein (D.C.P.)

per week. Therefore if a lamb is weaned at 10 weeks of age and is to gain as fast as unweaned lambs it must obtain these additional amounts of S.E. and D.C.P. from the pasture. Only about 22 lb./week of fresh young grass are required but at least twice as much will be needed when the herbage is in the flowering stage. This large increase in the additional herbage requirement is occasioned by the rapid decline in pasture protein content. As the pasture intake of the lamb is limited, so when the lamb is grazing a mature pasture it is impossible for the lamb to ingest enough herbage to meet its protein requirements and adequate energy to sustain satisfactory growth. Cameron and Hamilton (1961) found that lambs weaned at 10 weeks of age had a lower dressing percentage than those weaned at 15 or 20 weeks of age. However, age at weaning had no significant effect on carcass scores. They also found the single lambs heavier at market and having lower dressing percentage than twins. The lower dressing percentage for single lambs was associated with a younger average age at slaughter and significantly lower carcass score for finish, and lower average scores for all other carcass characteristics than those for twin lambs. They pointed out that lambs weaned at 10 weeks of age made more rapid average gains in the first two weeks following than during the remainder of the study, indicating that rumen function was developed sufficiently for the digestion of immature forage. They further stated that age at weaning had no effect on death losses. Single lambs made faster gains than twins and wethers made more rapid gains than ewes. Franklin (1965) weaned merino lambs at different ages on to a mixture of roughage and grain. Results showed that loss of lambs weaned at four weeks of age was significantly greater than in those weaned at 6, 8, or 12 weeks and lambs which survived were significantly heavier at birth and at weaning. Live weight at 22 weeks of age was not significantly affected by age at weaning. Field observations showed that lambs between 8 and 16 weeks of age could be weaned successfully under drought conditions on the roughage and concentrate provided they were closely confined until accustomed to their rations. Garrigus (1951) concluded that relatively simple creep rations were as effective in promoting rapid gains in early weaned lambs as more complicated grain mixes.

Perry, Beeson, and Harper (1957) studied the value of fortified creep rations for single and twin suckling lambs. The creep ration containing 17% crude protein was available from the third day of lamb's life. Single lambs receiving creep pellets containing corn, soybean meal, salt, bone meal and vitamin A, D and E grew as rapidly as lambs fed similar pellets but fortified with 10% sugar, B vitamins, ascorbic acid and trace minerals (super pellets). Twins which had access to "super pellets" grew as rapidly as single lambs not on "super pellets". Growth of twins was not as rapid as that of single lambs when both received "super pellets."

Hinds, Mansfield and Lewis (1963) indicated that the most rapid gains were obtained with lambs weaned at 10 weeks of age and receiving 12 percent protein.

Ranhotra and Jordan (1966) conducted experiments to determine the optimum level of protein for lambs weaned at 6 to 8 weeks of age and to determine the energy requirements of such lambs as measured by digestion trials and growth studies. Their results revealed that apparent digestibility of both protein and energy were increased significantly due to increased protein and energy content of the ration. Protein content of the ration was without significant effect upon rate of gain or efficiency of feed conversion, when measured on the basis of either 8 or 9-week feeding periods. However, rations containing between 12 and 14% protein resulted in more rapid gains during the first 28 days following weaning than rations with lower protein levels. Rations containing 16.5 to 16.7% protein did not support more rapid or more efficient gains than rations containing 13.5 to 14% protein. They further indicated that rations based on 75:25 concentrate to roughage ratio supported significantly greater and more efficient gains of lambs weaned at 7 weeks of age during the first 4 weeks than did rations based on a 55:45 concentrate to roughage ratio. Over the 8 week period gains were greater with the higher concentrate ration than with the lower concentrate ration. However, these differences were not significant.

Light (1966) indicated in a free choice of different feeding stuffs that rolled barley and oats were more readily accepted than cracked maize by the lambs weaned at 5 weeks of age. He also stated that lambs selected a ration with 21% protein.

Coetzee and Vermeulen (1966) fed merino lambs, 10 weeks before and 6 weeks after weaning, creep feeds with 9, 15 or 20% crude protein. Results pointed out that weight gain of creep-fed lambs was significantly greater than for the control group. After weaning gain of groups given 15 or 20% protein was significantly greater than those given 9% protein but results suggested that 9% protein before weaning and 15% protein afterwards would give best performance.

Heated soybean meal has been used to cause greater nitrogen retention by many workers. Glimp, Karr, Little, Woolfolk, Mitchell, Jr. and Hudson (1967) reported that reduced protein solubility resulted in increased nitrogen retention and decreased ruminal degradation of feed protein in lambs. Hudson et al. (1969) also experimented to determine the effects of reducing protein solubility from 72 to 35% by dry heat and the effect of feeding three levels of

10, 12 and 14%, crude protein on rate and efficiency of gain and nutrient utilization of early weaned lambs. Results showed that growth rate was highest at the 14% protein level. Heating the soybean meal had an inconsistent effect and feed efficiency was improved significantly. Results also showed that rumen ammonia concentrations increased with protein level and showed a slight depression due to heating the soybean meal. The beneficial effect of proper treatment is the result of greater destruction of several thermo-labile growth impairing factors than of soya protein itself. Fisher and Johnson (1958) attributed the poor growth of animals on diets containing raw soybean meal to an inhibition of intestinal proteolysis, haemagglutinin activity of some component of the beans and an inbalance of dietary amino acids. From the references given above it is clear that lambs should have at least 12 to 14% crude protein in their ration during the first few weeks, when weaned at 8 to 10 weeks of age and further that feeding the heated soybean meal by reducing its solubility from 72 to 35% results in greater nitrogen retention.

IV. UREA-NUTRITIONAL IMPORTANCE AS A NON-PROTEIN NITROGEN SOURCE

The first purpose of adding non-protein nitrogen compounds to the ration of ruminants is to supply nitrogen which can be incorporated into protein by the microbial population of the rumen or to provide other nitrogen containing molecules which can be used by the rumen microflora. The basis of this mechanism is the reaction:-

Non-protein nitrogen→microbial protein nitrogen

Harris (1940) was one of the first to test the theory that non-protein nitrogen could be used by rumen microorganisms to form protein useful to the host animal. He reported that lambs gained weight when they were kept on a low-protein, semipurified diet made up of starch, alkali washed straw, inorganic salts and urea. Wegner, Booth, Bohstedt and Hart (1940) were among the first to find that the level of protein in the ration influenced the conversion of non-protein nitrogen to protein and to find that as the level of protein in the ration was increased, the amount and rate of conversion of urea to protein decreased. To discuss the above mentioned topic and the usefulness of urea as a NPN (non-protein nitrogen) source it is necessary to discuss briefly the fate of protein and urea.

Annison (1956) stated that the amino acids produced by the hydrolysis of dietary protein are rapidly deaminated by the ruminal bacteria. The rate of deamination is only slightly less than that of their production, so that the level of free amino acids in rumen is low (of the order of 1 mg. amino N per 100 ml ruminal fluid), except after feeding a protein-rich ration, when it may increase fivefold to tenfold for a short period. Blackburn (1965) indicated that the end products of individual amino acids in most cases are ammonia, carbon dioxide and volatile fatty acids. Abou Akkada and Blackburn (1963) have shown that lesser amounts of ammonia are also produced in the rumen by the action of amidases on glutamine and asparagine and the amide groups of proteins. The production of ammonia from the above sources can result in very high levels in the rumen, for example, Johns (1955) has reported upto 130 mg. ammonia nitrogen per 100 ml. of ruminal fluid in sheep on high protein pastures but this is much higher than the ammonia level normally found in the rumen when urea or other forms of supplementary N.P.N. are fed under practical conditions.

Endogenous urea enters the rumen with the saliva and through the ruminal wall. In sheep, McDonald (1948) estimated that 0.5 g. urea N per day is introduced into the rumen with the saliva. Houpt (1959) reported that 16 times as much urea passed directly from blood to rumen as moved with the saliva but in this case the animal was not fed urea and the concentration of urea was greater in the blood than in the rumen so more urea passed from the blood to the rumen then was recycled with the saliva Urea is broken down very rapidly to ammonia and carbon dioxide by the ureases of ruminal bacteria so that the urea level in the rumen is negligible. The result of the secretion and hydrolysis of endogenous urea is that the animal is able to maintain a low but significant concentration of ammonia in the rumen, even when it is starved. When urea is given as a supplementary source of nitrogen, it shares the fate of endogenous urea in the rumen. The urease activity of the ruminal bacteria of animals on unsupplemented rations is sufficiently high to bring about the breakdown of large amounts of added urea within a short time, and little or no increase in activity occurs when the animals are conditioned to being fed urea for long periods.

Repp, Hale, Cheng and Burroughs (1955) stated that the entrance of large quantities of urea into the rumen in starved or fasted animals or by rapid consumption of feeds containing urea by animals not previously fed such rations, results in the release of ammonia at a rate which does not permit efficient utilization of nitrogen by the rumen micro-organisms for the synthesis of cellular protein. The hydrolysis of urea in the rumen is unrelated to the ability of micro-organisms to utilize ammonia produced. Ammonia not utilized by the rumen microflora is rapidly absorbed into the bloodstream where it may reach toxic levels. These workers further indicated that toxic symptoms appear in sheep when blood ammonia nitrogen level rises above 1 mg. %.

Warren (1962) pointed out that the rate of ammonia transfer across the rumen wall not only depends on the concentration gradient but also on pH of the rumen liquor. He stated that ammonia is most toxic in conditions where the pH of the rumen liquor is higher than 7.5, when unionized NH_3 is formed and most membranes are more permeable to the NH_3 moiety than the ammonium ion (NH_4^+).

Kammlade, Mitchell and Sleeter (1940) as cited by Briggs (1967) stated that up to one-third of the nitrogen in a sheep ration could be safely replaced by urea. They also stated that the rate of conversion of urea into bacterial protein decreased as the total protein, excluding non-protein nitrogen, of the ration increased above 12% of dry matter.

They also showed that the urea above 12% protein level was not retained as efficiently as casein and other protein sources, and that urea in the ruminant ration exerted no adverse effect on flavor and non-protein nitrogen content of meat and milk. Although the use of urea as a protein substitute in ruminant nutrition has become fairly common in North America, its use as the major or sole source of nitrogen is limited due to danger of ammonia toxicity.

The adverse effects of urea may be eliminated partially through the use of more slowly hydrolyzed, less toxic non-protein nitrogen compounds. Biuret is a compound of interest. It was shown by Repp _et al_ (1955) to be less toxic than urea. However Anderson, McLaren, Welch, Campbell and Smith (1959) stated that when pure biuret supplied 100% of the supplemental nitrogen instead of urea, nitrogen utilization was significantly depressed. They also stated that nitrogen digestibility was greater when purified soy-bean protein or a nitrogen equivalent mixture of urea and creatine replaced urea as the source of supplemental nitrogen.

In order to compare urea with other non-protein nitrogen sources Schaadt, Johnson and McClure (1966) investigated adaptation to urea, biuret and diammonium phosphate as non-protein nitrogen sources for sheep. The crude protein content of control and supplemented rations was 6.5 and 10.2% respectively on a dry matter basis. The results showed that percent diges-tibility of nitrogen in the control animals, fed on chopped wheat straw, chopped timothy hay, ground shelled corn and corn starch, and given no supplementary non-protein nitrogen, was significantly lower than in any other group and in the group given urea it was significantly higher than in all groups except that given urea with diammonium phosphate. Nitrogen balance was greatest with no supplement or with urea and diammonium phosphate. They also reported that as the trial progressed there was an increase in nitrogen balance in the group given urea but not in other groups. It showed that rumen microorganisms became better adapted to feeding of urea for the synthesis of microbial protein as the trial progressed but the biuret supplemented lambs failed to show the evidence of adaptation in nitrogen balance but they did show adaptation in the urinary biuret excreted because biuret excreted by the group given it decreased during the trial.

Schaadt et al (1966) also studied the palatability of four rations supplemented equally on a nitrogen basis with soybean meal (SBM), urea, diammonian phosphate (DAP) and diammonium phosphate + urea. Lambs used were previously adapted to the basal, urea or ADP + urea rations. The design of the trial was such that each lamb was exposed for a one week period to each possible combination of two supplemental feeds but to only two in any one period. Animals ate ad-libitum and palatability of the ration was calculated by the amount of each ration eaten over a six week period. Results showed that the daily intake for SBM or urea was 0.75 and 2.77 kg; for SBM or DAP, 1.14 and 0.40 kg; for SBM or DAP + urea, 1.06 and 0.52 kg; for urea or DAP, 1.19 and 0.26 kg, for urea or DAP + urea, 1.16 and 0.35 kg and for DAP + urea or DAP, 1.18 and 0.21 kg respectively. Results revealed that both urea and soybean meal supplemented rations were equally preferred over diammonium phosphate (DAP) or DAP + Urea. Diammonium phosphate plus urea was preferred over diammonium phosphate. In all periods, diammonium phosphate was very unpalatable.

Some workers have compared urea with melamine. Cronje and Coetzee (1966) determined the retention of nitrogen in sheep given a control feed based on pelleted dried T. triandragrass. The sheep were in negative nitrogen balance when receiving this grass. They were given 4.7 g. nitrogen daily by stomach tube. This nitrogen was provided by 10 gm. urea or 7 gm. melamine daily. The animals reverted to a positive balance when dosed with non-protein nitrogen. A significantly larger amount of nitrogen was excreted in the case of melamine and urea than in the control animals. This indicated that a considerable amount of nitrogen from these substances wasnot properly utilized by sheep and excreted through the urine. The significantly higher nitrogen content of the faeces of sheep receiving melamine indicated that part of melamine nitrogen was excreted through the faeces. Urea nitrogen, on the other hand, was not excreted in the faeces. This is illustrated by the fact that faeces in the urea group contained no more nitrogen than that of the control group. Although average nitrogen retention for urea was higher than for melamine, the difference was not statistically significant. Daily retention of nitrogen for urea, melamine and controls was +.50g., +0.94g. and -0.87g. Non protein nitrogen in blood as urea nitrogen was not affected by melamine but it increased significantly for eight hours after urea had been given.

Adaptation of the animal is important while feeding urea to avoid toxicity. The level of readily fermentable carbohydrate also has an effect on the level of absorbed nitrogen.

Szabo (1965) stated that for wethers the amount of urea per head per day could be gradually increased from 15 to 40g. without the risk of poisoning but the increase must be gradual taking at least 30 days to reach the maximum.

McLaren, Anderson, Tsai and Barth (1965) examined the influence of length of time of urea feeding and level of readily fermentable carbohydrates on the retention of absorbed nitrogen. Results showed that the retention of absorbed nitrogen by lambs, with initial retention of 36%, was significantly improved by 3 percentage units with each 10 day period of urea feeding up to 45 days. During the last 10 days the retention was constant. The retention of absorbed nitrogen was significantly improved by 2 percentage units for each 100 K. calories increase of readily fermentable carbohydrates in the ration of the lambs. The intake of readily fermentable carbohydrates ranged from 564 to 1178 K. calories/day. Average daily dry matter intake was 725g. Improvement in the retention of absorbed nitrogen due to the level of readily fermentable carbohydrates was observed in lambs regardless of the degree of their adaptation to urea feeding.

Addition of readily fermentable carbohydrate decreased the crude fiber digestibility. When 564 K. calories/day of readily fermentable carbohydrates were fed to 5 lambs the average crude fiber digestibility was 45.6%. When the level of readily fermentable carbohydrate was increased to 1173 K. calories for 5 lambs the average digestibility of crude fiber was 43.2%.

McLaren et al (1965) stated that sugars disappear too quickly from the rumen while cellulose becomes available too slowly to satisfy the energy needs of microorganisms. A mixture of readily available and the more complex slowly available carbohydrates seems satisfactory. When glucose or starch is added, the uptake of ammonia by the microorganisms is much more rapid than when roughage alone is present. It is this which makes the addition of readily fermentable carbohydrate desirable when non-protein nitrogen supplements are fed in a form in which large amounts of ammonia are rapidly produced in the rumen. By increasing the rate of utilization of ammonia so that it more nearly matches the rate of formation, the carbohydrate reduces the concentration of ammonia in the ruminal fluid and so decreases the amount lost from the rumen and lessens the danger of toxicity to the animal.

Some workers have fed urea as salt/urea blocks. Beames and Morris (1965) studied the effect of salt/urea blocks on body-weight, body composition and wool production of merino wethers fed to appetite on low-protein pasture grass hay with a crude protein content of 3.5%. The results indicated that the control group which did not have access to urea blocks lost 20% of their initial body weight, during the trial. Groups given salt blocks containing 20% urea plus molasses lost 10% of their initial body weight. Those given blocks containing 20% urea and no molasses lost 12% of their initial body weight showing that readily soluble sugars improve the utilization of urea. It shows that molasses serves as a source of energy for the microorganisms and causes slow intake because of its sticky syrupiness. Results also indicated that voluntary intake of hay and output of dry matter infaeces were increased by urea and weight of clean soured wool was greater but not significantly in groups given urea.

From comparative slaughter, energy reserves of the bodies of sheep given hay only were depleted to a greater extent than was indicated by body weight changes.

Urea increases the net energy value of high fiber mixtures in ruminant rations. Colovos, Keener, Davis, Reddy and Reddy (1963) confirmed the above statement. They fed cows on two concentrate mixtures either with a low level of fiber containing 5% fiber or a high fiber mixture containing 10% fiber along with early cut hay. These mixtures were fed alone or with a concentrate mixture containing 40 pounds/ton of urea and supplying 35% of the protein of the concentrate mixture. Results showed that net energy values for low fiber and high fiber rations without the addition of urea were 1.739 and 1.507 K. calories per g. respectively. When urea was added to these rations the respective values were 1.806 and 1.752 K. calories per g. There were no significant differences in net energy values obtained with or without the addition of urea. It showed that after the addition of urea the ration containing high fiber was comparable to the one containing low fiber. It was thought to be due to a decrease in the heat increment where urea was added in the ration.

Oestrogens have been shown to increase the urea nitrogen retention.

Bell, Taylor and Murphree (1957) investigated the effects of diethylstilbestrol on digestibility and nutrient retention of a corn-urea mixture containing 13.5% crude protein. This ration was fed to lambs at the level of 1.25 pounds per head daily alone or with 4 mg. diethylstilbestrol per head per day. Results showed that diethylstilbestrol feeding had no significant effect on the digestibility of crude protein or other nutrients but feeding of diethylstilbestrol significantly increased the daily nitrogen retention and it was 4.9g. and 3.3g. daily for diethylstilbestrol + urea and urea alone, respectively. This increased retention of nitrogen was found to be due to a decrease in the amount of nitrogen excreted in the urine. Diethylstilbestrol feeding significantly increased phosphorus retention which increased from 0.3 to 1.3g. during the 7 days. It was thought to be due to decreased excretion of phosphorus in the faeces. Urea had no effect on the retention of either calcium or phosphorus.

Karr, Garrigus, Hatfield and Norton (1965) showed that lambs implanted with 3 mg. diethylstilbestrol each in their ear and fed on a ration containing 1.5% urea with 13.1% crude protein gained faster than the unimplanted lambs. There were no significant differences in daily feed intake. Lambs on ration with urea and implanted with the hormone gained 15 pounds in 21 days with initial weight of 60 pounds but it took 54 days to gain the same weight by the lambs not implanted with diethylstilbestrol and fed on ration with urea. This was thought to be due to increased nitrogen retention and diethylstilbestrol also markedly reduced the adaptation period of lambs receiving urea nitrogen.

Some workers have investigated the relationship of sulphur and urea. Thomas, Loosli, Williams and Maynard (1951) stated that an adequate supply of sulphur is required for incorporation of ammonia into methionine and cysteine. They fed lambs on purified diets containing 4% urea and sulphur as $MgSO_4$(204g.) and $MnSO_4$(3g.) or urea without sulphur. Their results showed that lambs did not eat purified diets readily and they all lost weight during the first 60 days of the trial. Thereafter those fed urea + sulphate increased in body weight and their average daily gain was 34g. while those on sulphur deficient feed continued to lose weight and their daily loss was 70g.

Noble, Pope and Gallup (1955) reported that methionine and urea added separately to a low protein (8.4% crude protein) basal ration for fattening lambs failed to improve the rate of gain but when added in combination they increased the daily gain in each trial but the increases were not statistically significant. They further stated that soybean meal as a supplement to the basal ration consistently improved rate of gain and feed efficiency. Poor performance of lambs given urea alone to the basal ration was partly due to the deficiency of sulphur in the basal ration which had a sulphur content of 0.1%. The nitrogen: sulphur ratio of the nitrogen supplements in the urea ration was narrowed from 59:1 to 15:1 by the addition of methionine. This factor contributed to the improved daily gain.

Light, Dinusson, Richard and Bolin (1957) showed that soybean meal was a significantly better protein supplement for lambs than urea when urea was fed at the rate of three percent of the concentrate mixture and supplying 41% of nitrogen in the ration, with poor quality non-legume hay fed ad-libitum.

Soybean meal is a better source of nitrogen than urea. Drori and Loosli (1961) conducted experiments with sheep and showed that the diet with soybean meal gave better nitrogen retention and had a higher biological value than diets with urea. This finding was thought to be related to the excretion of urea in the urine. They also showed that urea nitrogen in blood rose after diets with urea and fell after diets with soybean meal but the differences were not significant. They further stated that blood urea levels in this study were not constant and the average levels of blood urea gave no clue to the value of protein in the feed. They gave the reason that the data in their experiment was not paired. They further showed that urea produced a sharp rise in rumen ammonia only when given rapidly through the fistula.

Preston, Schnakenberg and Pfander (1965) conducted experiments to find the effect of protein intake on blood urea nitrogen in lambs fed to appetite on finishing rations consisting of soybean meal and corn with different crude protein contents (9.2, 11.5, 13.1, 16.5 and 22.0%). Results indicated that the daily gain, feed intake, urea nitrogen in blood and digestibilities of energy and protein increased when there was more protein in the feed and efficiency of feed conversion improved also. The results also showed that the variation in the protein intake of the growing lamb resulted in blood urea nitrogen (BUN) ranging from 2.7 to 3.29 g.mg./100 ml. They stated that the protein status of the lamb can be assessed partially by the concentration of this blood constituent. In terms of protein adequacy a BUN value in excess of 10mg./100 ml. would indicate adequate protein intake with the type of rations fed in these experiments. In another experiment urea was used as a supplemental source of nitrogen (47% of total nitrogen) for lambs. They consumed 16g. protein/

$W^{0.75}$ where W=live weight in pounds. Their average BUN was 27.3 mg./100 ml. This BUN is higher than the level obtained with soybean meal and corn. They related this to a lower biological value of urea, when fed at this level.

Olivierand Cronje (1964) studied the effect of the rate of intake of urea upon the nitrogen retention of sheep. Special urea-containing pills which released the urea gradually over a 24 hour period were developed. One group received a dose of 8 g. urea daily, the other group received the pill containing 8 g. urea while the third group received no urea. The non-protein nitrogen content of the blood of sheep was determined 1.5, 3.5 and 8 hours after dosing. The group which received the urea in pill form retained significantly more nitrogen than the group which received one normal dose of urea daily. Urea supplementation had no effect on crude fiber digestion.

Many workers have investigated the effects of duodenally infused urea. Egan (1965) conducted various experiments to find the fate of duodenally infused casein (71 g.) and urea (22 g.) providing 10 g. of nitrogen in sheep fed on oaten hay (including seeds), molasses and minerals containing 9% crude protein. Results showed that the urea in the blood and ammonia nitrogen in rumen were increased by duodenally infused urea and casein. Both sources of nitrogen increased the rate of digestion of cell-lose (cotton thread) and the peak was reached earlier after urea than after casein. Peak values for both occured between the end of infusion and six hours later. Of the nitrogen supplied by these sources more nitrogen was excreted in the urine after urea than after casein. Results of this investigation clearly demonstrated the return of nitrogen to rumen after infusion per duodenum of single doses of either casein or urea as both ruminal ammonia nitrogen concentrations and the rate of cellulose digestion (cotton thread) in the rumen were increased. Return of nitrogen to the rumen after absorption rather than by back-flow from the duodenum through both abomasum and omasum was suggested by the following observations.

1) Maximum ruminal ammonia nitrogen concentrations were much lower when casein was given than when urea was given.
2) Ruminal ammonia nitrogen concentrations did not rise until after completion of the infusion of casein.
3) The time and magnitude of ruminal ammonia nitrogen changes reflected the time and magnitude of changes in blood urea nitrogen concentration.

The blood urea nitrogen level increased rapidly as urea was infused. A less rapid increase in the blood urea nitrogen level was recorded when casein was given. After infusion of casein neither the blood urea nitrogen level nor the ruminal ammonia nitrogen concentration were raised to the same extent as when urea was given which suggested that less nitrogen was returned to rumen after casein infusion.

Egan and Moir (1965) investigated the effects of duodenally infused single doses of casein and urea (4.5g.N/day)on voluntary intake of a low-protein roughage by sheep. Results showed that the casein and urea gave significant but transient increases in voluntary intake of feed, casein on the day it was given and urea on the day after.

Egan (1965) conducted another experiment to find the influence of sustained duodenal infusions of casein or urea upon voluntary intake of low-protein roughages by sheep. The results revealed that with urea the mean daily intake of dry matter was 12% and with casein 42% greater than that observed with the control group. It showed that when nitrogen balance was improved and the amount of amino acids absorbed was increased, the intake of dry matter increased. Results also showed that the apparent digestibility of dry matter was decreased consistently though not significantly by casein but urea had no consistent effect. The depressed digestibility of dry matter in case of casein was due to greater dry matter intake. It was also shown that the volume of rumen fluid was significantly increased by casein but urea had no effect. Nitrogen balance results showed that it was negative in controls but became positive with either casein or urea. Nitrogen content of faeces was not affected but urea though consistently but not significantly increased excretion of nitrogen in the urine.

V. EFFECT OF FEED UREA ON MILK YIELD AND MILK COMPOSITION

Effect On Milk Production

The problem of replacing proteins, as the main natural sourceof nitrogen in feeding milk-producing ruminants, by the addition of urea to the feed of these animals, is of interest not only from scientific but also from the economic point of view. This is because nitrogen is much cheaper if supplied in the form of urea, while proteins are among the most expensive constituents of conventional rations. The cost of milk production would be considerably lower if at least some part of the necessary proteins could be replaced by a cheaper synthetic product like urea.

Urea and other non-protein compounds have been shown to be utilized in milk production. Schoenemann (1946) and Kilian (1948) cited by Briggs (1967) first pointed out that urea labelled with N^{15} added to the feedstuff became a component of milk in goats. Land and Virtanen (1959) cited by Briggs (1967) used N^{15} in the form of ammonium salts and found that 17 to 25% of this nitrogen appeared in milk. They showed that the process of incorporation of labelled ammonium nitrogen is most intensive 14 hours after feeding, and affects the amine nitrogen fractions of such amino acids as glutamic acid, asparagine and alanine. They further showed that after 24 hours the amino acids in the milk protein are already more uniformly labelled, except for histidine and cystine, which show a comparatively low percentage of N^{15}. They also calculated that on the whole about 40% of the labelled nitrogen supplied is taken up by the tissue protein.

The effect of feed urea on milk production and milk composition has been mostly investigated in dairy cows and little work has been carried out in the case of sheep.

Rust, Lassiter, Davis, Brown and Seath (1956) evaluated soybean meal, urea and dicyandiamide as nitrogen sources in low protein (13.1%) concentrate mixture for dairy cows. Each nitrogen source supplied one third of the nitrogen in the concentrate mixture and each cow received two pounds of medium quality timothy hay per 100 lb. body weight daily as the only roughage. Differences in milk production were observed on a lactation basis or during a comparison period of 196 days in length beginning 30th day of lactation. The average daily milk production at the beginning and end of 196 days period was 35.3 and 18.5, 35.9 and 14.4; and 36.2 and 15.5 lb. per cow daily for soybean meal, urea and dicyandiamide rations, respectively. The differences were significant. Minor differences in feed consumption existed between groups. Hay consumption was 18.5, 18.0 and 16.8 lb./cow daily and concentrate consumption was 11.9, 10.8 and 11.5 lb./cow daily for the three groups, respectively.

Owen, Smith and Wright (1943) pointed out in their balance experiments on dairy cows that when urea and blood meal replaced 25% of the nitrogen in a ration no differences in milk production or in nitrogen balance were shown for many weeks. They also indicated that when urea was withdrawn a decrease in milk production occured immediately.

Hastings (1944) replaced maize glutein in a concentrate by urea which supplied 25% in the beginning and 43% of the total nitrogen in the end of the experiment in the ration of dairy cows. The protein content of the concentrate was 20.6%. Results showed that the average milk yield when using this urea ration was greater than in control ration.

Many workers have shown that urea is poor for milk production as compared to soybean meal.

Bartlettand Blaxter (1947) emphasized that any protein sparing effect of urea or other sources of non-protein nitrogen can only be determined in animals fed protein deficient rations. The addition of protein to such a ration by increasing the percentage of crude protein in the ration from 12.9 to 17.9, resulted in a significant increase in milk production. This confirmed the protein deficiency of the lowprotein ration. They stated that the addition of sufficient urea to such a low protein ration to increase the crude protein to 17.9%, that is the addition of the same amount of nitrogen as urea as had been added as protein, resulted in no significant mean change in milk production. When urea was added to a normal protein ration (17.9% crude protein) a decline in yield occured. This was however not statistically significant.

Ward, Huffman and Duncan (1955) fed cows a concentrate containing about 15% of soybean meal or 2% of urea besides basic feeds. Results showed that milk production in F.C.M. (fat corrected milk) was not significantly different when cows were on concentrate with soybean meal or urea. F.C.M. produced was 27.6 and 28.2 lb./day for urea and soybean meal rations, respectively.

Otagaki, Wayman, Morita and Iwanaga (1956) fed the cows a ration in which 21% of nitrogen requirement was supplied by urea. Results showed that there was no statistical difference in milk production between the control and the other group.

Effect of urea on milk production, fed as a spray on hay, has also been studied. Pallan and Pejovic (1965) fed sheep during winter on hay sprayed with urea solution at the rate of 0.25kg. urea in 2 liters of water on the days ration for 20 sheep. Results of their experiment showed that the ewes given urea maintained their body weight but milk yields for the first 10 week period were poorer. The controls who ate 0.3 to 1.5kg. hay daily without urea lost weight.

Some workers have compared urea with other NPN sources for milk production.

Loskutov and Berkoric (1965) studied the effect of 25% of digestible protein provided for prolonged periods by urea (90g. daily) and ammonia solution (225ml. daily) on milk production and milk composition of cows. Results showed that cows given urea had somewhat greater phagocytic activity of blood and higher globulin values than the others and also gave more milk throughout the lactation period with higher contents of fat, protein and casein.

Waite, Castle, Watson and Drysdale (1968) conducted an experiment to compare the feeding value of concentrates for milk production in which the nitrogen normally supplied by oil cake was completely replaced by either biuret or urea. Each cow had been milking for 70 days before the experiment started. Urea or biuret contributed 52% of the total nitrogen in the concentrates. Hay was fed as the sole roughage. Concentrates had 3.1% total nitrogen on dry matter basis. Concentrates were fed at the rate of 4 lb./10 lb. milk. Results showed that milk production was 10% less on urea and biuret treatments than on the control. Milk yield in pounds/cow/day was 25.5, 23.0 and 22.8 and live weight change in pounds/cow/day was -0.5,-0.6 and -0.5 for control, biuret and urea rations, respectively. Total dry matter intake (hay + concentrate) was 23.4, 23.1 and 22.4 lb./cow/day, respectively for the three treatments. Intake of the concentrates was 9.7, 9.5 and 9.0 lb./cow daily for the three groups. The percentages of fat and protein in the milk from urea and biuret treatments were higher than from the control. This was due to low milk yield in the former treatments. Percentage of fat in the milk was 4.05, 4.45 and 4.37% and that of crude protein was 3.10, 3.16 and 3.19% for control, biuret and urea treatments, respectively.

Urea has been fed separately along with silage. Some workers have used urea treated silage.

Van Horn, Jacobson and Graden (1969) fed cows on corn silage and ground shelled corn. One group was given added urea at the level of 423g. and the other group at the level of 81g. urea/cow daily. Crude protein content of both the rations was the same (13.5% on dry matter basis). Results showed that milk production and weight gains were lower on high urea than low urea ration. Feed intake for the low urea and high urea ration was 34.2 and 33.8kg. and milk production was 25.9 and 23.4kg. daily, respectively.

Van Horn, Hocraffer and Foreman (1969) conducted experiments to find the milk production responses from urea treated corn silage. Results of the first experiment showed that lactating Holstein cows produced significantly less milk when receiving urea in high-dry matter corn silage at the level of 0.5% as compared to the production when cows received soybean meal as the only nitrogen supplement. No significant differences were observed between respective dry matter intakes and fat percentage. Milk yields in Kg. per cow daily for soybean meal and urea supplemented cows were 26.9 and 26.4 kg. for the preliminary period and 23.2 and 20.5kg. during the experimental period, respectively. Body weight gains were 0.44 and 0.39kg./cow daily for urea and soybean meal ration, respectively.

In another experiment lactating Holstein cows receiving 31.9% dry matter urea treated silage produced significantly more milk than cows receiving 46.2% dry matter urea treated silage. Their preliminary period milk yields were 26.7 and 26.8kg. and experimental period milk yields were 22.7 and 20.6 kg. per cow daily, respectively. They concluded that high dry matter urea treated silage is not satisfactory as lower dry matter urea treated silage for lactating dairy cows. The feed intake was similar in both the cases. The digestibility and retention of absorbed nitrogen was lower for the high dry matter urea treated silage which resulted in lower milk production.

Solovev, Manenkova and Belova (1966) studied the effect of urea in the feed of cows on the quality of milk who were given urea to replace 35% of the digestible crude protein of the ration. Results indicated that urea in milk increased but there was little change in total protein.

Van Horn, Foreman and Rodriguez (1967) fed cows a ration containing 14.9% crude protein. Each cow was offered 4.6kg. hay, 18.2kg. corn silage and 18.2kg. of concentrate daily. Addition of 2.7% urea to the concentrate mixture resulted in significant depression of feed intake but there was no interaction between urea and corn silage. Depression in milk production was thought to be due to depressed feed intake. The depressed feed intakes were 4.4kg. hay, 17.0kg. corn silage and 7.8kg. concentrate daily. Milk production with urea was 22.0kg./day as compared to 26.4kg./day without urea.

Colovos, Holter, Davis and Urban,Jr. (1967) fed lactating cows on a ration containing 17.2% crude protein. A concentrate mixture containing 0.0, 1.25, 2.0 or 2.5% urea (42% N) was fed in place of an equivalent amount of plant protein nitrogen, with good quality timothy hay. There were no significant differences in milk production or composition or in ration digestibility. Protein balance was positive in all treatments.

Rohr (1962) as cited by Briggs (1967) studied the influence of a high proportion of cellulose in dairy cow rations. In his experiments in vivo and in vitro he found that a large amount of fiber in the ration leads to a marked reduction in the number of microorganisms in the contents of the rumen. The microflora originating under these conditions, inspite of its lower number, has a greater urease activity than a more numerous microorganism population when given starch feedstuff. A large amout of fiber and the resultant easy and rapid decomposition of urea into ammonium nitrogen causes a rise in the pH in the rumen which increases the permeability of the wall of the rumen. This consequently leads to an increase in the loss of ammonium nitrogen as a result of its entry into the blood circulation. However, he indicates further that urea well mixed with the ration, ensuring a constant regular supply of urea to the rumen, leads to good urea utilization and maintains a high milk production even when the ration contains a relatively large amount of crude fiber. He demonstrated this by comparing the influence of an addition of soybean bran or urea to a ration deficient in protein. When cows were fed ration deficient in protein with a large fiber content, the addition of urea well mixed with the ration mass caused an increase in the number of rumen microorganisms to the same degree as soybean bran. This in turn led to better digestion of the fiber, then to acidity of the rumen area, and by this to an improvement in the urea utilization in the rumen.

Effects of levels of fiber in the concentrate mixture and the effect of urea, on milk production has been further investigated.

Colovos et al (1967) used Holstein cows, in the second through fifth months of their lactation, to study the effect of concentrate fiber and urea on ration utilization and production. Crude protein content of the concentrate mixture was 16.7%. Body weight of the four animals used at the beginning of experiment ranged from 400 to 500kg. and daily milk production was between 20 and 23kg. Concentrate mixtures containing corn meal, oat meal feed, brewer's grains, molasses, soybean meal and minerals were fed according to milk production. Levels of urea (42% N) in the concentrate mixture were 0 and 2% and the levels of fiber were 5 and 8%. Fair quality timothy hay was fed as the only forage at the rate of 2% of body weight.

Only minor differences occured in ration intake, protein digestibility and milk production. The higher levels of concentrate fiber and urea slightly depressed actual milk production. Average 4% FCM (fat corrected milk) production was 16.30 and 15.78kg. for 5% and 8% fiber and 16.3 and 15.75kg./day for 0 and 2.0% urea, respectively. High levels of concentrate fiber and urea significantly depressed ration digestibility. Dry matter, energy and protein intake were not significantly affected by treatments. Ration protein digestibility was 66.6 and 65.4% with 5 and 8% fiber and 65.6 and 66.4% with 0 and 2.0% urea in the concentrate, respectively. Urea significantly improved the digestibility of fiber in the ration when included in the low fiber concentrate mixture but had the opposite effect in high fiber concentrate. They attributed this to higher intake of fiber. The level of urea in milk under various conditions of feeding, has also been investigated.

The National Research Council (1953) indicated that cows normal milk contains from 10 to 60mg. urea/100 ml.

Briggs and Hogg (1964) studied the effect of dietary urea on the level in milk. One group of cows was fed a conventional ration which included a protein supplement. The second group received a daily average of 3 lb. per head of urea feed (10% urea in molasses with added minerals and vitamins). Individuals showed significant variations in the milk urea level from day to day which were independent of milk yield. In cows given urea the range in milk urea was from 15 to 40mg./100 ml. In cows fed the conventional ration including protein supplement the range was from 33 to 58 mg./100ml. The differences between the two groups were not significant.

Urea feeding has been shown to exert no influence on milk composition or flavour. Virtanen (1966) studied the effect of feeding urea on milk composition in lactating cows. Results showed that the composition of the test milk was similar to that of normal milk.

Fractionation of casein and serum proteins of the test milk and normal milk by different methods showed the similarity of the proteins of the two milks. He further stated that the flavours of the two milks was also similar.

VI. EXPERIMENTAL

Experiment No. I

Animals Used

Thirty bred ewes, belonging to The University of British Columbia, were used for this study during the session of 1967-68. Ewes were maintained at the sheep unit. Ewes were divided equally into two groups on the basis of weight, breed and age. In Group I all ewes lambed. In Group II two ewes did not lamb.

Feeding

Both groups of ewes received the same amount of protein 90g.(0.21b.) digestible crude protein (D.C.P.)/head/day) during the last six weeks of pregnancy and 225g. (0.51b.) D.C.P. during lactation. Their Digestible Energy (D.E.) requirement was supplied as follows.

	During last 6 weeks of pregnancy	During lactation
Group I	Maintenance + 50%	Maintenance + 150%
Group II	Maintenance + 100%	Maintenance + 100%

The above mentioned amount of protein and energy was supplied to both groups by various amounts of brome hay, alfalfa hay, beet pulp and, or dairy pellets, as indicated below:-

Energy Levels and Feed Supply - Per Head Per Day

	Live weight (Kg)	Required Digestible Energy (K.Calories)	Brome hay (Kg)	Beet pulp (Kg)	Dairy pellets (Kg)
Group I (Pregnancy)					
	55	3000	1.36		
	60	3200	1.45		
	65	3400	1.54	X	X
	70	3600	1.63		
	75	3800	1.72		
Group II (Pregnancy)	55	4100	0.72	0.81	
	60	4400	0.77	0.86	
	65	4700	0.81	0.90	
	70	4900	0.86	0.95	
	75	5100	0.90	1.00	
Group I (Lactation)	55	5200	0.68		1.13
	60	5700	0.77		1.22
	65	6000	0.81	X	1.27
	70	6200	0.86		1.31
	75	6500	0.90		1.36
Group II (Lactation)	55	4100	1.40		0.31
	60	4400	1.45		0.36
	65	4700	1.50	X	0.40
	70	4900	1.54		0.45
	75	5100	1.59		0.50

The composition of the rations is given in Table A1. All ewes were weighed 7 weeks before parturition, pre-partum, post-partum and then every week during lactation.

Milking of Ewes and Analysis of Milk Samples

Three ewes from each group were used for hand milking. Ewes were given an injection of an oxytocinic preparation in the morning and their udders were emptied by hand milking. The lambs were kept separate from the ewes in the adjoining pen where ewes could see the lambs. After four hours the ewes were again given an injection of the oxytocinic preparation and immediately hand milked after keeping them secure in the metabolism cages. The quantity of milk obtained for four hours was measured and the total amount of milk produced during 24 hours was determined. Samples were obtained after thorough mixing of the milk and were retained for the analysis of fat, protein, lactose, total solids and ash. All samples were brought back to the laboratory and kept overnight under refrigeration. Samples were analyzed in the morning in the Provincial Government Dairy Branch Laboratory by infra red milk analyzer for the determination of fat, protein, and lactose percentage. For total solids determination 5mls. of milk were put into an already weighed crucible, weighed and then crucible was placed in a boiling water bath for 4 hours and then put in the oven for 3 to 4 hours until constant weight was obtained. Crucibles were weighed again and the amount of total solids determined. For the determination of ash crucibles containing total solids were weighed and put in furnace for 2 hours at 500°C. Afterwards they were taken out of the oven at 100°C, cooled in a desiccator and weighed again. The difference in weight gave the amount of ash and then the percentage in the original 5 ml. of milk samples was determined. All determinations were done in duplicate.

Weaning of Lambs

Birthweight of every lamb was recorded and they were weighed every week until weaning. Twenty-seven lambs from both the groups of ewes were weaned at 6 to 8 weeks of age and divided into three groups of nine lambs each on a weight basis. Lambs in Group I received hay + pelleted grain ration (20% protein); Group II, hay + pelleted grain ration (16% protein) and Group III, hay + pelleted grain ration (13% protein). Composition of the rations is given in Table A-2. Pellets were fed to appetite and the amount being fed was increased gradually. The amount of hay given and refused was recorded and thus the amount of hay consumed daily by each group was determined. The amount of pellets consumed by each group was also recorded daily. Total amount of feed consumed during 10 weeks was also calculated. All the groups received almost same amount of total pellets and hay during the 10 week period after weaning. Lambs were weighed every week.

Digestibility Study

Four male lambs from each of the three groups were used for this study. They were kept in metabolism cages and fed on hay and received the same pellets as their parent group. Water was available all the time. They were kept for 5 days during preliminary period and then the amount of hay and pellets consumed each day was recorded at the commencement of the study. The study lasted for 4 days for each animal during which the amount of faeces and urine produced was recorded daily, 10 ml. of 10% sulphuric acid was added daily to the urine collection vessel and 10 ml. of 2% boric acid to trap ammonia was also added to the faeces container. Representative samples of urine and faeces were obtained after thoroughly mixing each and were brought back to the laboratory where urine samples were put in the freezer.

Faeces samples were put in the preweighed petri dishes, weighed and dried for 7 hours at 95°C and reweighed. So the amount of dry matter in faeces was determined. Dried faeces samples were analyzed for nitrogen (on dry matter basis) by Kjeldahl's method. Later urine samples were also analyzed for nitrogen by the same method. Feed samples were also analyzed on a dry matter basis. All samples were analyzed for nitrogen in duplicate.

Experiment No. II

Management

Thirty lactating Dorset ewes, Dorset ewe lambs and crossbred ewes were used for this study. They were divided equally into 3 groups, of 10 ewes each, on a weight basis. The groups of ewes were allotted to three different rations which provided equal amount of nitrogen to all the three groups. Group I was provided nitrogen from pellets containing soybean meal; Group II from pellets containing soybean meal + urea and Group III from pellets containing urea alone. These pellets were analyzed for nitrogen by Kjeldahl's method. Urea percentage in the pellets was determined by using p-dimethylaminobenzaldehyde (PDAB) and by using the basis of the method of Watt and Chrisp (1952). Pellets were finely ground and a known amount of sample was extracted with water and filtered into a volumetric flask and made up to the mark and mixed. This solution was diluted so that the concentration was 20 to 200 mg. %, 0.2 ml. of this solution was added to 4 ml. of PDAB solution, mixed thoroughly and read at 435 mμ. against a blank made in the same way by substituting 0.2 ml. water for the sample. Sample values obtained this way were read against a standard curve made using freshly prepared known urea solutions.

Milk Yield

Three Dorset ewes from each group were taken for milk yield determination. The method used for the determination of milk yield, carried out once a week for 8 weeks, was the same as in the first experiment except that an udder cover like the one used by Owen (1957) was employed. The udder cover was applied after first hand milking in the morning and the lambs remained, along with their dams in the same pen. The udder cover was removed after 4 hours at the time of second milking. Total yield for 24 hours was determined.

Milk Analysis

Milk samples were analyzed for fat, protein, lactose, total solids and ash by the same method as in the first experiment. Samples of milk were also freeze dried for later milk urea nitrogen determination. The freeze dried milk was reconstituted by the addition of water on thebasis of percentage of total solids in each sample and analyzed by the method of Brown (1959) which is described in a later section. The method employed was similar except that milk was used instead of blood plasma and milk urea nitrogen level was determined.

Blood Analysis

Blood samples were taken from the 30 ewes once a week for 8 weeks for the determination of plasma urea nitrogen. Analysis was carried out by the method of Brown (1959). Whole blood was used for this determination and the values obtained were corrected on blood plasma basis after finding the percentage of blood plasma in the whole blood. The whole blood was used because it was collected in heparinized tubes and then frozen. The blood hemolyzed and serum or plasma could not be taken out of it.

Blood samples were also taken every week from 5 lambs in each group for a period of 4 weeks. Blood plasma was used for urea nitrogen determination by the method mentioned above (Brown, 1959). The procedure was as follows.

One ml. of water (blank for standards), one ml. of urea-free plasma (obtained by adding 3 or 4 drops of urease preparation to five ml. of pooled plasma and used as blank for unknowns), one ml. aliquots of the standards and one ml. aliquots of the unknown plasmas were pipetted into appropriately labelled test tubes. Seven ml. of water was added to each tube and mixed. One ml. of zinc sulphate solution was added to each tube and mixed thoroughly.

One ml. of sodium hydroxide solution was then added to each tube and again mixed thoroughly. The contents of the tubes were transferred to appropriately labelled tubes and centrifuged. Then two ml. aliquots of the clear portion of the centrifugate were transferred to appropriately labelled cuvettes. Two mls. of the p-dimethylaminobenzaldehyde color reagent was added to each and mixed thoroughly. Cuvettes were allowed to stand for 10 minutes. Absorbance was measured in a "Spectronic 20" spectrophotometer at 400 mμ., setting the instrument at zero absorbance with the water blank for the standards and with the urea free plasma blank for the unknowns. A standard curve was prepared by plotting the absorbances against the concentrations of the standards. The concentrations of the unknowns was determined from the standard curve.

Growth of Lambs

Thirty lambs were weaned at 8 to 10 weeks of age and were divided equally on the basis of weight into three groups and were allotted to three different rations providing equal amount of nitrogen from soybean, soybean + urea and urea pellets. Lambs were weighed weekly for 16 weeks.

Digestion Trial

A digestion trial was carried out with 2 male lambs from each group for 5 days after a preliminary period of 4 days. Water was available all the time. Lambs were given pellets up to appetite and the amount of pellets given and refused was recorded and the amount of pellets consumed was determined. Faeces and urine were collected and analyzed as in the first experiment.

VII. RESULTS AND DISCUSSION

Experiment I

Two groups of ewes were fed two rations providing different levels of energy. Maintenance requirement of Digestible Energy + 50% and maintenance + 100% was fed to Group I and Group II, respectively, during late pregnancy. Both the groups were fed 90g. (0.21b.) D.C.P./head/day during late pregnancy and 225g. (0.51b.) D.C.P./head/day during early lactation. During early lactation, maintenance requirement of energy + 150% was fed to Group I and maintenance + 100% was fed to Group II. Out of thirty ewes all but two (in the second group) were pregnant and lambed. Both groups gained weight during late pregnancy and lost weight during early lactation. The weight changes of the ewes are shown in Fig. I. Average weights of ewes during late pregnancy and early lactation are given in Table I. Weight gain by the ewes in Group II during late pregnancy was significantly greater ($P<0.01$) than that by ewes in Group I. Weight loss during early lactation was significantly lower ($P<0.05$) in ewes of Group I as compared to ewes in Group II. Ewes average daily milk yield is given in Table II. There were no significant differences in milk production by the two groups of ewes. The protein supply of the ewes during pregnancy was in line with the National Research Council (1968) recommendation of 0.21b. Digestible Crude Protein during the last six weeks of gestation for a ewe of 140 lb. live weight or over. However, Phillipson (1959) has suggested 0.25 lb. D.C.P. for ewes of this weight range in the later stages of pregnancy. Robinson and Forbes (1968) supplied to their ewes a standard digestible crude protein intake of 8.8g/kg. $W^{0.73}$ (W=live weight in Kg.) or 0.42 lb. D.C.P./150 lb. ewe daily during early lactation. This level of protein was fed in conjunction with a Metabolizable Energy intake of 125% or 150% of the maintenance requirement of non-pregnant ewes. They indicated that the difference between the rates of liveweight gain on the two energy levels was about

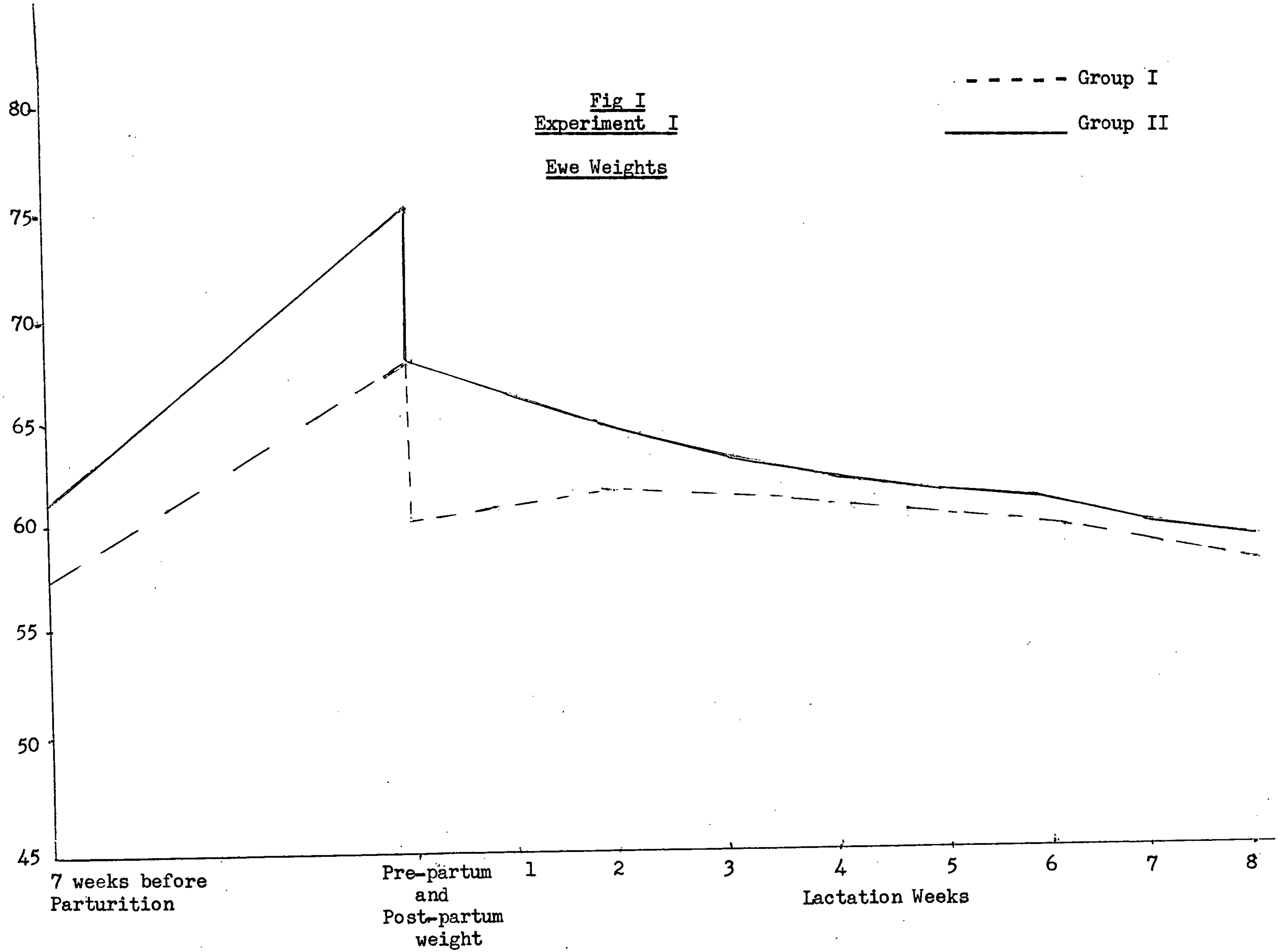


Fig I
Experiment I
Ewe Weights
Group I
Group II
80
75
70
65
60
55
50
45
7 weeks before Parturition
Pre-partum and Post-partum weight
1
2
3
4
5
6
7
8
Lactation Weeks

0.06 kg./day in favour of the higher level. The difference was significant. In line with Robinson and Forbes (1968) experiment the protein supplied during lactation in this trial should have been adequate.

Pre-weaning weekly weights of singles and twins from both the groups of ewes are shown graphically in Fig. II. During the eight weeks of the lactation single lambs in Group I weighed significantly heavier ($P<0.05$) than those in Group II. Single and twin lamb growth during the pre-weaning period is shown in Tables III and IV.

Twins in Group I were also significantly heavier ($P<0.05$) than those in Group II. Single lambs from ewes in Group II were significantly heavier ($P<0.05$) than twins from the ewes in Group I.

As already indicated there were no significant differences in milk yield by the two groups of the ewes. There were also no significant differences in fat, protein and lactose percentage of milk from the two groups.

Average daily milk production of the ewes and fat, protein and lactose percentage of the milk are shown graphically in Figs. III and IVa and IVb. Average fat, protein and lactose percentages is given in Tables V, VI and VII. Milk production in both groups declined sharply at the end of the second week after which the decrease was gradual. The pattern of the curves for the percentages of protein and lactose was similar in both the groups during the 8 week period. Lactose content of the milk was fairly constant in both the groups. The protein content of the milk in both the groups increased after the 3rd week when the milk yield had declined but it was almost the same from 4th week to the end of the 8 week period. Fat content of the milk decreased after the first three weeks of lactation and there was greater fluctuation during the first three or four weeks than during the later period. The milk composition as shown graphically indicated

Fig II

Experiment I

Lamb growth (Pre-weaning)

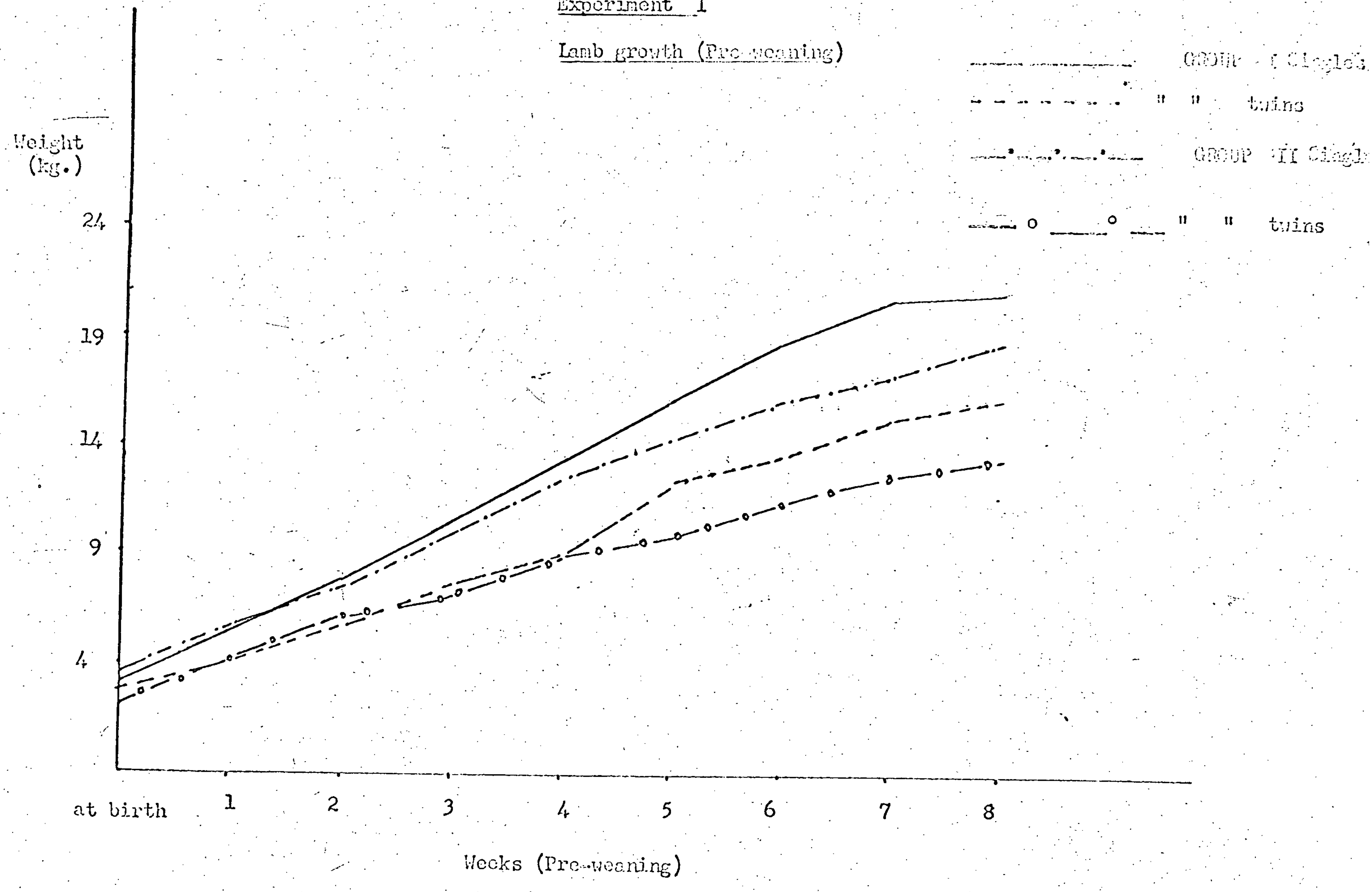


Fig. III

Experiment I

Average Milk yield (ml./24 hr)

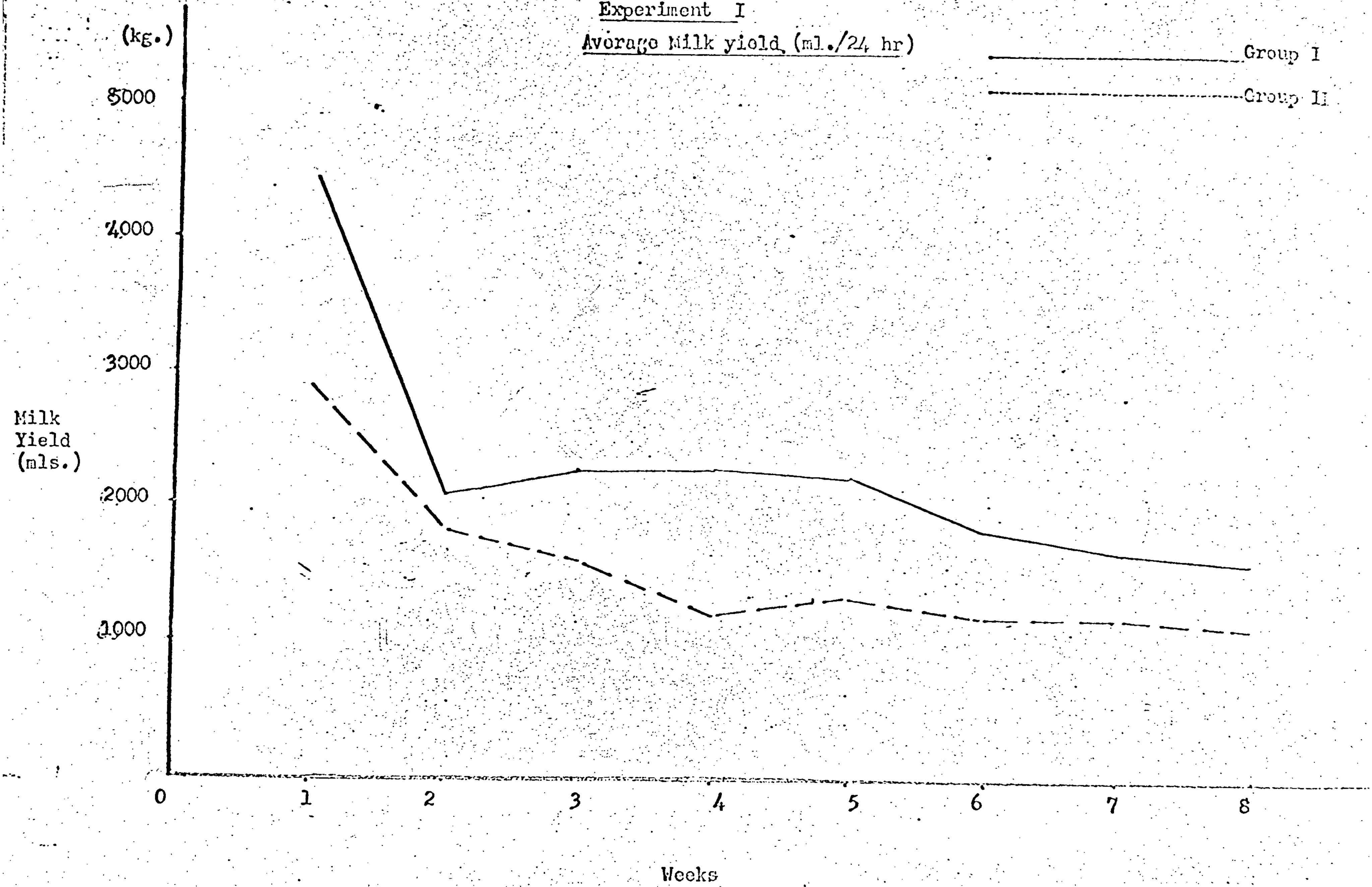
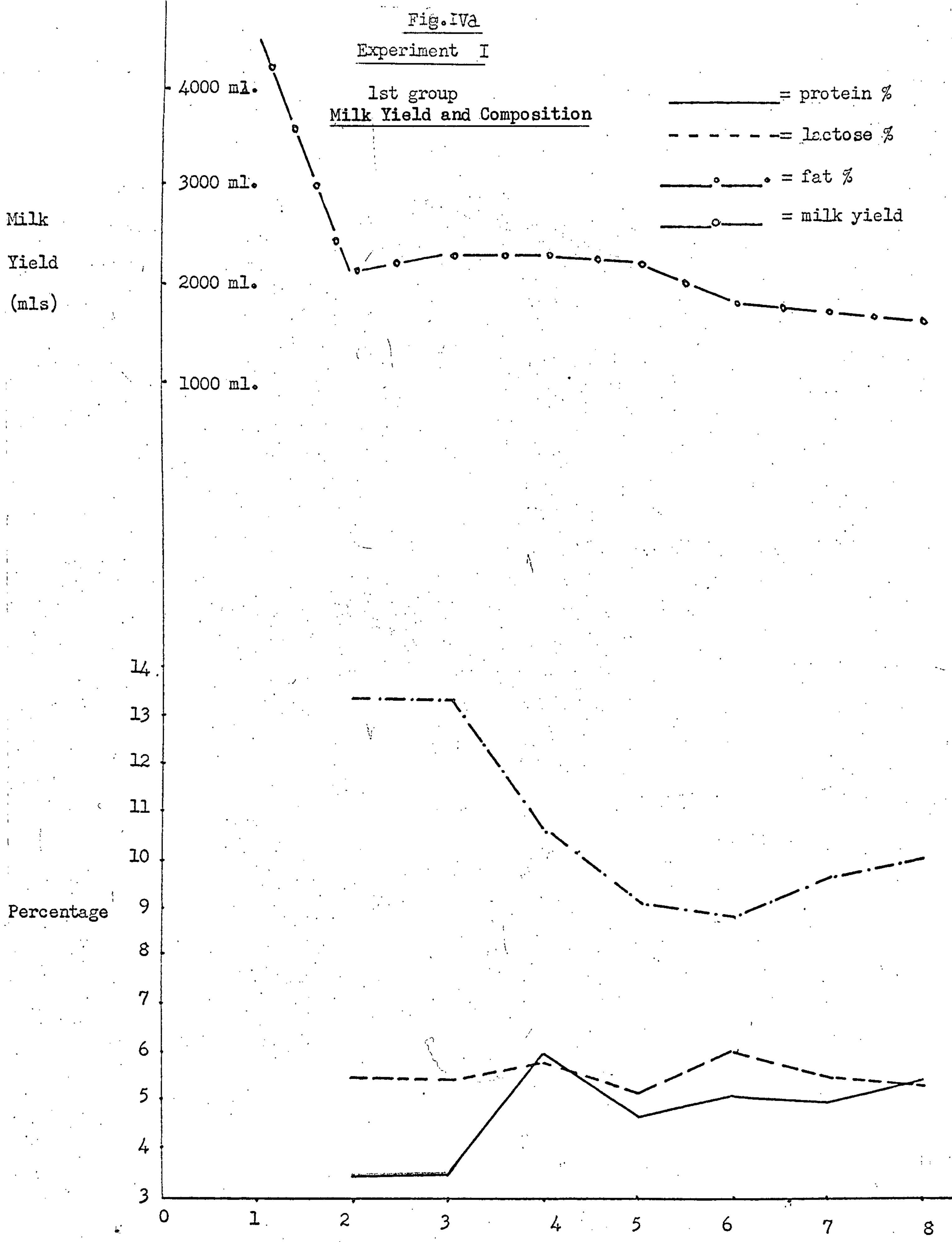


Fig. IVa

Experiment I

1st group
Milk Yield and Composition



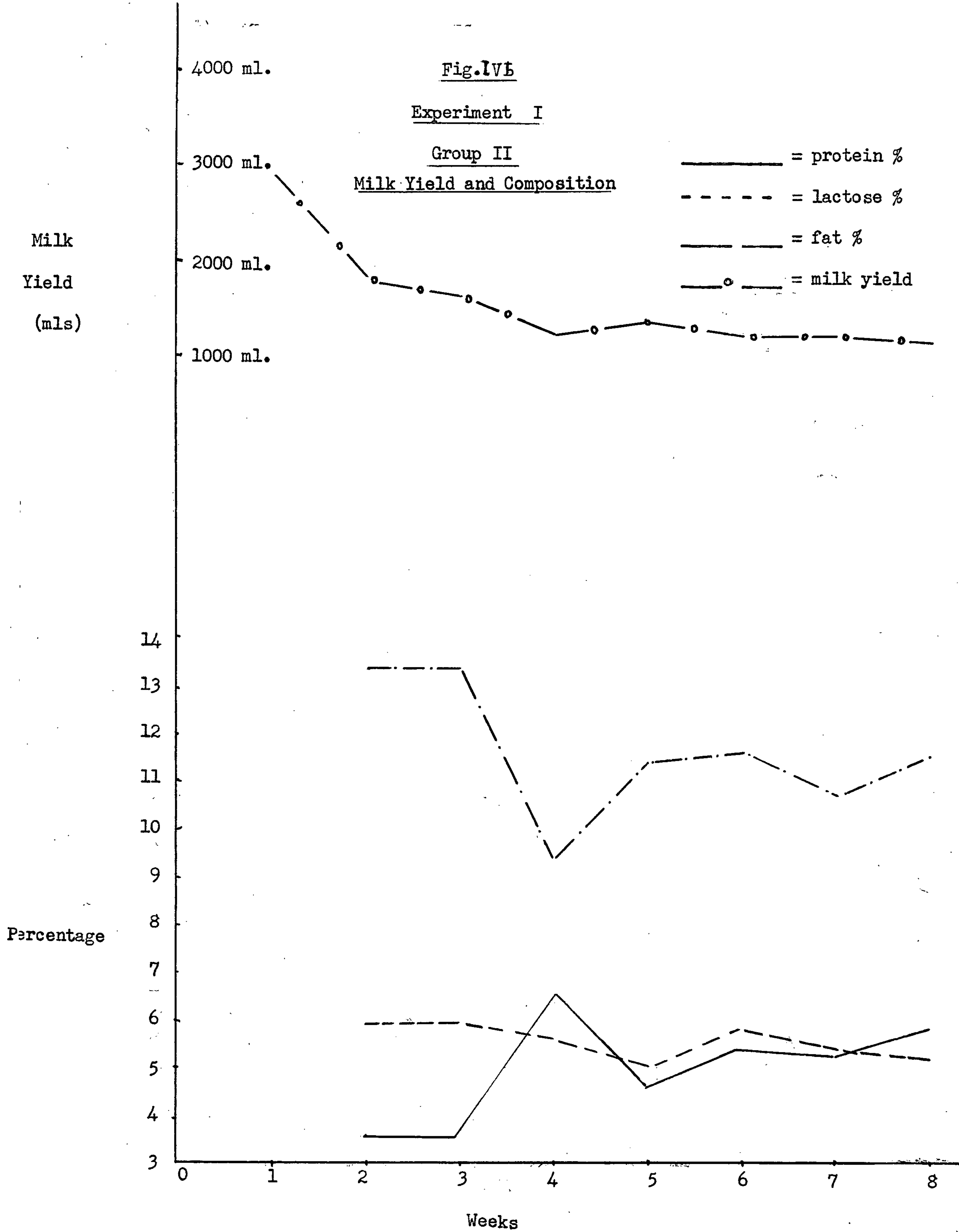


Fig.IVb
Experiment I
Group II
Milk Yield and Composition
= protein %
= lactose %
= fat %
= milk yield
Milk
Yield
(mls)
4000 ml.
3000 ml.
2000 ml.
1000 ml.
Percentage
14
13
12
11
10
9
8
7
6
5
4
3
0
1
2
3
4
5
6
7
8
Weeks

that the content of the above mentioned solids in milk increased with a corresponding decrease in milk yield.

Gardner and Hogue (1964) pointed out in their experiment with ewes that fat and protein values were higher at the beginning of lactation, declined to a minimum after 2 to 4 weeks, remained constant for next 3 to 4 weeks and then rose with each successive week of lactation, during a trial period of 12 weeks. Lactose values remained relatively constant.

TABLE I

EXPERIMENT I

Average weight of ewes (Kg.)

Weight of ewes before parturition				Weight of ewes during early lactation (Weeks)							
Group	7 weeks before parturition weight	Pre-partum weight	Post-partum weight	1st	2nd	3rd	4th	5th	6th	7th	8th
I	56.9	66.0	59.4	60.1	60.6	60.2	59.8	59.3	58.8	57.9	56.9
II	60.2	73.1	65.9	64.6	63.0	61.8	61.0	60.4	60.0	58.8	58.1

TABLE II

EXPERIMENT I

Ewes Average Daily Milk Yield (mls/24 hr.)

	Weeks of lactation							
Group	1st	2nd	3rd	4th	5th	6th	7th	8th
1st Group	4500	2136	2316	2308	2220	1840	1734	1645
2nd Group	2940	1896	1656	1248	1380	1221	1227	1165

TABLE III

EXPERIMENT I

Single Lamb Growth (Pre-weaning)

Average Weekly Weight (Kg.)

		Weeks after birth							
Group	Birth Weight	1st	2nd	3rd	4th	5th	6th	7th	8th
I	3.8	5.9	8.0	10.6	13.1	15.5	18.0	19.9	20.1
II	4.2	6.1	7.8	10.1	12.4	14.0	15.6	16.6	18.0

TABLE IV

EXPERIMENT I

Twin Lamb Growth (Pre-weaning)

Average Weekly Weight (Kg.)

		Weeks after birth							
Group	Birth Weight	1st	2nd	3rd	4th	5th	6th	7th	8th
I	3.4	4.6	6.1	7.7	9.2	12.3	13.2	14.7	15.7
II	3.1	4.5	6.4	7.5	9.1	10.1	11.3	12.5	13.2

TABLE V

EXPERIMENT I

Average Fat Percentage of Milk

Week of Lactation	1st	2nd	3rd	4th	5th	6th	7th	8th
1st Group	-	13.33	13.33	10.66	9.11	8.82	9.65	10.05
2nd Group	-	13.42	13.43	9.43	11.41	11.65	10.75	11.54

TABLE VI

EXPERIMENT I

Average Protein Percentage of Milk

Week of Lactation	1st	2nd	3rd	4th	5th	6th	7th	8th
1st Group	-	3.46	3.46	5.92	4.69	5.09	4.97	5.44
2nd Group	-	3.53	3.53	6.52	4.55	5.34	5.28	5.88

TABLE VII

EXPERIMENT I

AVERAGE LACTOSE PERCENTAGE OF MILK

Week of Lactation	1st	2nd	3rd	4th	5th	6th	7th	8th
1st Group	-	5.49	5.48	5.80	5.17	6.03	5.51	5.37
2nd Group	-	5.94	5.98	5.66	5.04	5.83	5.41	5.21

Waite et al (1968) indicated in their experiment with cows that fat and protein content of milk increased with a corresponding decrease in milk yield. The milk yield was very high for the first two or three weeks as compared to the later 5 week period of lactation. Clark (1961) indicated that for ewes nursing twins the milk production of the first week of lactation was about double the production of the eighth week. The milk yield obtained in the experiment during the first week was more than double the production of the eighth week in both the groups. It was 4500 ml. as compared to 1645 ml. in Group I and 2940 ml. as compared to 1165 in Group II for the 1st and 8th week, respectively.

The following conclusions can be drawn from the above discussion.

1. Single lambs weighed heavier at birth and at weaning than twins regardless of the energy levels imposed during pregnancy and lactation in this experiment.
2. The weight of the lambs at birth was affected by the weight of their dams during late pregnancy. It shows that heavier ewes produce heavier lambs. Ray and Smith (1966) also indicated that the heaviest ewes produced heavier lambs at birth and at weaning than did the lighter ewes.
3. Milk yield of the ewes was greatest during first 2 or 3 weeks after which it declined.
4. Protein and lactose were the least fluctuating constituents of milk and with a decrease in the milk yield there was a corresponding increase in the solids. Fat content was more variable during the first four weeks of lactation but after this period the fluctuation was less, and later there was an increase with a corresponding decrease in milk yield.

Weaning of Lambs

Twenty seven lambs were weaned at 8 to 10 weeks of age and divided into three groups. Their average weight at weaning was 17.7, 19.3 and 19.3 kg. for Group I, Group II and Group III, and they were fed pellets containing 20, 16 and 13% crude protein, respectively. Average daily gain by weaned lambs is shown in Table VIII and Fig. V.

TABLE VIII

EXPERIMENT I

Post-weaning Lamb Growth

Average Daily Gain

No. of Animals	Average Daily Gain (kg.)	Ration
1	0.25	
2	0.24	
3	0.23	
4	0.21	20 % Crude protein
5	0.17	
6	0.14	
7	0.23	
8	0.20	
9	0.16	
Average	0.20	
1	0.17	
2	0.12	
3	0.10	
4	0.14	16.% Crude protein
5	0.18	
6	0.14	
7	0.09	
8	0.16	
9	0.12	
Average	0.15	
1	0.19	
2	0.13	
3	0.18	
4	0.12	13% Crude protein
5	0.16	
6	0.20	
7	0.16	
8	0.17	
9	0.09	
Average	0.16	

Results showed that there were significant differences ($P < 0.05$) in average daily gain of lambs fed pellets containing 20% and 16% protein, and the lambs fed the pellets containing 20% crude protein achieved the greatest gain. There were no significant differences between lambs fed 20% or 13% and between 16% or 13% crude protein. There were minor differences in feed intake by the three groups. The reason that lambs fed 13% protein made better gains may have been due to the fact that there was a higher proportion of single lambs in this group, compared to the other two groups. The feed efficiency ratio of these lambs is shown in Table IX. The feed efficiency ratio was 3.9, 5.7 and 5.0 for 20, 16 and 13% protein, respectively. Dickson (1959) suggested that after two months of age grass becomes the dominant factor in the lamb's diet. Ranhotra and Jordan (1966) reported that rations containing between 12 and 14% protein resulted in more rapid gains during the first 28 days following weaning, when weaned at 6 to 8 weeks of age, than rations with a lower protein level. They also reported that rations containing approximately 16.5% protein did not support more efficient gains than rations containing 13.5 to 14% protein.

Digestion Trial.

Dry matter digestibility is shown in Table X and nitrogen digested and retained is given in Table XI. Results of the digestion trial with lambs indicate that the differences in the dry matter digestibility and protein digestion coefficient of the three kinds of pellets (20, 16 and 13% C.P.) were not statistically significant. Lambs fed the 20% C.P. ration retained significantly ($P < 0.05$) more nitrogen than those fed the 16% and 13% C.P. ration. Nitrogen retention was not significantly different between lambs fed the 16% and 13% ration. Results of the digestion trial indicate that 20% C.P. ration was better for the growth of lambs, but 16%

C.P. ration did not provide extra growth as compared to 13% C.P. ration.

TABLE IX

EXPERIMENT I

POST-WEANING LAMB GROWTH

FEED EFFICIENCY RATIO

	20% Crude Protein	16% Crude Protein	13% Crude Protein
Total Weight Gain (kg)	130	89.5	102.2
Total Feed Consumed (kg)	510.4	512.2	511.3
Feed Efficiency Ratio	3.9	5.7	5.0

TABLE X

EXPERIMENT I

DIGESTION TRIAL OF LAMBS

DRY MATTER DIGESTIBILITY

No. of Animals	Total D.M. Intake g	% D.M. Digested	Ration
1	2175	72.3	20% Crude Protein
2	2037	72.6	
3	2023	68.8	
4	1754	74.0	
Average	1997	71.9	
1	1888	62.2	16% Crude Protein
2	1905	75.4	
3	961	77.6	
4	1234	66.4	
Average	1497	70.4	
1	2115	65.1	13% Crude Protein
2	1969	76.0	
3	2167	68.3	
4	960	71.9	
Average	1802	70.3	

TABLE XI

EXPERIMENT I

DIGESTION TRIAL OF LAMBS

NITROGEN DIGESTED AND RETAINED

No. of Animals	Total N Intake g	Digestion coefficient percent - %	N Retained / N Digested %	Ration
1 2 3 4	83.4 80.6 80.3 72.6	88.7 85.1 86.4 83.3	91.6 90.9 89.1 92.2	20% Crude Protein
Average	79.2	85.8	90.9	
1 2 3 4	66.4 64.7 30.0 41.5	88.7 85.6 79.3 87.9	88.2 81.4 86.5 89.3	16% Crude Protein
Average	50.6	85.3	86.3	
1 2 3 4	60.1 57.2 61.2 28.9	82.6 84.7 80.5 67.1	85.7 80.6 85.5 86.5	13% Crude Protein
Average	51.8	78.7	84.5	

EXPERIMENT II

During early lactation, nitrogen was provided to ewes in equal amounts in three different forms in pelleted rations containing supplemental nitrogen as soybean, + soybean + urea, and urea alone. Ewes average daily milk yield is shown in Table XII and Fig. VI. There were no significant differences observed in average daily milk production of ewes fed these rations. Ward et al (1955) reported that milk production in F.C.M. (fat corrected milk) was not significantly different when cows were fed a concentrate with soybean meal or urea. Bartlett and Blaxter (1947) emphasized that any protein sparing effect of urea can only be determined in animals fed a protein deficient ration. The addition of protein to such a ration, by increasing the percentage of crude protein in the ration from 12.9 to 17.9% resulted in a significant increase in milk production. This confirmed the protein deficiency of the low protein ration. They stated that the addition of sufficient urea to such a low protein ration to increase the crude protein to 17.9% resulted in no significant mean change in milk production. When they added urea to a normal protein ration (17% crude protein) a decline in milk yield occured. This was however not significant. Otagaki et al (1956) also reported that there was no statistical difference in milk production between control cows and a group of cows fed a ration in which 21% of nitrogen requirement was supplied by urea.

There were no significant differences in fat, protein and lactose percentage of milk from the three groups. In all the three groups of ewes, milk yield started to decline after the 4th week. Average fat, protein, lactose and total solids are given in Tables XIII, XIV, XV and XVI, and Figs. VII, VIII and IX. The milk yield and solids (fat and protein and lactose percentage) followed an almost similar pattern to the first

Fig. V.

Experiment I

Growth rate of Weaned Lambs

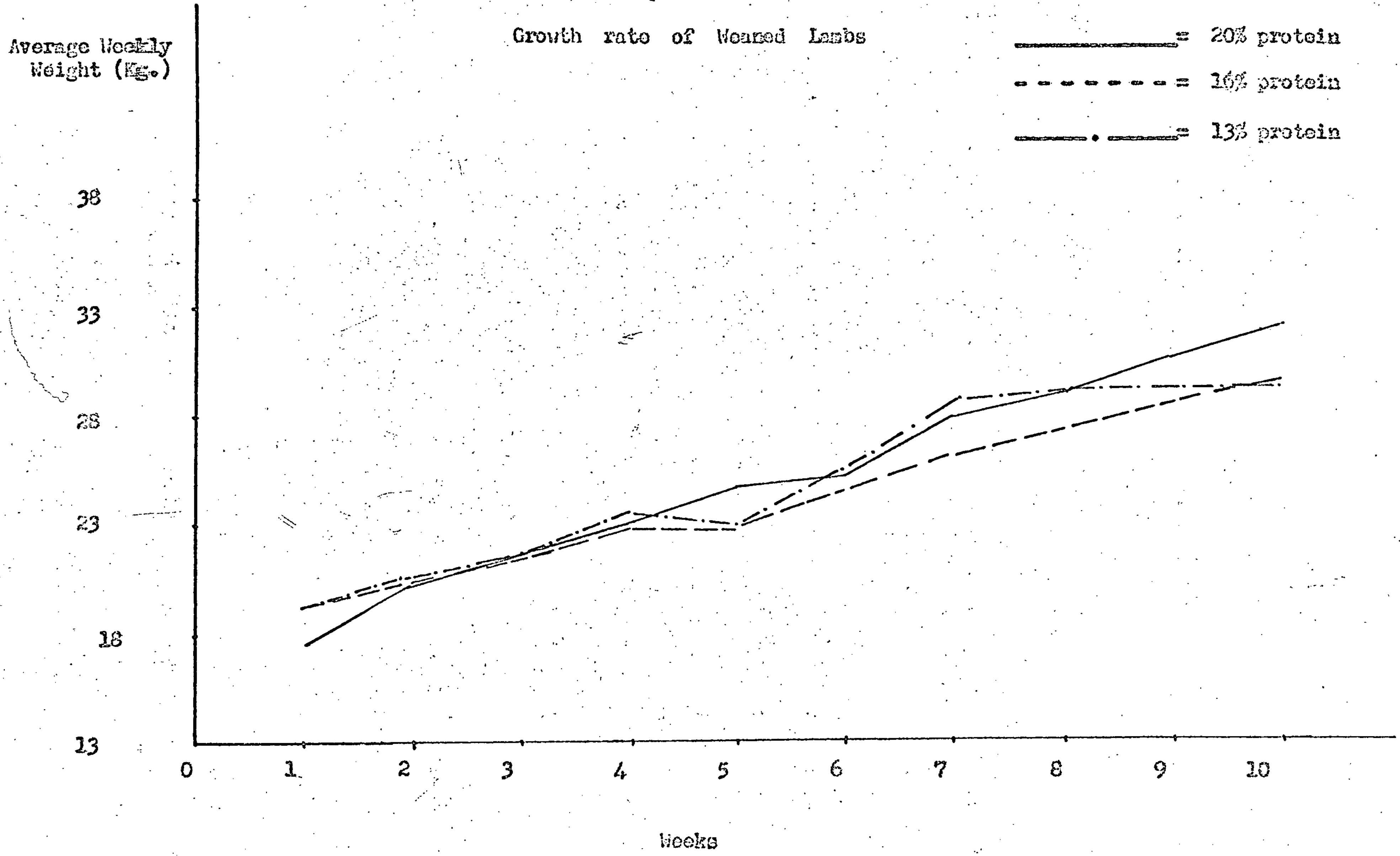
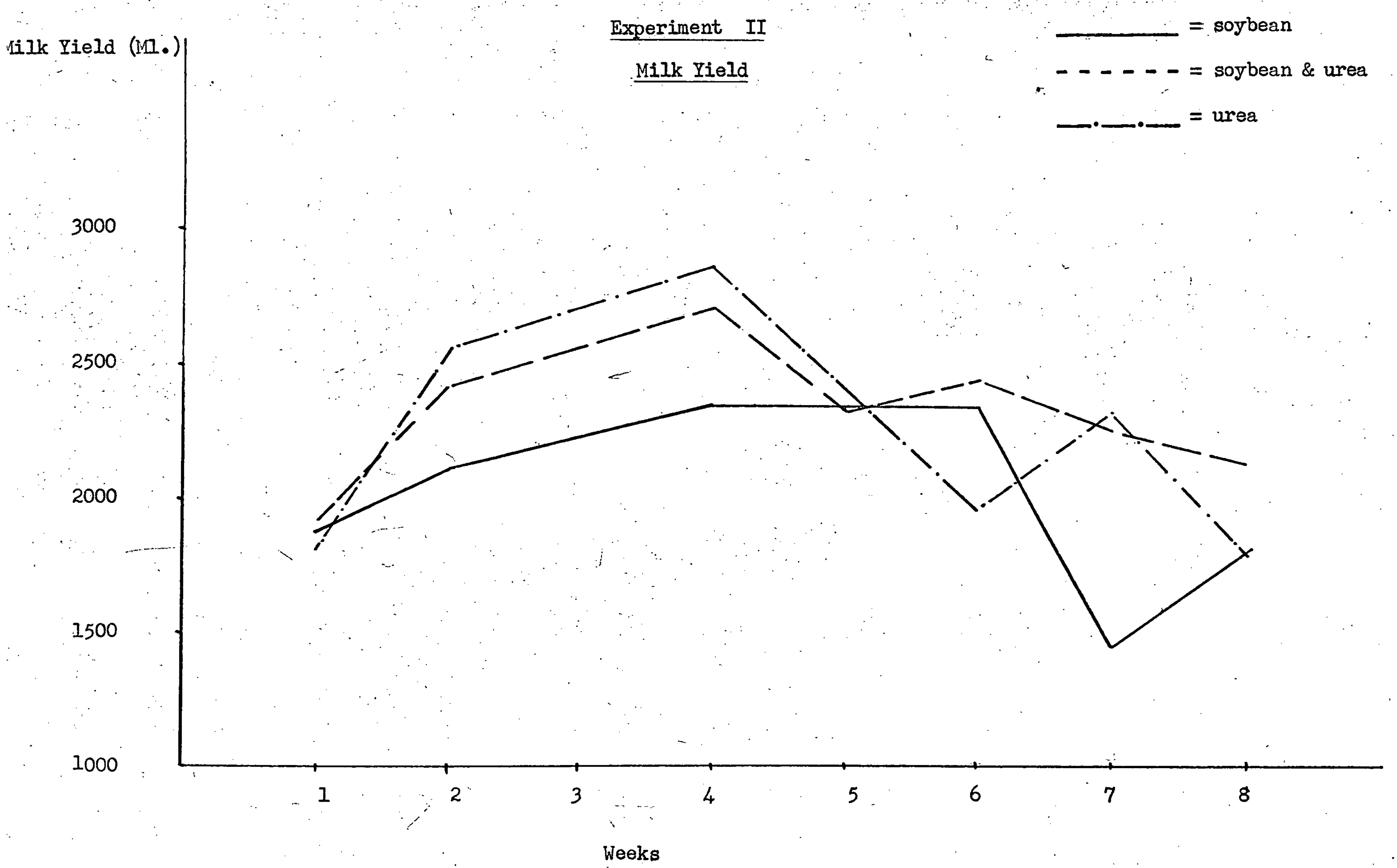


Fig VI

Experiment II

Milk Yield



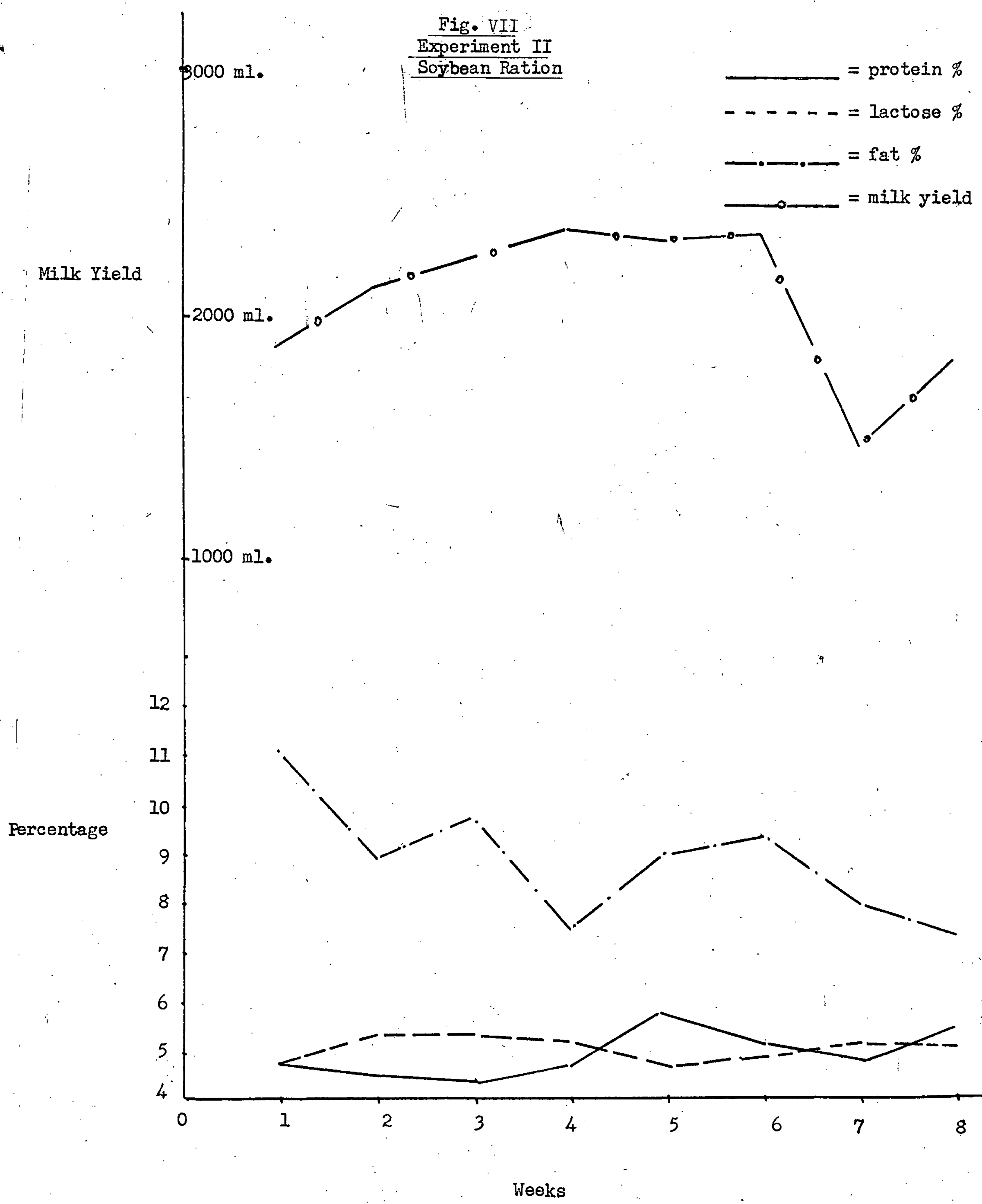


Fig. VII
Experiment II
Soybean Ration
= protein %
= lactose %
= fat %
= milk yield
Milk Yield
3000 ml.
2000 ml.
1000 ml.
Percentage
12
11
10
9
8
7
6
5
4
0
1
2
3
4
5
6
7
8
Weeks

Fig. VIII
Experiment II
Urea & Soybean ration

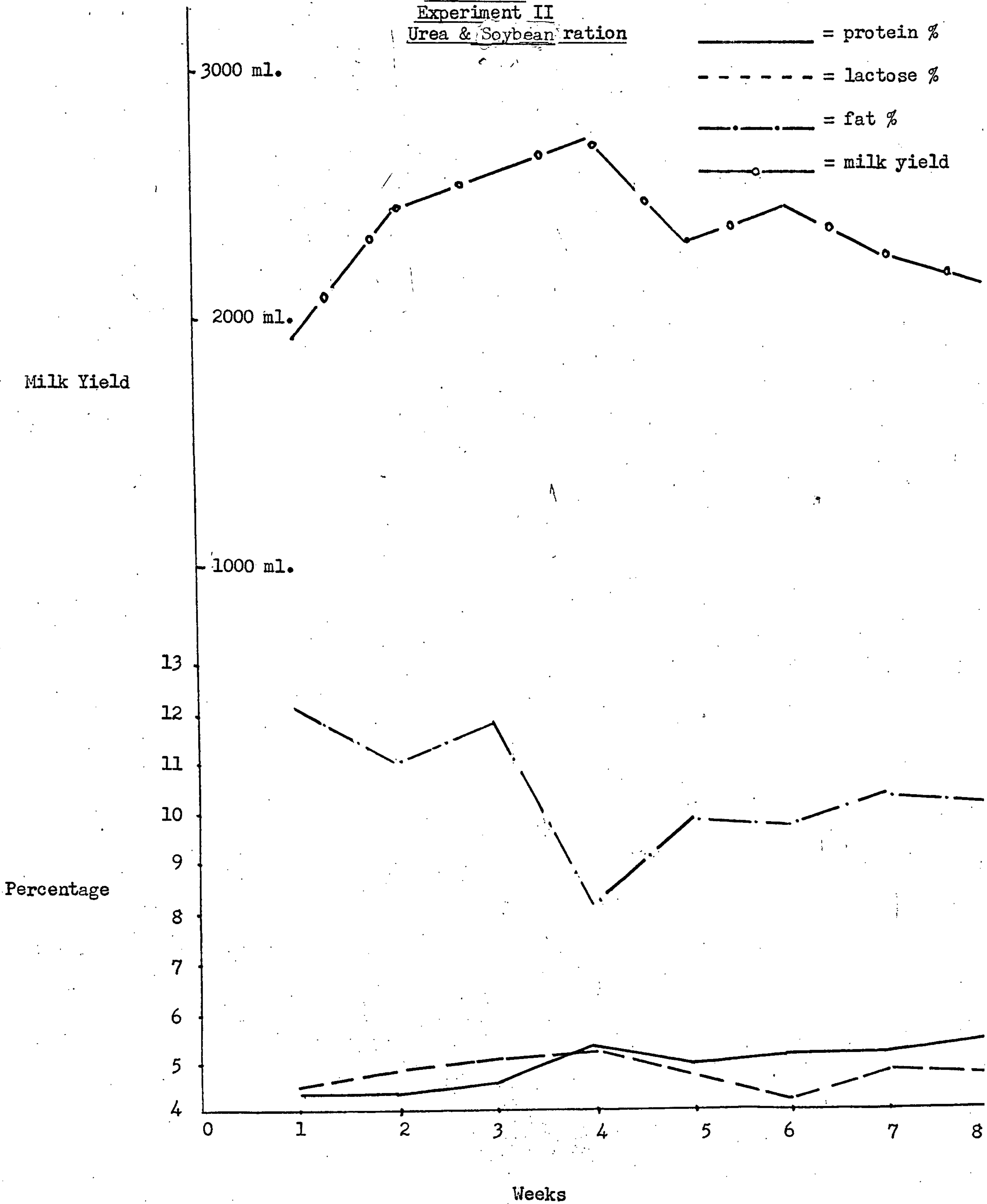
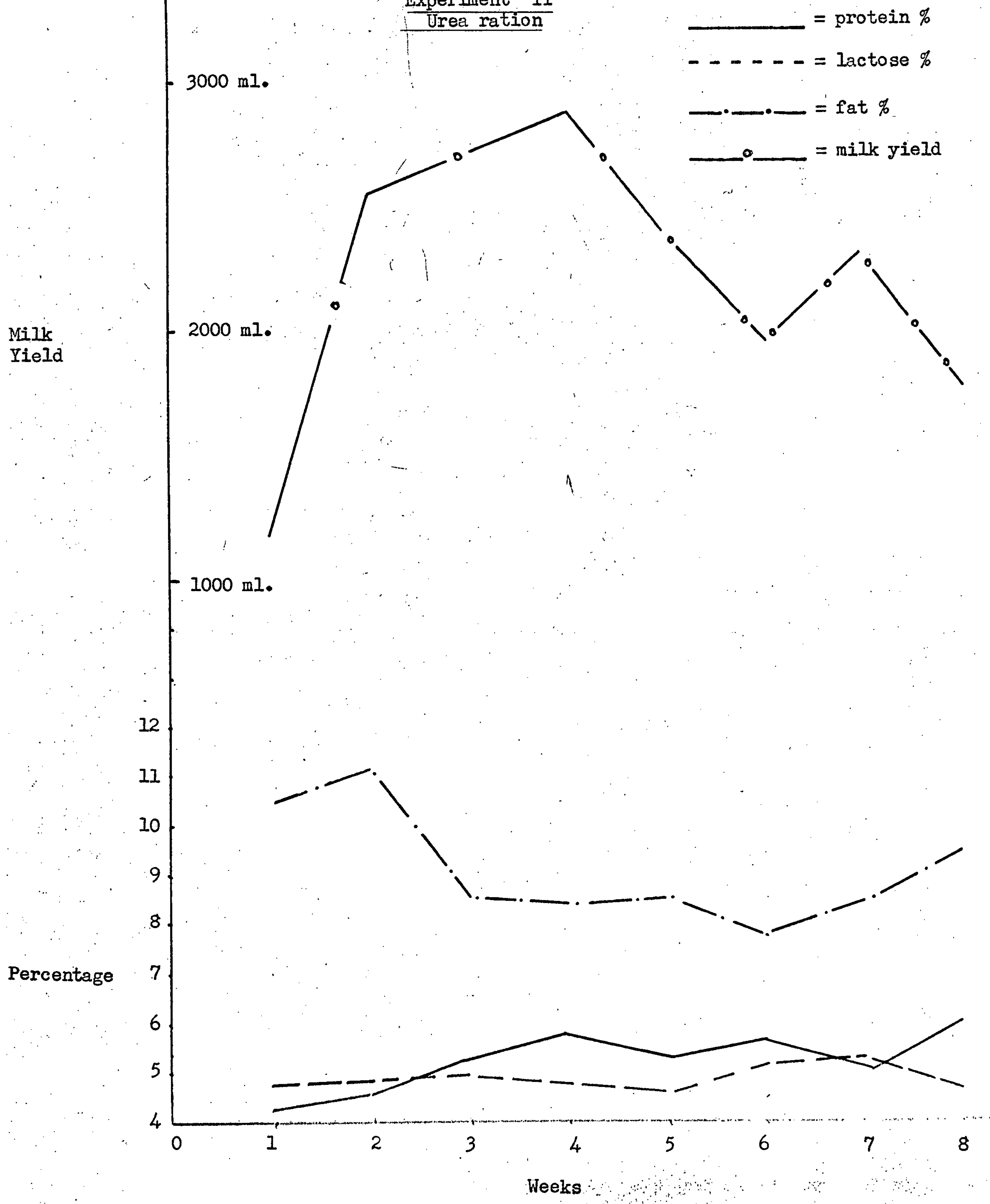


Fig. IXI
Experiment II
Urea ration



experiment, that is there was an increase in the percentage of these solids with a corresponding decrease in milk yield. Ewes average milk urea N level is shown in Table XVII. There were no significant differences in ewes milk urea nitrogen level among the three groups but there was variation within the groups which was independent of the milk yield. The range in milk urea nitrogen level was from 2.7 to 7.5, 0.2 to 5.7, and 0.3 to 5.3 mg/100 ml. for urea, urea + soybean and soybean containing pellets, respectively.

Briggs and Hogg (1964) reported that in cows given urea the range in milk urea level was from 15 to 44 mg/100 ml. In cows fed conventional rations including protein supplements the range was from 33 to 58 mg/100 ml. but the differences were not significant. It seems that levels of urea in milk of sheep is lower than that in cow's milk as indicated by this experiment. They also reported that these levels of urea did not affect the quality of cow's milk. Since the level of urea in sheep milk is far lower than that in the cow's milk, as indicated by the results of the experiment, there is less possibility of the quality of sheep milk being affected by the urea secretion in milk. Briggs and Hogg (1964) also reported that milk urea excretion was 1.4 to 10.0g/day and 3.7 to 17.3g/day for urea supplemented and protein supplemented rations, respectively. Their work suggests that feeding urea to dairy cows has no significant effect on the level or output of urea in the milk.

Ewes Blood Analysis.

Ewes average plasma urea N level is given in Table XVIII. Results of the blood analysis showed that these were no significant differences between plasma urea nitrogen level (during first 8 weeks of lactation) of ewes fed soybean or soybean + urea containing pellets. Ewes fed these pellets had significantly lower ($P<0.05$) plasma urea nitrogen level than

TABLE XII

EXPERIMENT II

EWES AVERAGE DAILY MILK YIELD (mls/24 hr)

WEEKS OF LACTATION

RATION	1st	2nd	3rd	4th	5th	6th	7th	8th
Soybean	1880	2120	-	2360	2310	2340	1454	1813
Soybean + Urea	1920	2430	-	2720	2320	2450	2260	2133
Urea	1813	2550	-	2880	2400	1965	2310	1786

TABLE XIII

EXPERIMENT II

AVERAGE FAT PERCENTAGE OF MILK

WEEKS OF LACTATION

RATION	1st	2nd	3rd	4th	5th	6th	7th	8th
Urea	10.48	11.17	8.56	8.37	8.51	7.74	8.45	9.47
Urea + Soybean	12.18	11.01	11.84	8.12	9.86	9.74	10.36	10.17
Soybean	11.14	8.95	9.70	7.42	8.94	9.35	7.94	7.36

TABLE XIV

EXPERIMENT II

AVERAGE PROTEIN PERCENTAGE OF MILK

WEEKS OF LACTATION

RATION	1st	2nd	3rd	4th	5th	6th	7th	8th
Urea	4.22	4.56	5.26	5.79	5.25	5.61	5.07	5.94
Urea + Soybean	4.39	4.40	4.58	5.31	4.91	5.11	5.17	5.45
Soybean	4.78	4.51	4.38	4.70	5.79	5.16	4.86	5.47

TABLE XV

EXPERIMENT II

AVERAGE LACTOSE PERCENTAGE OF MILK

WEEKS OF LACTATION

RATIONS	1st	2nd	3rd	4th	5th	6th	7th	8th
Urea	4.73	4.84	4.94	4.77	4.59	5.17	5.25	4.66
Urea + Soybean	4.59	4.86	5.02	5.21	4.74	4.21	4.85	4.74
Soybean	4.78	5.32	5.32	5.18	4.68	4.89	5.16	5.06

TABLE XVI

EXPERIMENT II

AVERAGE TOTAL SOLIDS PERCENTAGE OF MILK

WEEKS OF LACTATION

RATIONS	1st	2nd	3rd	4th	5th	6th	7th	8th
Urea	20.13	21.30	19.46	19.63	19.10	19.32	19.47	20.82
Urea + Soybean	21.92	21.07	22.24	19.47	20.34	19.89	21.20	21.16
Soybean	21.43	19.58	20.13	18.03	20.13	20.16	18.71	18.65

TABLE XVII

EXPERIMENT II

EWES AVERAGE MILK UREA N (mg. Urea N/100 ml.)

WEEKS OF LACTATION

RATIONS	1st	2nd	3rd	4th	5th	6th	7th	8th
Soybean	2.1	5.3	2.0	2.3	0.3	2.6	2.8	2.0
Soybean + Urea	0.2	4.8	3.8	0.8	1.3	2.2	4.5	6.1
Urea	3.5	7.5	2.3	6.7	2.7	4.3	4.8	5.5

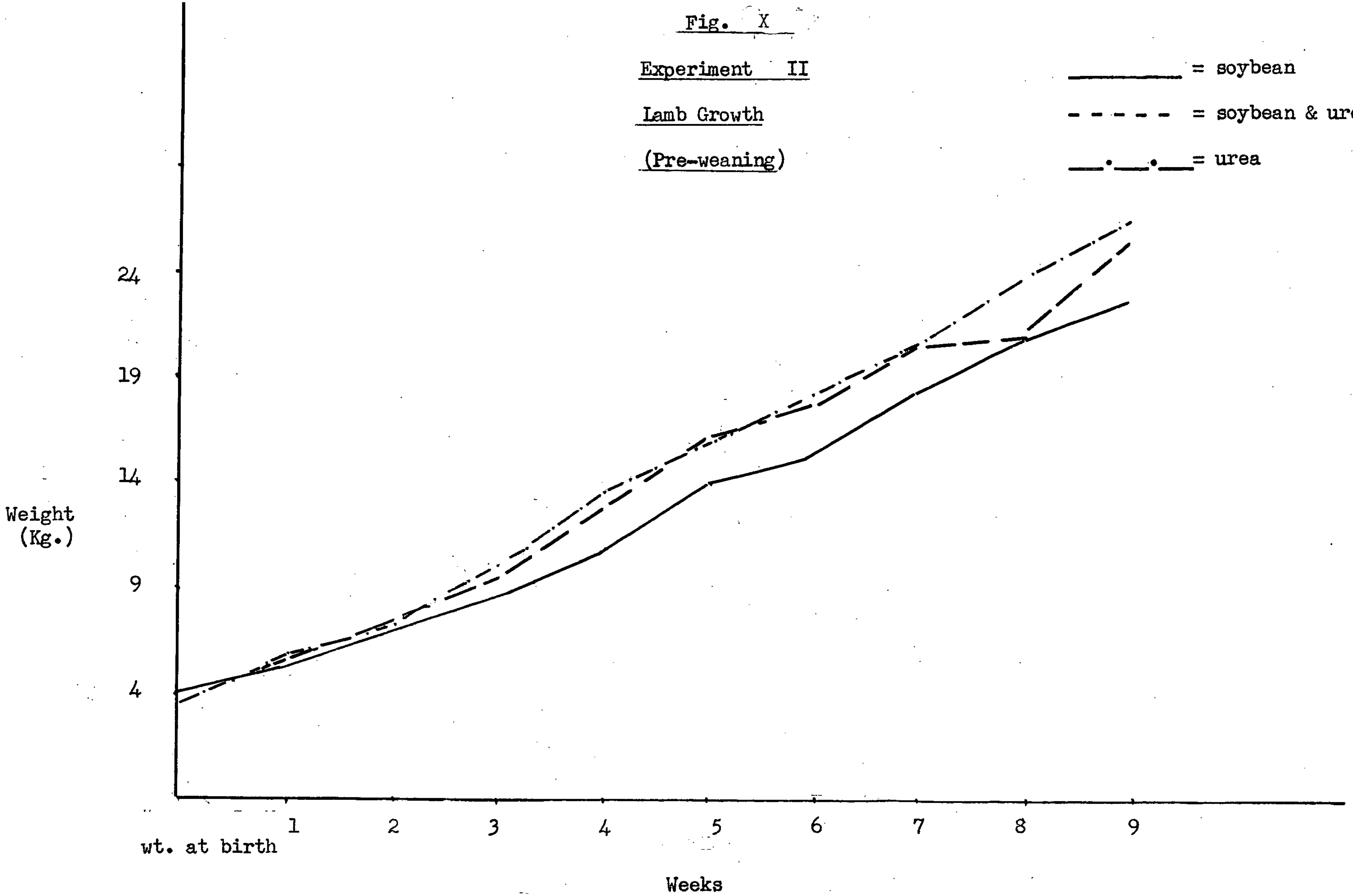
those fed pellets containing urea alone. Drori and Loosli (1961) also reported that urea nitrogen in blood of sheep rose after diets with urea and fell after diets with soybean meal but the differences were not significant. The ewes plasma urea nitrogen level in this experiment varied from 19.0 to 30.5, 23.6 to 48.1 and 31.5 to 48.6 mg/100 ml., for soybean, soybean + urea and urea containing pellets, respectively.

Lamb Growth

Average weekly weights of lambs during the pre-weaning period are given in Table XIX and graphically in Fig X. The growth curves of lambs nursing ewes fed on soybean + urea and urea containing pellets overlap each other during the pre-weaning period, indicating little difference in the growth of lambs suckling ewes fed on these type of pellets. Growth curves of the lambs nursing ewes fed soybean containing pellets showed slower growth by such lambs. Statistical analysis showed that there were no significant differences in the pre-weaning growth of lambs nursing ewes fed on pellets containing soybean + urea, and urea alone, and those lambs from ewes fed on pellets containing soybean made significantly slower gain ($P<0.05$) than those from the other two groups. The reason for this slower rate of gain is difficult to explain.

Average weekly weights of lambs during the post-weaning period are given in Table XX and Fig. XI. During the post-weaning period of 16 weeks, lambs fed on pellets containing soybean gained significantly greater ($P<0.05$) than those on pellets containing urea alone, but there were no significant differences in the weight gain of lambs fed on pellets containing soybean or soybean + urea and soybean + urea or urea alone. This indicated that pellets containing soybean proved better for the growth of lambs than those containing urea alone.

Fig. X


Experiment II
Lamb Growth
(Pre-weaning)
= soybean
= soybean & urea
= urea
24
19
14
9
4
Weight (Kg.)
1
2
3
4
5
6
7
8
9
wt. at birth
Weeks

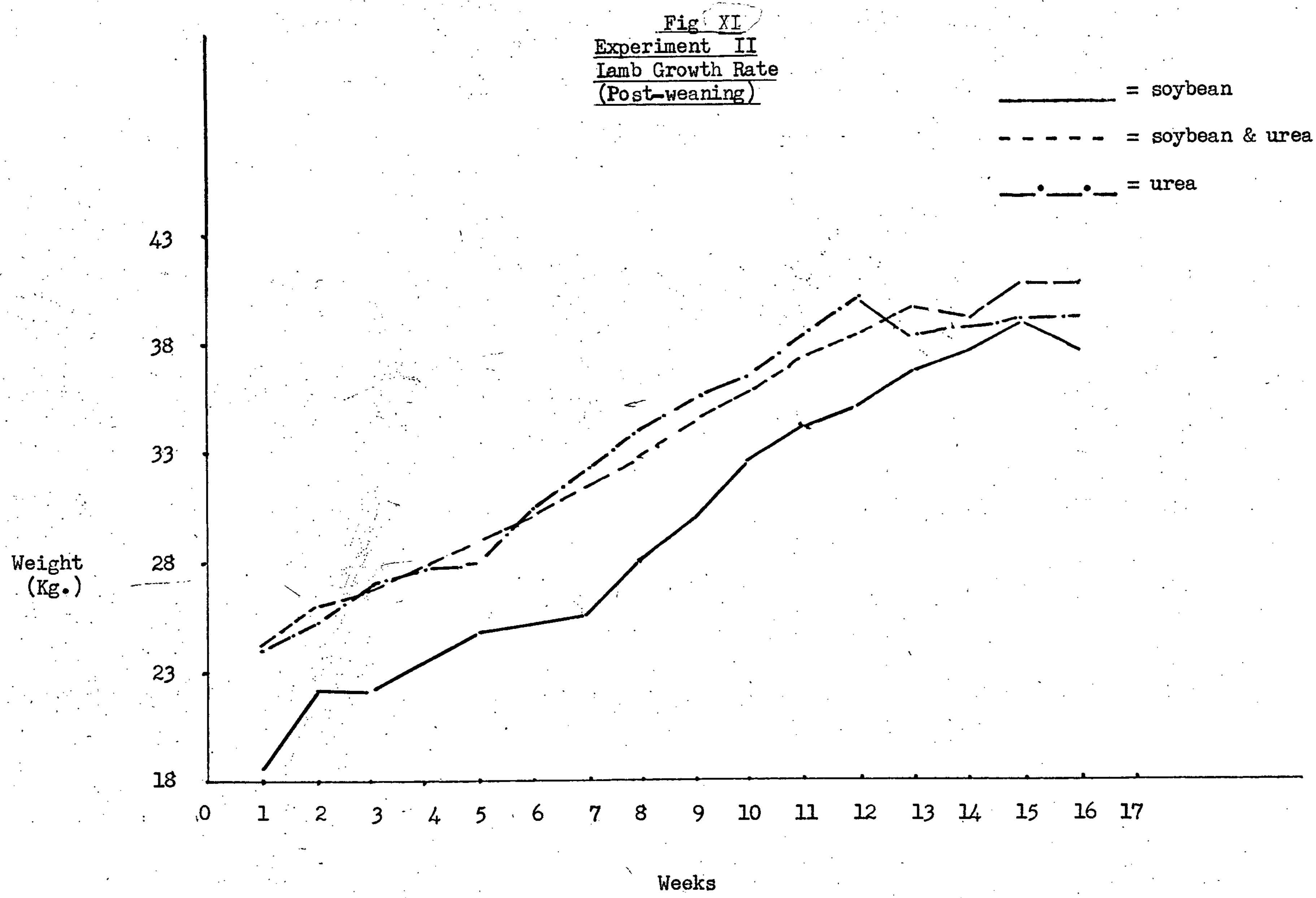


Fig XI
Experiment II
Lamb Growth Rate
(Post-weaning)
= soybean
= soybean & urea
= urea
43
38
33
28
23
18
Weight
(Kg.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Weeks

TABLE XVIII

EXPERIMENT II

EWES AVERAGE PLASMA UREA N (mg. Urea N/100 ml)

WEEKS OF LACTATION

RATIONS	1st	2nd	3rd	4th	5th	6th	7th	8th
Soybean	26.0	28.9	28.2	27.1	30.5	28.7	19.0	27.1
Soybean + Urea	23.7	29.2	27.7	25.3	45.0	27.8	27.0	33.6
Urea	30.7	33.4	35.8	33.9	47.2	32.8	33.9	39.1

TABLE XIX

EXPERIMENT II

LAMB GROWTH (PRE-WEANING)

AVERAGE WEEKLY WEIGHTS (kg)

WEEKS AFTER BIRTH

RATIONS	BIRTH WEIGHT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Soybean	4.7	5.7	7.2	8.6	10.5	13.5	14.7	17.3	19.8	21.5
Soybean + Urea	4.0	5.9	7.6	9.0	12.3	15.3	16.8	19.3	19.9	23.8
Urea	4.0	6.2	7.5	9.7	13.0	15.0	17.4	19.4	22.2	24.8

Feed conversion ratios were 4.0, 5.1 and 5.9 for soybean, soybean + urea and urea containing pellets, respectively.

Lambs plasma Urea N Level is indicated in Table XXI.

There were no significant differences between plasma urea nitrogen level of lambs fed on soybean or soybean + urea containing pellets. Lambs fed these two types of pellets had significantly higher ($P<0.05$) plasma urea nitrogen level than those fed pellets containing urea alone. Plasma urea nitrogen level for lambs varied from 25.2 to 26.3, 19.6 to 28.1 and 20.0 to 26.9 mg./100 ml., for soybean, soybean + urea and urea containing pellets, respectively. The reason that the picture of the blood urea level was different in the case of lambs compared to ewes could be due to variation in the protein intake of the growing lambs, which can cause greater variation in BUN levels. Preston et al (1965) reported that the variation in the protein intake of the growing lamb resulted in blood urea nitrogen ranging from 2.7 to 32.9 mg./100 ml.

Digestion Trial of Lambs.

Dry matter digestibility and nitrogen retained and digested is shown in Tables XXII and XXIII. Results of the digestion trial with lambs showed that although the protein digestion coefficient and dry matter digestibility was higher for pellets containing urea, the differences between pellets containing soybean, soybean + urea and urea alone, were not statistically significant. Pellets providing nitrogen from soybean resulted in greatest nitrogen retention. Nitrogen retained from pellets containing soybean + urea was greater than that from pellets containing urea alone. The differences were significant ($P<0.05$). Least nitrogen retention was obtained from pellets containing urea and was due to greater excretion of nitrogen in the urine. Drori and Loosli (1961) also reported that diets with soybean meal gave better nitrogen retention and had a higher biological value than diets with urea. They indicated that this was related to the excretion of urea in the urine.

TABLE XX

EXPERIMENT II

LAMB GROWTH RATE (POST-WEANING)

AVERAGE WEEKLY WEIGHT (kg)

WEEKS AFTER WEANING

RATIONS	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
Soybean	18.6	21.9	22.0	23.1	24.4	24.7	25.0	27.3	29.0	31.4	32.3	33.6	35.0	35.8	37.0	36.0
Soybean + Urea	23.9	25.3	26.1	27.0	28.1	29.1	30.3	31.5	32.9	34.1	35.5	36.5	37.7	37.3	38.6	38.7
Urea	23.7	24.8	26.1	27.0	27.1	29.3	31.0	32.7	34.0	34.9	36.5	38.0	36.4	36.8	37.1	37.3

TABLE XXI

EXPERIMENT II

LAMBS AVERAGE PLASMA UREA N (mg. Urea N/100 ml.)

WEEKS DURING POST-WEANING PERIOD

RATION	1	2	3	4
Soybean	26.3	32.2	32.5	27.2
Soybean + Urea	19.7	27.7	28.1	22.7
Urea	21.1	26.0	26.9	20.0

TABLE XXII

EXPERIMENT II

DIGESTION TRIAL OF LAMBS

DRY MATTER DIGESTIBILITY

NO. OF ANIMALS	TOTAL D.M. INTAKE g.	% D.M. DIGESTED	RATION
1	4529	58.6	Soybean
2	4329	60.9	
AVERAGE	4429	59.7	
1	4529	47.2	Soybean + Urea
2	4192	70.1	
AVERAGE	4360	58.6	
1	3264	60.0	Urea
2	4128	62.3	
AVERAGE	3698	61.4	

TABLE XXIII

EXPERIMENT II

DIGESTION TRIAL OF LAMBS

NITROGEN DIGESTED AND RETAINED

NO. OF ANIMALS	TOTAL N INTAKE g	DIGESTION COEFFICIENT PERCENT %	N RETAINED / N DIGESTED %	RATION
1	45.2	55.7	84.1	Soybean
2	43.2	62.2	80.7	
AVERAGE	44.2	58.9	82.4	
1	45.2	64.8	73.0	Soybean + Urea
2	41.8	66.9	73.2	
AVERAGE	43.5	65.8	73.1	
1	32.5	83.3	62.3	Urea
2	41.2	75.4	64.9	
AVERAGE	36.8	79.3	63.6	

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IX APPENDICES

TABLE A-1

EXPERIMENT I

COMPOSITION OF RATIONS FOR EWES DURING LACTATION

Feed	No. of Samples	Crude Proteins	% Ash
Grass hay	1	11.49	7.2
	2	11.64	7.3
	Average	11.56	7.2
Alfalfa hay	1	14.48	6.7
	2	-	6.8
	Average	14.48	6.7
Beet pulp	1	10.72	7.8
	2	10.51	
	3	9.95	
	4	9.86	
	Average	10.26	7.8
Dairy pellets	1	14.08	6.97
	2	-	6.90
	Average	14.08	6.93

TABLE 2

EXPERIMENT I

RATION COMPOSITION

(FOR WEANED LAMBS)

Ration (Protein level)	No. of Samples	Crude Protein (after analysis)
20%	1	18.9
	2	19.7
	3	19.8
16%	1	15.4
	2	16.0
	3	16.1
13%	1	13.0
	2	12.8
	3	13.2

TABLE : A-3

EXPERIMENT I

WEIGHT OF EWES (Kg) GROUP I

	WEIGHT OF EWES BEFORE PARTURITION			WEIGHT OF EWES DURING EARLY LACTATION (Weeks of lactation)							
No. of Ewes	7 Weeks Before Parturition Weight	Pre-Partum Weight	Post-Partum Weight	1st	2nd	3rd	4th	5th	6th	7th	8th
1	65	69	65	70	72	71	71	74	76	74	74
2	61	75	67	66	70	65	69	68	68	64	63
3	65	73	65	65	64	62	64	62	62	62	59
4	49	53	47	49	45	49	48	48	47	48	47
5	60	75	68	67	65	64	62	64	65	66	66
6	57	67	59	63	63	64	61	53	57	55	50
7	79	95	79	89	84	81	81	80	80	70	71
8	65	73	68	65	66	67	67	65	64	56	59
9	60	78	71	70	66	64	62	64	65	68	67
10	71	81	79	79	80	79	79	75	76	71	71
11	50	55	50	49	53	58	54	53	55	52	52
12	42	48	41	44	47	45	45	43	42	44	53
13	43	49	41	44	44	40	39	42	38	44	41
14	42	51	44	45	44	46	44	45	43	44	39
15	39	45	42	40	40	43	45	45	41	43	43

GROUP I

TABLE A-3

EXPERIMENT I

WEIGHT OF EWES (Kg) GROUP II

	WEIGHT OF EWES BEFORE PARTURITION			WEIGHT OF EWES DURING EARLY LACTATION (Weeks of lactation)								
No. of Ewes	7 Weeks Before Parturition Weight	Pre-Partum Weight	Post-Partum Weight	1st	2nd	3rd	4th	5th	6th	7th	8th	
1	65	76	68	65	62	62	59	59	60	61	57	
2	56	72	66	65	64	62	60	62	66	61	60	G
3	69	80	74	70	72	70	70	72	75	74	73	R O
4	46	55	50	48	48	41	45	50	45	43	44	U
5	42	60	48	52	50	49	47	44	43	42	43	P
6	69	83	76	75	74	72	71	67	65	64	62	II
7	65	80	75	72	72	61	74	72	71	70	60	
8	85	98	89	87	84	80	79	78	77	76	77	
9	65	78	73	71	70	69	69	66	67	67	69	
10	69	82	76	74	71	68	70	68	67	68	71	
11	43	49	92	41	40	40	40	39	39	38	39	
12	42	51	46	45	43	44	42	42	40	38	38	
13	61	80	62	68	64	64	62	60	60	54	55	

TABLE A-4

EXPERIMENT I

SINGLE LAMB GROWTH (PRE-WEANING)

WEEKLY WEIGHTS (Kg)

NO. OF ANIMALS	BIRTH WEIGHT	1st	2nd	3rd	4th	5th	6th	7th	
1	2.7	4.8	6.7	8.4	10.2	12.7	15.4	16.0	
2	5.0	7.7	10.5	14.0	16.4	18.1	19.5	21.3	
3	4.0	5.6	7.0	9.3	12.7	16.3	19.0	20.0	GROUP I
4	5.1	7.7	10.9	13.5	15.9	18.6	21.3	22.7	
5	4.2	6.5	9.0	11.7	14.5	16.8	20.4	23.1	
6	3.7	6.0	8.5	12.2	15.0	17.7	20.0	22.2	
7	3.2	4.3	5.9	8.0	10.2	12.2	14.5	16.8	
8	3.2	5.5	7.0	8.5	11.3	13.1	15.9	16.3	
9	3.0	5.1	7.2	9.3	12.4	14.0	16.0	20.0	
1	4.0	6.3	7.9	10.0	13.6	15.9	17.2	18.6	
2	4.7	6.0	7.4	11.3	13.2	14.5	15.9	16.8	
3	3.6	5.7	7.4	9.5	12.7	13.2	15.0	15.9	
4	4.1	6.9	8.7	11.5	13.6	15.0	15.4	16.8	GROUP II
5	4.2	4.7	6.5	9.0	11.8	13.6	15.4	15.4	
6	5.7	8.5	11.1	14.5	16.8	19.0	21.3	21.8	
7	4.0	5.3	7.0	10.0	11.3	13.1	15.4	16.8	
8	3.3	5.2	6.6	7.5	9.5	10.9	11.3	13.6	
9	4.5	6.7	7.8	7.8	10.0	10.9	13.6	14.5	

TABLE A-5

EXPERIMENT I

TWIN LAMB GROWTH (PRE-WEANING)

WEEKLY WEIGHTS (Kg.)

NO. OF ANIMALS	BIRTH WEIGHT	WEEKS AFTER BIRTH 1st	2nd	3rd	4th	5th	6th	7th	8th	
1	2.7	4.3	5.5	7.4	8.5	11.8	11.8	13.6	15.0	GROUP I
2	2.9	4.8	6.9	8.8	11.0	14.0	14.5	16.3	17.7	
3	4.0	4.7	5.9	7.5	8.5	11.3	12.7	14.0	14.0	
4	3.8	4.9	6.0	7.3	8.9	12.2	13.8	15.0	16.3	
1	3.2	4.4	6.4	7.2	8.4	9.0	10.6	11.8	11.8	GROUP II
2	2.5	3.5	5.1	6.2	7.2	8.0	9.3	10.9	11.8	
3	3.2	4.8	6.0	8.5	10.9	12.7	13.6	14.5	15.9	
4	3.7	5.5	7.2	8.0	10.0	10.9	11.8	12.8	13.6	

TABLE A-6

EXPERIMENT I

DRY MATTER DIGESTIBILITY OF WEANED LAMBS

RATION (PROTEIN LEVEL)	NO. OF ANIMALS	TOTAL D.M. INTAKE FOR 4 DAYS	TOTAL D.M. LOST FOR 4 DAYS	TOTAL D.M. DIGESTED FOR 4 DAYS	%. D. M. DIGESTED
		g	g	g	
20%	1	2175	601	1574	72.3
	2	2037	558	1479	72.6
	3	2023	630	1393	68.8
	4	1754	455	1299	74.0
	Average	1997	561	1436	71.9
16%	1	1888	713	1175	62.2
	2	1905	468	1437	75.4
	3	961	215	746	77.6
	4	1234	414	820	66.4
	Average	1497	452	1047	70.4
13%	1	2115	737	1378	65.1
	2	1969	471	1498	76.0
	3	2167	685	1482	68.3
	4	960	269	691	71.9
	Average	1802	540	1262	70.3

TABLE A-7

EXPERIMENT I

N. DIGESTED AND RETAINED BY WEANED LAMBS

RATION (PROTEIN LEVEL)	NO. OF ANIMALS	TOTAL N. INTAKE FOR 4 DAYS	TOTAL N. LOST IN FAECES FOR 4 DAYS	TOTAL N. DIGESTED FOR 4 DAYS	DIGESTION COEFFICIENT PERCENT	TOTAL N. LOST IN URINE FOR 4 DAYS	TOTAL N. LOST FOR 4 DAYS (faeces & urine)	TOTAL N. RETAINED FOR 4 DAYS	N.RETAINED / N. DIGESTED
		g	g	g	%	g	g	g	%
20%	1	83.4	9.2	74.2	88.7	6.2	15.4	68.0	91.6
	2	80.6	12.0	68.6	85.1	6.2	18.2	62.4	90.9
	3	80.3	10.9	69.4	86.4	7.5	18.4	61.9	89.1
	4	72.6	12.1	60.5	83.3	4.7	16.8	55.8	92.2
	Average	79.2	11.0	68.1	85.8	6.1	17.2	62.0	90.9
16%	1	66.4	7.5	58.9	88.7	6.9	14.4	52.0	88.2
	2	64.7	9.3	55.4	85.6	10.3	19.6	45.1	81.4
	3	30.5	6.2	23.8	79.3	3.2	9.4	20.6	86.5
	4	41.5	5.0	36.5	87.9	3.9	8.9	32.6	89.3
	Average	50.6	7.0	43.6	85.3	6.0	13.0	37.5	86.3
13%	1	60.1	10.4	49.7	82.6	7.1	17.5	42.6	85.7
	2	57.2	8.7	48.5	84.7	9.4	18.1	39.1	80.6
	3	61.2	11.9	49.3	80.5	7.1	19.0	42.2	85.5
	4	28.9	9.5	19.4	67.1	2.6	12.1	16.8	86.5
	Average	51.8	10.1	41.7	78.7	6.5	16.6	35.1	84.5

TABLE A-8

EXPERIMENT II

PERCENTAGE OF UREA IN RATIONS

RATION	NO. OF SAMPLES	% UREA IN RATION
Soybean	1	0.07
	2	0.07
	3	0.06
	Average	0.06
Soybean	1	0.90
&	2	1.00
Urea	3	0.80
	Average	0.90
Urea	1	1.90
	2	2.00
	3	2.00
	Average	1.96

TABLE A-9
EXPERIMENT II
LAMB GROWTH (Pre-weaning)
WEIGHTS IN KGS.

SOYBEAN

NO. OF LAMBS	BIRTH WEIGHT	Weeks after birth 1	2	3	4	5	6	7	8	9
1	3.8	6.5	8.4	10.9	14.0	15.9	16.8	19.0	21.3	24.5
2	4.3	6.3	8.4	10.4	15.4	16.3	18.1	22.7	26.8	27.2
3	3.8	5.6	7.9	9.7	11.3	15.9	17.2	19.0	21.3	23.1
4	4.1	5.9	7.5	10.9	13.1	15.0	18.1	20.9	20.9	20.9
5	5.0	7.7	7.9	8.8	10.0	13.1	14.1	18.1	20.9	23.6
6	4.3	5.4	6.1	6.8	8.4	11.3	11.3	16.8	16.8	18.3
7	2.5	4.3	5.4	6.5	7.5	10.4	11.8	13.1	15.9	17.5
8	3.6	5.2	7.5	7.2	8.8	14.0	14.0	14.5	17.2	20.0
9	3.2	5.4	5.4	9.0	10.6	15.0	15.4	17.2	21.8	23.6
10	4.6	6.3	7.2	7.7	8.8	11.8	12.7	15.0	17.5	18.1
11	3.7	4.3	5.2	7.2	8.6	11.8	12.7	14.0	16.8	18.1
Average	4.7	5.7	7.2	8.6	10.5	13.5	14.7	17.3	19.8	21.5

TABLE A-9
EXPERIMENT II
LAMB GROWTH (Pre-weaning)
WEIGHTS IN KGS.

SOYBEAN AND UREA

NO. OF LAMBS	BIRTH WEIGHT	Weeks after birth 1	2	3	4	5	6	7	8	9
1	3.1	4.5	5.9	7.2	9.0	13.1	13.1	15.9	17.2	20.0
2	3.1	4.5	5.4	6.8	8.6	12.2	13.1	15.0	16.8	18.6
3	4.8	6.8	8.8	10.9	15.0	17.2	19.0	22.2	23.6	25.0
4	3.8	4.5	6.8	7.9	9.0	14.0	15.4	17.2	18.6	22.2
5	3.6	5.0	6.3	7.2	8.8	13.1	14.5	16.3	17.5	19.0
6	4.7	7.9	9.3	12.2	15.9	18.1	19.0	20.9	22.2	24.5
7	4.8	6. 5	8.6	11.1	15.0	16.8	19.0	20.9	23.6	27.2
8	3.6	5.0	6.5	7.2	10.0	12.7	15.0	17.2	19.0	21.8
9	4.1	6.3	9.3	11.3	14.3	17.7	20.0	25.0	26.8	30.0
10	4.4	6.5	8.1	9.7	13.1	15.9	17.2	19.0	22.2	25.4
11	4.8	7.0	8.8	11.3	16.8	17.7	19.0	22.2	24.5	28.6
Average	4.0	5.9	7.6	9.0	12.3	15.3	16.8	19.3	19.9	23.8

TABLE A-9

EXPERIMENT II

LAMB GROWTH (Pre-weaning)
WEIGHTS IN KGS.

UREA

NO. OF LAMBS	BIRTH WEIGHT	Weeks after birth 1	2	3	4	5	6	7	8	9
1	3.0	4.5	5.6	6.8	9.5	11.3	14.0	15.9	18.1	20.0
2	3.5	5.4	6.3	7.9	11.3	12.7	15.0	16.3	18.6	20.9
3	4.0	6.1	7.2	8.8	12.2	13.6	16.3	17.5	20.4	22.7
4	3.4	5.6	6.3	8.1	12.2	13.1	15.9	17.5	20.0	22.7
5	4.5	8.1	9.0	12.2	15.0	17.7	20.9	22.2	25.4	29.5
6	3.6	5.0	6.1	8.1	12.2	13.1	15.0	16.8	18.6	20.4
7	4.3	5.4	6.5	8.4	12.2	14.0	16.3	17.5	20.4	23.6
8	4.7	6.8	8.1	11.3	14.0	19.0	20.4	23.1	26.8	29.0
9	4.5	7.2	9.0	11.8	15.4	16.8	19.0	21.7	23.6	27.2
10	4.9	7.7	9.0	12.2	15.4	17.7	19.0	21.3	26.3	28.1
11	4.0	6.5	8.4	11.5	14.0	16.3	19.0	23.1	26.8	23.6
Average	4.0	6.2	7.5	9.7	13.0	15.0	17.4	19.4	22.2	24.8

TABLE A-10
EXPERIMENT II

EWES PLASMA UREA N. (mg. urea N/100 ml.)

UREA

NO. OF ANIMALS	Weeks of Lactation							
	1st	2nd	3rd	4th	5th	6th	7th	8th
1	27.9	40.1	34.5	20.1	41.8	15.5	27.9	35.6
2	34.1	20.1	33.3	34.1	24.8	18.6	34.1	41.8
3	29.4	35.8	31.1	38.7	62.0	38.4	34.3	35.6
4	38.7	26.3	39.5	44.9	62.0	35.6	43.4	46.5
5	34.1	38.9	28.2	23.2	26.3	49.6	38.7	44.9
6	29.4	32.5	36.4	37.2	46.8	33.3	31.0	39.3
7	21.7	35.6	39.3	37.2	37.2	39.3	32.5	31.3
8	27.1	34.2	31.0	31.0	62.0	27.1	30.2	35.6
9	34.4	37.2	49.6	38.9	62.0	38.4	33.3	41.8
Average	30.7	33.4	35.8	33.9	47.2	32.8	33.9	39.1

TABLE A-10
EXPERIMENT II

EWES PLASMA UREA N. (mg. urea N/100 ml.)

SOYBEAN AND UREA

NO. OF ANIMALS	Weeks of Lactation 1st	2nd	3rd	4th	5th	6th	7th	8th
1	23,2	19.6	18.6	20.9	45.4	20.9	14.6	24.8
2	19.3	36.4	37.2	41.8	34.8	35.6	27.1	34.1
3	27.1	27.1	24.8	24.8	58.1	26.3	37.2	36.4
4	27.9	33.3	15.5	10.8	31.0	16.3	24.0	27.9
5	21.7	33.3	21.7	24.0	55.8	20.9	23.2	31.0
6	17.0	31.3	40.3	29.4	55.8	39.3	24.8	41.8
7	23.2	34.1	34.1	28.0	49.6	30.2	24.8	26.3
8	29.4	23.2	21.7	20.1	43.7	34.1	41.8	41.8
9	24.0	24.8	35.6	28.0	31.1	27.1	18.6	38.7
Average	23.7	29.2	27.7	25.3	45.0	27.8	27.0	33.6

TABLE A-10
EXPERIMENT II

EWES PLASMA UREA N. (mg. urea N/100 ml.)

SOYBEAN

NO. OF ANIMALS	Weeks of lactation							
	1st	2nd	3rd	4th	5th	6th	7th	8th
1	27.9	31.0	28.0	31.0	31.0	31.0	19.6	25.7
2	24.0	31.0	21.7	24.6	31.0	24.8	13.9	24.8
3	26.3	31.0	24.8	17.8	31.0	31.0	21.7	30.0
4	29.7	28.0	31.0	31.0	31.0	26.6	18.6	26.3
5	23.2	27.9	27.9	23.2	31.0	31.0	21.7	27.0
6	21.7	23.2	27.9	29.4	27.2	27.4	24.8	29.4
7	30.2	31.0	31.0	31.0	31.0	31.0	18.4	29.4
8	20.1	24.8	31.0	31.0	31.0	24.8	15.5	24.8
9	31.0	31.0	31.0	25.1	31.0	31.0	17.0	26.3
Average	26.0	28.9	28.2	27.1	30.5	28.7	19.0	27.1

TABLE A-11

EXPERIMENT II

EWES MILK UREA N (MG. UREA N/100 ML.)

NO. OF ANIMALS	Weeks of Lactation 1st	2nd	3rd	4th	5th	6th	7th	8th	RATION
1	5.1	10.0	1.0	5.0	1.1	5.0	3.0	2.5	
2	1.1	0.8	3.2	0.0	0.0	3.0	4.0	1.5	Soybean
3	0.1	5.3	2.0	2.1	0.0	0.0	1.6	2.2	
Average	2.1	5.3	2.0	2.3	0.3	2.6	2.8	2.0	
1	0.0	3.3	0.7	0.0	0.0	2.0	2.5	5.0	
2	0.5	6.5	9.5	2.5	2.5	4.7	4.5	7.0	Soybean &
3	0.1	4.6	1.3	0.0	1.5	0.0	6.7	6.5	Urea
Average	0.2	4.8	3.8	0.8	1.3	2.2	4.5	6.1	
1	3.1	11.6	4.0	9.0	4.7	4.1	4.2	4.0	
2	1.5	6.0	0.7	4.5	0.7	4.5	5.5	7.0	Urea
3	6.0	5.1	Dead	----	----	----	----	----	
Average	3.5	7.5	2.3	6.7	2.7	4.3	4.8	5.5	

TABLE A12

EXPERIMENT II

DRY MATTER DIGESTIBILITY OF WEANED LAMBS

RATION	NO. OF ANIMALS	TOTAL D.M. INTAKE FOR 5 DAYS	TOTAL D.M. OUTGO FOR 5 DAYS	TOTAL D.M. DIGESTED	%. D. M. DIGESTED
		G	G	G	
Soybean	1	4529	1875	2654	58.6
	2	4329	1692	2637	60.9
	Average	4429	1783	2645	59.7
Soybean & Urea	1	4529	2390	2139	47.2
	2	4192	1251	2941	70.1
	Average	4360	1820	2540	58.6
Urea	1	3264	1284	1980	60.6
	2	4128	1556	2572	62.3
	Average	3696	1420	2276	61.4

TABLE A-13
EXPERIMENT II
N. DIGESTED ANDRETAINED BY WEANED LAMBS

RATION	NO. OF ANIMALS	N. INTAKE FOR 5 DAYS g	TOTAL N. LOST IN FAECES FOR 5 DAYS g	TOTAL N. DIGESTED FOR 5 DAYS g	DIGESTION COEFFICIENT PERCENT %	TOTAL N. LOST IN URINE FOR 5 DAYS g	TOTAL N. LOST DURING 5 DAYS (faeces & urine)	TOTAL N. RETAINED FOR 5 DAYS g	N.RETAINED / N.DIGESTED %
Soybean	1	45.2	20.0	25.2	55.7	4.0	24.0	21.2	84.1
	2	43.2	16.3	26.9	62.2	5.0	21.3	21.9	80.7
	Average	44.2	18.1	26.0	58.9	4.5	22.6	21.5	82.4
Soybean & Urea	1	45.2	15.9	29.3	64.8	7.9	23.8	21.4	73.0
	2	41.8	13.8	28.0	66.9	7.5	21.3	20.5	73.2
	Average	43.5	14.8	28.6	65.8	7.7	22.5	20.9	73.1
Urea	1	32.5	5.4	27.1	83.3	10.2	15.6	16.9	62.3
	2	41.2	10.1	31.1	75.4	10.9	21.0	20.2	64.9
	Average	36.8	7.7	29.1	79.3	10.5	18.3	18.5	63.6

TABLE A-14

EXPERIMENT II

LAMBS PLASMA UREA N (MG. UREA N/100 ML.)

NO. OF ANIMALS	1	2	3	4	RATION
1	15.9	26.0	27.0	38.0	
2	41.0	41.5	41.0	24.0	Soybean
3	20.0	28.0	29.0	24.0	
4	23.0	25.9	25.9	24.0	
5	32.0	40.0	40.0	30.0	
Average	26.3	32.2	32.5	27.2	
1	18.0	22.1	24.0	26.0	
2	24.0	29.5	29.5	20.0	Soybean
3	20.1	28.1	29.0	21.5	&
4	20.0	29.5	28.5	24.0	Urea
5	16.5	29.5	29.5	22.0	
Average	19.7	27.7	28.1	22.7	
1	18.0	28.5	29.0	20.0	
2	23.5	25.0	28.0	20.0	
3	17.0	20.1	20.0	20.0	Urea
4	23.0	29.0	30.0	20.1	
5	24.2	27.7	27.9	20.1	
Average	21.1	26.6	26.9	20.0	