



The effects of M-analog supplementation when fed pre and postpartum to range cows and ewes  
by William Jon Langford

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE  
in Animal Science

Montana State University

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**Abstract:**

Two studies of range cows and sheep, each lasting one year, were conducted at the Red Bluff Research Ranch of the Montana Agricultural Experiment Station. Purpose of the two part- experiments was to check the effects of feeding M-analog to range cows and sheep, determine the proper time to feed (pre or postpartum) and find the most beneficial level of supplementation. Forty-two cows selected at random, divided into three treatments: control (no M-analog) , two (10 g M-analog postpartum) and three M-analog (5 and 10 g M-analog pre and postpartum) were weighed and supplemented for 101 days. Data collected included cow: weights, gains, milk production and composition, calf weights and gains. Milking data revealed no significant effects due to calf sex or cow treatment. Calf ADG and weaning weight showed a significant( $P<.05$ ) effect due to cow supplementation . Control cows reared 211.8 kgs. calves compared to 216.7 and 231.7 kgs. for treatment two and three cows, respectively. Ewes (57) randomly distributed over a similar feeding design revealed no effects due to M-analog supplementation on weights, gain, wool data, milk data, lamb(s) weight or gain. Type of birth and lamb rearing combination had significant ( $P<.05$ ) effects on ewe weights on trial and weight loss during parturition. In 1 978,. 80 cows were fed four levels of elemental sulfur and M-analog. Cow treatment effect on milk showed a significant decrease in amount of milk collected at the  $42\pm 1$  day milking. Cows fed 5 g of M-analog per day milked 2.45 kgs per one half the udder as compared to 1.96 kgs. for cows fed 15 g of M-analog. -Control and 10 g fed cows produced 2.19 and 2.28 kgs, respectively. Calves on control and 5 g M-analog cows, 225.5 and 225.7 kgs were significantly ( $P<.05$ ) heavier than 10 and 15 g treatment reared calves at 212.5 and 213.5 kgs by weaning (204 average days of age). Calf sex affected cow weights and losses ( $P<.05$ ) and calf weights and gains ( $P<.01$ ) for the 1977 and 1978 beef cow feeding trials. Ewes (127) which were divided into four random groups for a similar feeding trial showed treatment two ewes fed 1.25 g M-analog per day lost significantly ( $P<.05$ ) less weight postpartum and produced the most milk .21 Kg. at the  $35\pm 1$  day milking. However, ewes on 3.75 g M-analog weaned the heaviest and fastest gaining lambs on trial.

**THE EFFECTS OF M-ANALOG SUPPLEMENTATION  
WHEN FED PRE AND POSTPARTUM TO  
RANGE COWS AND EWES**

by

**William Jon Langford**

A thesis submitted in partial fulfillment  
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**MASTER OF SCIENCE**

in

**Animal Science**

**Montana State University  
Bozeman, Montana**

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APPROVAL

of a thesis submitted by

William Jon Langford

This thesis has been read by each member of the thesis committee and found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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## TABLE OF CONTENTS

	Page
Approval. . . . .	ii
Statement of Permission to Copy . . . . .	iii
Vita. . . . .	iv
Acknowledgements. . . . .	v
Table of Contents . . . . .	vi
List of Tables. . . . .	ix
List of Figures . . . . .	xi
Abstract. . . . .	xii
Introduction. . . . .	1
Literature Review . . . . .	3
Limiting Amino Acid. . . . .	4
M-analog vs. Methionine. . . . .	6
Rumen Bypass . . . . .	6
Postruminal Effect of M-analog and Methionine. . . . .	8
M-analog's Effect on the Rumen . . . . .	10
Rumen Amino Acid and M-analog Absorption . . . . .	10
M-analog and Rumen Protein Synthesis . . . . .	11
Rumen Microflora and M-analog. . . . .	12
Protozoa . . . . .	12
Bacteria . . . . .	13
Rumen Lipids . . . . .	14
Overall Digestion Effects. . . . .	16
M-analog and Sulfur Supplementation. . . . .	17

M-analog and Production. . . . .	19
Dairy Cattle . . . . .	20
Beef Cattle. . . . .	21
Sheep. . . . .	22
Materials and Methods . . . . .	23
Experiment I, Cows 1977. . . . .	23
Milking Procedure. . . . .	25
Experiment II, Ewes 1977. . . . .	26
Milking Procedure . . . . .	29
Experiment III, Cows 1978. . . . .	30
Milking Procedure. . . . .	32
Experiment IV, Ewes 1978 . . . . .	33
Milking Procedure . . . . .	35
Statistical Analysis. . . . .	36
Results and Discussion. . . . .	37
Experiment I . . . . .	37
Cows 1977 . . . . .	37
Calves 1977 . . . . .	38
Milk Data, Cows 1977. . . . .	40
Discussion. . . . .	42
Experiment II. . . . .	42
Ewes 1977 . . . . .	42
Lambs 1977. . . . .	44
Milk Data, Ewes 1977. . . . .	46
Discussion. . . . .	47
Experiment III . . . . .	49

Cows 1978 . . . . .	49
Calves 1978 . . . . .	49
Milk Data, Cows 1978. . . . .	52
Discussion. . . . .	54
Experiment IV. . . . .	55
Ewes 1978 . . . . .	55
Lambs 1978. . . . .	57
Milk Data, Ewes 1978. . . . .	58
Discussion. . . . .	60
Summary. . . . .	62
Literature Cited. . . . .	63

## LIST OF TABLES

Table		Page
1	SUPPLEMENTS FOR M-ANALOG STUDY - 1977. . . . .	24
2	DESIGN OF FEEDING TRIAL FOR COWS - 1977. . . . .	24
3	DESIGN OF FEEDING TRIAL FOR EWES - 1977.. . . .	27
4	SHEEP INDUSTRY DEVELOPMENT (SID) ADJUSTMENT FACTORS. .	29
5	MILKING PERIODS OF EWES - 1977.. . . .	30
6	SUPPLEMENTS FOR M-ANALOG STUDY - 1978. . . . .	31
7	DESIGN OF FEEDING TRIAL FOR COWS - 1978. . . . .	31
8	DESIGN OF FEEDING TRIAL FOR EWES - 1978.. . . .	34
9	LEAST SQUARE MEANS IN KGS. OF PREPARTUM (MARCH 1, 1977) AND POSTPARTUM (MAY 12, 1977) COWS WEIGHTS - 1977.	37
10	LEAST SQUARE MEANS FOR THE EFFECT OF TREATMENT ON THE AVERAGE DAILY LOSS (KGS/DAY) OF COWS - 1977. . . .	38
11	LEAST SQUARE MEANS OF CALF WEIGHTS IN KGS FOR BITRH, MAY 12 AND OCTOBER 13, 1977. . . . .	38
12	LEAST SQUARE MEANS FOR AVERAGE DAILY GAINS KGS/DAY OF CALVES BETWEEN BIRTH AND MAY 12 (GAIN 1), MAY 12 AND OCTOBER 13 (GAIN 2) AND BIRTH - OCTOBER 13, 1977 (TOTAL GAIN). . . . .	39
13	LEAST SQUARE MEANS OF MILK PRODUCTION AND COMPOSITION FOR COWS - 1977. . . . .	41
14	MEANS OF EWE WEIGHTS (KGS) AND WEIGHT LOSS KGS/DAY FOR THE FEEDING PERIOD WITH RESPECT TO TREATMENT, TYPE OF BIRTH AND LAMB REARING COMBINATION MARCH 24 AND JUNE 1, 1977. . . . .	43
15	MEANS FOR WOOL WEIGHT, GRADE (SCORES) AND LENGTH (SCORES) BY TREATMENT OF EWES - 1977. . . . .	44
16	MEANS FOR TREATMENT AND TREATMENT BY BREED OF LAMB WEIGHTS (KGS) AT 32 DAYS (JUNE 1 1977), 59 DAYS (JUNE 28 1977) AND 116 DAYS (AUGUST 24, 1977). . .	45

17	MEANS (KGS) FOR TREATMENT ON AVERAGE GAINS; BIRTH - JUNE 1 (GAIN 1), JUNE 1 - JUNE 28 (GAIN 2), JUNE 28 TO AUGUST 24 (GAIN 3) AND BIRTH TO AUGUST 24 (TOTAL GAIN) OF LAMBS - 1977. . . . .	45
18	MEANS OF MILK PRODUCTION AND COMPOSITION COLLECTED DURING EWE MILKING AS AFFECTED BY TREATMENT, LAMB REARING COMBINATION AND TYPE OF BIRTH - 1977. . . . .	47
19	MEANS FOR CALF WEIGHTS (KGS) AT BIRTH, 28 DAY, 60 DAY, 80 DAY, 125 DAY, 164 DAY AND 204 DAY MEAN AGE BY TREATMENT - 1978. . . . .	50
20	MEANS FOR AVERAGE DAILY GAINS (KGS) FOR GAIN PERIODS FROM BIRTH TO 28 DAYS, 60 DAYS, 80 DAYS, 125 DAYS, 164 DAYS AND 204 AVERAGE DAYS OF AGE OF CALVES - 1978. . . . .	51
21	MEANS FOR MILK PRODUCTION AND COMPOSITION AT 14±1 DAYS 28±1 DAYS AND 42±1 DAYS AFTER PARTURITION OF COWS - 1978. . . . .	53
22	MEANS OF EWE ON TRIAL (MARCH 14), OFF TRIAL (MAY 26) WEIGHTS AND AVERAGE DAILY WEIGHT LOSS (KGS) - 1978. . . . .	56
23	MEANS OF EWE WOOL PRODUCTION (KGS) GRADE (SCORES) AND LENGTH (SCORES) - 1978. . . . .	56
24	MEANS (KGS) OF LAMB WEIGHTS AS AFFECTED BY TREATMENT AND EWE BREED AT BIRTH, MAY 26, JUNE 23 AND AUGUST 29, 1978. . . . .	57
25	MEANS OF LAMB GAINS (KGS) FOR GAIN 1 (BIRTH - MAY 26), GAIN 2 (MAY 26 - JUNE 23), GAIN 3 (JUNE 23 - AUGUST 29) AND TOTAL GAIN (BIRTH - AUGUST 29) - 1978. . . . .	58
26	MEANS OF EWE MILK PRODUCTION AND COMPOSITION FOR TREATMENT, TYPE OF BIRTH AND LAMB REARING COMBINATIONS TAKEN 21±1 AND 35±1 DAYS POSTPARTUM - 1978. . . . .	59

LIST OF FIGURES

Figure		Page
1	Chemical Structures of Methionine and M-analog. . . . .	1

## ABSTRACT

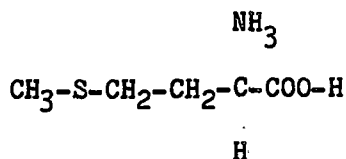
Two studies of range cows and sheep, each lasting one year, were conducted at the Red Bluff Research Ranch of the Montana Agricultural Experiment Station. Purpose of the two part experiments was to check the effects of feeding M-analog to range cows and sheep, determine the proper time to feed (pre or postpartum) and find the most beneficial level of supplementation. Forty-two cows selected at random, divided into three treatments: control (no M-analog), two (10 g M-analog postpartum) and three M-analog (5 and 10 g M-analog pre and postpartum) were weighed and supplemented for 101 days. Data collected included cow: weights, gains, milk production and composition, calf weights and gains. Milking data revealed no significant effects due to calf sex or cow treatment. Calf ADG and weaning weight showed a significant ( $P < .05$ ) effect due to cow supplementation. Control cows reared 211.8 kgs. calves compared to 216.7 and 231.7 kgs. for treatment two and three cows, respectively. Ewes (57) randomly distributed over a similar feeding design revealed no effects due to M-analog supplementation on weights, gain, wool data, milk data, lamb(s) weight or gain. Type of birth and lamb rearing combination had significant ( $P < .05$ ) effects on ewe weights on trial and weight loss during parturition. In 1978, 80 cows were fed four levels of elemental sulfur and M-analog. Cow treatment effect on milk showed a significant decrease in amount of milk collected at the  $42 \pm 1$  day milking. Cows fed 5 g of M-analog per day milked 2.45 kgs per one half the udder as compared to 1.96 kgs. for cows fed 15 g of M-analog. Control and 10 g fed cows produced 2.19 and 2.28 kgs, respectively. Calves on control and 5 g M-analog cows, 225.5 and 225.7 kgs were significantly ( $P < .05$ ) heavier than 10 and 15 g treatment reared calves at 212.5 and 213.5 kgs by weaning (204 average days of age). Calf sex affected cow weights and losses ( $P < .05$ ) and calf weights and gains ( $P < .01$ ) for the 1977 and 1978 beef cow feeding trials. Ewes (127) which were divided into four random groups for a similar feeding trial showed treatment two ewes fed 1.25 g M-analog per day lost significantly ( $P < .05$ ) less weight postpartum and produced the most milk .21 Kg. at the  $35 \pm 1$  day milking. However, ewes on 3.75 g M-analog weaned the heaviest and fastest gaining lambs on trial.

## INTRODUCTION

Ranchers raising cattle or sheep strive to raise the heaviest calves or lambs possible under the existing conditions each year. Weight gains and weaning weights of both calves and lambs depend in part on the producing ability of the dam. Each dam must have proper nutrition to maintain maximum productivity. Complete rations meeting the nutritional requirements for production and maintenance of the dam are a necessity. A feed additive affecting the producing ability of the dam by increasing milk production levels, constituent levels of milk, or wool production could result in economic gain through increased weaning weights of the young or dam production.

Methionine Hydroxy Analog, M-analog, or hydroxymethionine have been shown to increase the producing ability of the dam (Varner 1974). M-analog is considered a natural feed substance formed as a salt of calcium. It is similar to the amino acid methionine, yet the structures of methionine and M-analog differ (Figure 1.)

Methionine:



M-analog:

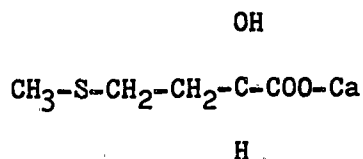


Figure 1. Chemical Structures of Methionine and M-analog.

M-analog research has been done primarily with dairy cows, because environments in dairy operations allow for closer and more frequent inspection of each cow's production. An alteration in milk quantity or quality because of nutritional or other factors can be determined, and changed when necessary.

Range cow and sheep operations are as varied as the individuals who manage them. After animals are turned out in the spring, it is difficult to assess how well each animal unit is doing until weaning. The rancher therefore attempts to give the cow and calf or ewe and lamb(s) the most advantageous start toward higher gains and weaning weights. How well a cow or ewe produces between parturition and weaning will have a direct bearing on the weights of the young at weaning. Production increased through supplemental feeding could therefore be useful in a ranch management plan.

In an attempt to alter postpartum productivity of range cows or sheep, supplemental feeding of M-analog was used in this study. Experiments assessing M-analog's effects were undertaken to determine the following:

1. The effects of feeding M-analog to range cows and ewes.
2. The best time to feed M-analog (pre or postpartum).
3. The most beneficial level of M-analog supplementation.

The following manuscript is a discussion of the nutritional aspects and results of M-analog supplementation.

## LITERATURE REVIEW

McCarthy et al. (1968a) discovered alterations of lipoprotein fatty acid composition in the metabolically disturbed situation of ketosis and low fat test. McCarthy et al. (1968b) considered that this condition resulted from a deficiency of methionine.

The amino acid methionine has been shown to be effective in alleviation symptoms of bovine ketosis through intravenous administration (McCarthy et al. 1968b). It was believed that giving methionine would be unsuccessful due to ruminal microflora degradation. M-analog (Methionine Hydroxy Analog) was selected as a possible substitute for methionine in oral feeding to prevent bovine ketosis. Treatment of 42 dairy cows of four different breeds gave inconclusive results as none of the control treatment cows exhibited symptoms of the disease according to McCarthy et al. (1968b).

Milk production of the above mentioned cows during the eight weeks the cows consumed M-analog was monitored by Griel et al. (1968). Results of the milk monitoring showed 15 cows fed no M-analog produced on the average 87.9 kilograms (kgs) of 4% fat corrected milk (FCM) per week. Feeding M-analog at 40 grams and 80 grams per day to 14 and 13 cows respectively gave levels of 94.5 and 89.4 kgs. of fat corrected milk. Several explanations have been proposed for the increases in milk production.

1. Rumen microflora, while producing protein were unable to produce sufficient methionine; in other words, methionine may be a limiting amino acid. M-analog thus reduced a

possible methionine amino acid deficiency.

2. M-analog altered the rumen environment of the postruminal digestibilities, increasing the amount and/or availability of constituents required for milk production.
3. M-analog was a more readily available source of sulfur required by the cows.

#### Limiting Amino Acid

Methionine, an essential amino acid, serves as an important building block of proteins. Ruminant animals degrade amino acids into their various components to be resynthesized into protein by rumen microbes.

The quality of the microbial synthesized protein has been investigated. Ellis et al. (1959) used urea, gelatin and casein ration to check rumen microbes' ability to synthesize protein. Their findings indicated that the capacity of rumen microorganisms to synthesize tryptophan, methionine, or lysine was insufficient. Abdo et al. (1964), in processing preparations of mixed ruminal bacteria and protozoa to be used as a monogastric diet, discovered high levels of tryptophan and lysine and limiting or low amounts of the sulfur containing amino acids.

The methionine plasma levels of cows fed a purified diet with urea as the only significant nitrogen source were only 67% of the value for normally fed cows (Virtanen 1966). Because normal feeding showed a low free methionine plasma level, the 33% decrease from normal to the purified nitrogen diet may be quite significant.

McDonald (1968) suggested that microbial and leaf protein would have a biological value of 75 on an amino acid basis when compared with whole egg protein at nearly 100, with amino acids containing sulfur again being the first limiting factors. Contrary to the above references, Schwab et al. (1975) deemed lysine followed by methionine as limiting in trials conducted on lactating dairy cows.

Abomasal infusion has been used to establish which amino acids, if any, are limiting in the ruminant animal. Nimrich et al. (1970), using urea as the sole source of nitrogen for growing lambs, tested by abomasal infusion the use of supplemental amino acids. Results of the qualitative assessment showed methionine to be the first limiting amino acid for the lambs on this trial. Similar results were achieved by Schelling et al. (1973) on growing sheep fed a high quality 11.6% protein diet. Comparison of methionine infusion and a combination of urea and sulfate at levels equal to the nitrogen and sulfur levels supplied by methionine led Schelling et al. (1973) to suggest methionine as a limiting amino acid.

Lysine was shown to result in 16% of the total response to amino acid supplementation with infusion (Schwab et al. 1976). Methionine infusion had no effect on secretion of milk, milk protein or fat concentration in the same experiment. A combination of lysine and methionine, however, accounted for 43% of the total response of amino acid supplementation. Thus Schwab et al. (1976) assumed lysine and methionine to be co-limiting.

Clark et al. (1978), by tracing amino acids uptake on cell cultures of mammary glands, discovered that threonine or methionine

improved Beta lactoglobulin synthesis and that cystine increased Beta casein. Beta lactoglobulin and beta casein are both milk proteins formed by the mammary gland cells. Clark et al. (1978) considered the limiting amino acids order for the synthesis of milk protein by mammary gland cells to be: cystine, threonine and then methionine.

Using a mixture of 13 amino acids, Reis and Tunks (1978) discovered that the omission of methionine from the 13 amino acid standard mixture inhibited wool growth rate. Both the fiber diameter and length of wool grown per day were reduced below those of the controls. These results agreed with experiments by Wright (1969). Both experiments show that the sulfur containing amino acids are specifically limiting for maximal wool growth.

#### M-analog vs. Methionine

References thus far have indicated methionine to be at least one of the three main limiting amino acids. M-analog replacement of methionine depends on the following:

1. Whether M-analog bypasses rumen degradation and replaces methionine post-ruminally.
2. Whether M-analog does have an affect in the rumen if rumen bypass cannot be accomplished.

#### Rumen Bypass

One of the first explanation of M-analog's effect was its structure. Enzymes of microorganisms responsible for methionine breakdown may not recognize and act upon the analog of methionine. This would allow M-analog to pass into the abomasum where either

absorption of M-analog or conversion to methionine could take place. Benefits from M-analog supplementation thus might be possible if M-analog and methionine were interchangeable in the free amino acid plasma pool.

Gosset et al. (1962) assumed M-analog did not function or perform well as DL-methionine. This assumption was based on findings of no benefit to gains or feed efficiencies at 5 grams of M-analog per head per day of steers fed high urea content fattening rations.

Wright (1969), using sheep, reported significant increases in the wool growth rates of lambs fed either 8% or 12% protein rations with 0.3% methionine or M-analog making up part of the total diet. Unlike Gosset et al. (1962), Wright (1969) believed this improved growth indicated that both methionine and M-analog may have been effective in the rumen or postruminally.

Reis (1970), using orally administered amounts of M-analog to wethers at 0, 2, 4, and 8 grams per day, indicated that at the dosages given the M-analog did not influence wool growth, as seen by the corresponding wool growth rates of 108%, 113%, 107% and 115%. Because the wool growth rate percentages did not follow the effects of abomasal infusion of M-analog, Reis (1970) felt degradation of M-analog had occurred in the rumen.

Belasco (1970) conducted research on the stability of M-analog in rumen fluid. M-analog proved to be more resistant than L-methionine to rumen degradation. Thus, M-analog would be in a higher concentration postruminally than the same amount of methionine if both were fed orally.

Langland (1972) fed 2.69 grams of M-analog per day to penned sheep, increasing wool production 15%. Abomasal infusion of the same amount of M-analog increased growth of wool 32%. Experiments with grazing sheep being fed 3.9 grams M-analog per head per day showed a 35% increase in wool production. These experiments may indicate that rumen bypass of M-analog is not 100%. The difference between wool growth in oral and abomasal feeding of the same amount of M-analog produced a 17% difference in wool growth.

Papas et al. (1974) orally administered to lambs 3.08 grams of M-analog and 2.7 grams of DL-methionine (equivalent amounts of both active ingredients) in an attempt to increase the plasma methionine:valine ratio. Neither treatment was effective in increasing the methionine:valine plasma level above that of the controls, indicating that neither DL-methionine or M-analog may undergo rumen bypass.

#### Postruminal Effect of M-analog and Methionine

If some portion of the orally fed M-analog was unaffected in the rumen, what effect could it have postruminally if absorbed through the gastrointestinal system?

An in vitro experiment by Belasco (1972) revealed that microsomal fraction enzyme systems of calf kidney and liver were capable of converting M-analog to methionine, indicating that once absorbed, M-analog could take the place or be used in place of methionine.

However, Papas et al. (1974) felt it unlikely that M-analog would support the postruminal requirements for methionine. The plasma

methionine:valine ratios indicated that less than one-third of the abomasally infused M-analog was converted to methionine. The plasma methionine:valine ratio was significantly less for control lambs fed either M-analog or DL-methionine. Lambs fed M-analog still had ratios significantly less than lambs infused with DL-methionine.

In preruminant lambs, Walker and Kick (1975) concluded that the D and L isomers of methionine had similar biological activity when used to supplement isolated soya protein and that M-analog was effective as DL-methionine. However, Miller and Rodriguez (1975) showed reduced gains, intake and serum amino acids, possible due to an amino acid imbalance when M-analog was given to 36-three day old Holstein calves.

In nonruminants, M-analog was found to have a 70.1% activity on a feed efficiency basis for broilers (Harms et al. 1976). Chow and Walser (1975) using rats, felt that the ability of M-analog to replace methionine was complete.

The only sure way devised to study the effect of methionine of M-analog without rumen degradation is through infusing the desired amount of either into the abomasum of the ruminant animal. Sheep are used in this capacity because of handling and sampling ease of wool growth.

Methionine infusion at 2.46 grams per day increased wool growth from 35 to 150% over a 6 week period for Reis and Schinckel (1963). Wool growth was again increased by 123 to 181% in experiments conducted by Reis and Schinckel (1964) using the infusion of 60 grams of casein per day for 9 weeks. An increase of 16 to 37% in wool growth over the casein diet was obtained by the addition of sulfur

containing amino acids to the casein upon infusion. A comparison of DL-methionine at 2.46 grams per day increased wool growth by an average of 80%. A 78% increase was observed when 3 grams of M- analog were given per abomasum with a 37% recovery of supplemented sulfur found in the wool. Similarly, Reis (1970) doubled the wool growth rate using 3 grams of M-analog through abomasal infusion.

The references listed above seem to indicate that introduction of M-analog into the postruminal digestion may be of benefit, at least in wool growth. Methionine seems more consistent in causing increased wool growth, yet increases caused by M-analog and methionine are very similar when both were administered through abomasal infusion.

#### M-analog's Effect on the Rumen

Consideration of M-analog's action has also centered around the possibility that M-analog does not undergo rumen degradation and is bypassed to the abomasum. Evidence contrary to rumen bypass has also been cited. If this evidence is true, the question of M-analog's effect on the rumen environment requires exploration to find the full extent of M-analog supplementation. A large fermenting vat, the rumen acts not only as a manufacturing site for protein, lipid and/or volatile fatty acids, synthesized by bacteria and protozoa, but also as a site of absorption of these products.

#### Rumen Amino Acids and M-analog Absorption

Cook et al. (1965) determined that absorption of amino acids did occur through the rumen wall. Inserting polyethelene catheters into the right ruminal veins of 3 ruminant animals allowed measurement of

amino acid levels of blood from the rumen before, during and after amino acid supplementation. Analysis of the blood samples showed that no methionine was absorbed, but an altered form methionine sulfoxide was found. Thus, methionine activity is possible through rumen absorption, if methionine sulfoxide has the ability to take methionine's place in the blood amino acid plasma pool.

Unlike Cook et al. (1965), Whiting et al. (1972) showed M-analog supplementation at .22% of the basal diet of cubed alfalfa with a pelleted concentrate increased the rumen content of threonine and not that of methionine.

M-analog fed at .3, .8 and 1.2% of a 10% hay and 90% concentrate diet by DeVuyst et al. (1976) resulted in each level giving a considerable rise in the total methionine concentration of the rumen. The amounts of amino acids in the blood stream are very small. Any increase in methionine activity through supplement of M-analog in which there are significantly increased amounts of methionine sulfoxide in the rumen outflow blood may be beneficial to the ruminant animal.

#### M-analog and Rumen Protein Synthesis

It is well documented that bacterial and protozoal protein synthesis occurs in the rumen. Kahlon et al. (1975a) tested 6 different chemical sources of sulfur for their effect on in vitro rumen protein synthesis. The six sources of sulfur were L-methionine, calcium sulfate, sodium sulfate, elemental sulfur, M-analog and a control with no additional sulfur added. The rumen inoculum was

tested at various incubation times of 0, 6, 12 and 18 hours. Protein synthesis observed with M-analog was significantly lower than that with any other source at 12 hours of incubation. The effectiveness of M-analog over the whole 18 hours trial ranked no higher than third compared to all sulfur sources. Only the control averaged lower in stimulation of protein synthesis. Kahlon et al. (1975a) continued by checking the in vitro protein synthesis availability of these same sulfur sources plus DL-methionine and ammonium sulfate. L-methionine exhibited the highest sulfur source availability at 100%. M-analog's availability was only 28.8%, the lowest of all the sulfur sources tested.

#### Rumen Microflora and M-analog

Aside from protein synthesis, the rumen has many other functions. Rumen microorganisms, bacteria and protozoa are used by the ruminant animal, and alterations in amounts or quality may have an effect on the animal's production. M-analog's effect, if any, may be beneficial to rumen microflora.

#### Protozoa

Rumen protozoa, bacteria and brewer yeast, when fed to rats as a protein source, revealed biological values for protein of 80, 81 and 72%. Corresponding values for the digestibilities were 81, 74 and 84%, respectively (McNaught et al. 1954). A comparison of the biological value with the digestibility suggests that the conversion of bacterial or dietary protein into protozoal protein in the rumen would be advantageous to the host animal. Further, studies on protozoa by

Yoder et al. (1966) demonstrated that the addition of washed rumen protozoa increased the cellulose digestion by in vitro bacterial cultures. The cellulose breakdown was in the presence of added volatile fatty acids, vitamin B<sub>12</sub>, biotin and hydrolyzed casein.

Patton et al. (1970) discovered rumen protozoa concentrations significantly higher in sheep fed a grain plus M-analog diet than in sheep receiving only grain. However, for sheep fed grain plus M-analog, protozoa levels were significantly lower than those of sheep fed hay and grain. Samples showed protozoal concentrations of  $6.0 \times 10^6$  protozoa as compared to  $5.0 \times 10^6$  protozoa per milliliter of rumen fluid in cows receiving 80 grams or 0 grams of M-analog.

Levels of M-analog were used by DeVeryst et al. (1976) at .3, .8 and 1.2% of the diet on rumen fistulated sheep. The .8% level showed marked increase in the total number of ciliate protozoa found in the rumen. No further increase was obtained with the 1.2% M-analog diet. From the evidence cited above, there is a possible advantage to be gained through alteration of the bacteria to protozoa ratio.

### Bacteria

Cellulose digestion depends on the production of enzymes by bacteria which are able to breakdown Beta 1-4 glucose linkages, the primary constituent of cellulose. Altered cellulose digestibility could mean activation or inhibition of bacteria because of M-analog.

The addition of 4 grams of M-analog per 100 milliliters of rumen bacteria and fluid increased cellulose digestion by 6 and 5% at 24 and 48 hours of incubation in in vitro studies by Gil and Shirley (1972).

Experiments found M-analog to be more effective at 24 hours of incubation, but no difference between sodium sulfate and M-analog was observed at 48 hours of incubation on cellulose digestion. A highly significant difference was also found in the bacterial nitrogen levels. Values were .26 milligrams nitrogen per milliliter of rumen fluid with M-analog and .16 milligrams without M-analog.

Bull and Vandersall (1973) used sodium sulfate, calcium sulfate, DL-methionine and M-analog as sulfur sources. Bacterial cellulose digestibility was comparable among all forms of sulfur, with no significant alterations from M-analog in in vitro trials. However, Gil et al. (1973) again demonstrated that both methionine and M-analog accelerated bacterial nitrogen incorporation when cellulose or glucose was used along with urea as a nitrogen source.

#### Rumen Lipids

Alterations of the rumen environment with respect to rumen lipids or volatile fatty acids can also play major roles in the production picture of the ruminant animal.

A marked stimulation in lipid synthesis, approximately 63.6% greater than control rations, regardless of the total quantity of lipid present in the rumen fluid sample, was seen with in vitro addition of methionine (Patton et al. 1968). Tracer studies using acetate, glucose and long chain fatty acids revealed that methionine produced substantial transfer of carbon from these sources to complex microbial lipid associated with rumen protozoa (Patton et al. 1970). Patton et al. (1970) used rations with 0, 40 and 80 grams of M-analog

over an eight week trial period. Rumen lipid levels were tested at weeks 1, 3 and 8. Results were measured in milligrams per 75 milliliters of rumen fluid. All three diets resulted in decreases, yet decreases seen in M-analog diets were much larger. Blood lipid levels were increasing during the same interval with the M-analog diet. Highly significant increases of rumen volatile fatty acid production were observed with M-analog used in in vitro studies conducted by Gil and Shirley (1972). Contrary to the above, Whiting et al. (1973) showed no effects by M-analog on rumen volatile fatty acids levels. However, their measurement of volatile fatty acids was by the accumulation of serum cholesterol in the blood and not serum lipid levels.

Volatile fatty acid levels greatly influenced the amount of fat found in milk in the ruminant animal. Significant rumen increases in propionic acid levels were followed by decreases in blood ketone bodies and milk fat. Feeding sodium acetate increased milk fat, whereas feeding sodium propionate further decreased milk fat (Van Soest and Allen, 1959). In two trials conducted by Emery et al. (1964), sodium bicarbonate increased milk fat .81 and .86% units. The treatment effect, at least 40 to 69% was explained by the acetic to propionic acid ratio established in the rumen. However, Davis (1967) concluded that an absolute shortage of acetate due to decreased rumen production is not responsible for the depression of the fat content of milk when a low fiber-high grain diet was fed.

M-analog's roles may be the enhancement of triglyceride transport into the mammary gland, as suggested by Rosser et al. (1971). This

conclusion was reached by checking triglyceride levels of arterial versus venous blood of the mammary gland of cows fed M-analog. This ration increased ruminal amounts of acetate and butyrate while decreasing proprionate. The increase in acetate with reduced proprionate may help to explain the reason for possible increase in milk fat while feeding M-analog. As both Van Soest and Allen (1950) and Emery et al. (1964) suggest the alteration of milk fat is due to the ratio of acetic to proprionic volatile fatty acids in the rumen.

However, alteration of the volatile fatty acids though M-analog supplementation may not affect the various lipid levels in the bloodstream of the ruminant. Fuquay et al. (1975) tested blood samples from cows fed 24 grams of M-analog per day for 80 days. No lipid classes were altered, leading to a conclusion of no M-analog effect.

#### Overall Digestion Effects

Rumen digestion is only a part of the overall digestion of the ruminant animal. Alteration of postruminal digestibilities must also be considered in forming a complete picture of all the possible actions of M-analog.

M-analog's effect on the total digestibility was considered nil by Whiting et al. (1972), because feeding of M-analog with cubed alfalfa and pelleted concentrate had no significant effect on digestibility of protein, fiber, fat or total feed. Bouchard and Conrad (1973) and Kahlon et al. (1975a) obtained similar results.

In contrast, Bull and Vandersall (1973) discovered significantly

greater dry matter and acid detergent fiber digestibilities with M-analog. The dry matter digestibility was greater for M-analog than for DL-methionine, sodium sulfate and the control ration. The acid detergent fiber digestibility was significantly higher for M-analog, but similar to that of DL-methionine, and sodium sulfate, when all were compared to a control ration. Bharagans et al. (1977) showed that daily fiber intake was higher for cows supplemented with .3% M-analog, from -1.6 kgs for control to 2.2 kgs with M-analog. Twenty-eight Holstein cows were divided into four treatments to compare unpelleted and pelleted rations (Polan et al., 1970). M-analog was added to one pelleted and one unpelleted ration. The pelleted ration demonstrated that M-analog was associated with a marked increase in digestibility of crude fiber, dry matter, the ether extract fraction, and improved nitrogen retention of the cows. Holter et al. (1972) fed cows two weeks prepartum to 24 weeks postpartum, and results indicated M-analog increased digestibilities of the fiber and fat portion of the ration.

#### M-analog and Sulfur Supplementation

Some researchers have felt that the beneficial effect of supplementation of M-analog are due to its sulfur content. A more available source of sulfur may have been presented to the ruminant animal by feeding M-analog. This sulfur source could improve digestibility, sulfur retention, nitrogen retention, or even feed intake if the animals were in need of more sulfur.

Reference to sulfur supplementation should include the National

Research Council (NRC) recommendation. In 1975 the NRC recommended 0.14 to .18% sulfur in the diet on a dry matter basis for mature ewes. Beef cattle recommendations are vague. It is recommended that 3 grams of sulfur be given for each 100 grams of nonprotein nitrogen. The recommendation drops to .10% of diet on a dry matter content.

Whiting et al. (1954) used six lots of mature range ewes fed sulfur in the form of methionine, inorganic sulfate and elemental sulfur. Treatment ewes were fed sulfur levels for eight months. Wool growth and quality, lamb production, ewe weight gain, sulfur serum content, and sulfur milk content were measured, with no significant differences among the various forms of sulfur used in the experiment. Whiting et al. (1954) indicated that the sulfur requirement of mature range ewes did not exceed .10% of the total diet.

Jacobson et al. (1967) divided 24 lactating Holstein cows into two equal groups. The low sulfur group was given a supplement containing 10% sulfur. The sulfur supplemented group was given the same diet plus sodium sulfate. No significant differences were detected among treatments in any of the amino acid contents for either deproteinized blood plasma or hydrolyzed rumen samples taken from cows 3 to 5 hours after feeding. Data collected indicated the sulfur supplemented group of cows failed to maintain the free plasma and rumen amino acid levels. Jacobson et al. (1967) felt the quality of sulfur was ineffective or the quantity insufficient to maintain the levels over the 9 week period.

Bouchard and Conrad (1973) fed M-analog, sodium sulfate and a mixture of potassium and magnesium sulfates, attempting to evaluate

their use as sulfur sources for lactating dairy cows. Ration containing 0.10, .15 and .18% sulfur were made using the basal diet sulfur content (.10% sulfur) plus sodium sulfate to make rations of .15 and 0.18% sulfur, respectively. A fourth ration was made by adding enough M-analog to the basal diet to bring the sulfur content to .18%. Sulfur supplementation of the basal diet increased the dry matter intake and dry matter digestibility. Sodium sulfate and M-analog both improved the sulfur balance of the lactating cows with supplements of 0.15 and .18% sulfur in the complete ration.

In vitro experiments conducted by Kahlon et al. (1975a) observed the availability of sulfur from various sources measured by in vitro protein synthesis. M-analog exhibited a lower availability than DL-methionine, calcium sulfate and even elemental sulfur. Unlike the in vitro experiment results which showed M-analog to be the lowest in sulfur availability, only 28.8% was as available as L-methionine sulfur. Kahlon et al. (1975b) in vivo studies showed that lambs fed M-analog had sulfur retention, sulfur intake and sulfur digestibility levels equal to or greater than those fed any other sulfur source, including DL-methionine.

#### M-analog and Production

Production of the ruminant animal varies with species. Sheep production is measured in amount of wool produced and lambs weaned. Dairy cattle have much different production measurements. Large quantities of high quality milk is the major criteria of production evaluation, along with reproductive performance. Beef cows have two

parameters of measurement: weaning the heaviest calf possible and returning to estrus for the following breeding season as soon as possible. M-analog research has been conducted on each species, with major emphasis on dairy cattle.

#### Dairy Cattle

M-analog, first used to experimentally treat ketosis in dairy cows by McCarthy et al. (1969b), was discovered to improve milk production (Griehl et al., 1968). Milk production and butterfat content have been observed with positive effects on both parameters of production by Polan et al. (1971), Bishop (1971), Fosgate et al. (1973). Increases in butterfat content of milk with M-analog supplementation, but no substantiated increases in milk production were illustrated by Van Horn et al. (1975) and Bharagans et al. (1977). Experiments in which M-analog did not improve milk production or butterfat content of milk in dairy cows have been reported by Burgos and Olson (1970), Hutjens and Schultz (1971), Whiting et al. (1972), Bouchard and Conrad (1973), Fuquay et al. (1974), Olson and Grubaugh (1974) and Williams and Whithurd (1975).

Fuquay et al. (1975) examined M-analog's effect on the reproductive performance of dairy cows. A comparison of the M-analog to control diet shows a reduction in the number of days to first estrus from 45.8 days for control cows to 38.6 days for M-analog treated cows. Days to conception were reduced from 135.4 to 115.1, with number of services to conception decreased from 3.03 to 1.72. Similar data collected by Chandler et al. (1976) indicated that dairy

cows on control diets required 2.9 services per conception and were open an average of 156 days. Supplementation of M-analog at .125% of the diet to treatment cows cut service to conception ratios to 1.8 to 2.2 services and days open were reduced to the 124 to 134 day range.

### Beef Cattle

Literature on beef cattle fed M-analog for fatten indicates reduced palatability (Sather et al., 1975, and Johnson and Totusek, 1976), no benefits to gains or feed efficiencies (Gosset et al., 1972, and Thomas and Langford, 1977), and even depression of gain performance when urea was fed to early weaned calves (Winter, 1976).

In the lactating beef cow, results have been similar to those in dairy cattle. Varner (1974) used 78 straight bred Hereford cows divided into three treatment groups: Control cows fed 0 grams, cows fed 5 grams, and cows fed 15 grams M-analog per day. Cows were fed from about 30 days before predicted calving date until an average of 60 days after calving. There was a significant increase in butterfat, milk production and 4% FMC for cows fed the 15 grams of M-analog per day. Weaning weights and adjusted 205 day weights for calves from the same cows were significantly greater than those of cows on the control ration.

In contrast, Varner et al. (1975) found no differences in treatments using 0 and 10 grams of M-analog per day from 30 days before the predicted calving date until 60 days after calving.

Reproductive performance was altered by M-analog supplementation. Varner (1974) decreased the postpartum period from 48.5 days with no

M-analog to 44.5 days with 15 grams of M-analog per day. However, feeding of 10 grams of M-analog per day did not affect the postpartum period or number of cows pregnant according to Varner et al. (1975). Lesperance et al. (1977) demonstrated no effect on cow or calf weaning weight with M-analog supplementation. Reproductive performance was improved. Cows fed M-analog had a 16 day shorter calving interval and the percent pregnant from artificial insemination increased from 36% for control cows to 52% for M-analog supplemented cows. Supplementation of M-analog could increase beef cow production through decreased length of the postpartum period, thus improving the reproductive performance.

#### Sheep

The main production measurement monitored in sheep as a result of M-analog supplementation is probably wool growth. Increases in wool production using M-analog both orally (Wright, 1968 and Langland, 1972) and abomasally infused (Reis, 1967 and 1970) have been reported. Reis (1970), however, demonstrated no effect on wool production with oral feeding of M-analog. Lambs fed 8% and 12% protein rations had improved growth rates and feed efficiencies on the 8% protein ration, but there was no effect on the 12% protein diet with M-analog supplementation (Wright, 1969). No references were found on the effects of M-analog fed to ewes during lactation.

## MATERIALS AND METHODS

Two studies of range cows and sheep, were conducted at the Red Bluff Research Ranch, Norris, Montana. An outline of each year and species is presented because of differences in the treatment and feeding procedures each year.

Experiment I. Cows 1977

Forty-two, 7-year old range cows were randomly allotted to three treatment groups of 14 cows each. Allotment was done according to previous treatment of these cows, which had consisted of varying levels of protein supplementation upon weight gains of the cows and calf production over a six year period.

All cows were Hereford-Angus crossbreeds, except for one straight bred Hereford in the control group. Angus bulls were used in a 45-day, natural mating situation. All cows were pregnancy tested and considered pregnant at the start of the trial.

Two supplements (Table 1) were mixed and formed into 0.6 cm pellets to facilitate easy handling and quicker consumption. Protein was calculated to be 13% and phosphorous was also balanced for each ration. The sulfur content of the M-analog supplement was matched by adding the equivalent amount of inorganic sulfur to the control supplement. M-analog was added at the expense of barley, accounting for the slight difference in the percentage of barley between the two supplements.

Table 2 demonstrates the feeding design used on the 3 groups of cows in 1977. This design was implemented to test the effects of

feeding M-analog per and postpartum (Treatment 3) and postpartum (Treatment 2).

TABLE 1. SUPPLEMENTS FOR M-ANALOG STUDY - 1977.

Supplement Type	Control	Treatment
	<u>Contents in Percentages</u>	
Barley	60.08	59.10
Wheat millrun	30.00	30.00
Molasses	6.50	6.50
Dicalcium Phosphate	3.00	3.00
Ruminant Trace Mineral	.20	.20
Elemental Sulfur	.22	0.00
M-analog (Hydan)	0.00	1.20
Vitamins A & D <sup>a</sup>	+	+
	100.00	100.00

<sup>a</sup>Provided 22,000 IU of vitamin A per kg and 5,500 IU of vitamin D per kg.

TABLE 2. DESIGN OF FEEDING TRIAL FOR COWS - 1977.

Treatment Groups:	1	2	3
Supplement type:			
Prepartum	Control	Control	M-analog
Postpartum	Control	M-analog	M-analog
Supplement fed: Kg/hd./day			
Prepartum	.45	.45	.45
Postpartum	.91	.91	.91
Amount of M-analog: g/day			
Prepartum	0	0	5
Postpartum	0	10	10

Cows were eartagged with color codes for each of the three groups to facilitate ease of feeding. Initial weights were taken January 20, 1977. All the cows were grazed on native range in one pasture. Every other day cows were rounded up and .45 kg per day of the appropriate

feed was offered to each individual animal. Feedings continued in this manner until March 1, 1977, when all cows were again weighed and turned into a small pasture for calving. Feeding was then conducted every day, with each animal receiving .45 kg of the proper supplement. Grass hay supplemented the two protein supplements throughout the entire trial.

At birth, each calf was weighed, tattooed and eartagged. Each postpartum cow was fed .90 kg of the correct supplement.

On May 12, 1977, cows and calves were turned into the spring pastures. No supplements were fed during spring or summer grazing. Calf and cow weights were obtained 28, 124 and 154 days after turning the cattle out to graze.

#### Milking Procedure

Milk samples were obtained in order to check for altered production through M-analog supplementation. These samples were collected  $14 \pm 1$  and  $28 \pm 1$  days after parturition. On the morning of the 14th day, feeding was conducted as usual. Calves ( $14 \pm 1$  days old) were then isolated from their dams at 7 am. and held away from the mother cow at least 8 h. Milkings of the cows commenced at 3 pm. Each cow was restrained in a head catch chute. A 14 gauge, 1 1/2 inch needle used to inject 1 ml of 20 mg oxytocin via the left jugular vein. In order to obtain a representative milk sample, one half of the udder (right side) was completely milked out by hand, which required about 5 minutes per cow. Milk samples were weighed on a small Fairbanks arm scale, recorded to the .01 kg, and portions of the

sample were poured in two 180 ml whirl pacs. Preservative pills (Dichromate tablets by Nasco) were added to prevent souring and the samples were sealed. The only difference between the first milking at two weeks and the second milking at 28±1 days was in the handling of the calves. After the first milking, calves were released to rejoin the cows. In the second milking, each calf was weighed to the nearest 0.45 kg before rejoining the cow. After the calf had finished nursing, the calf was weighed again. Both weights were recorded and the cow and calf were allowed to rejoin the treatment herd.

Preserved milk samples from each cow were transported to the Dairy Herd Improvement (DHI) Laboratory on the campus of Montana State University, where Butterfat content using the Babcock fat test as described by Peterson (1950), and percent solids-not-fat (%SNF) using the Golding (1960) bead method, were conducted on each milk sample. Protein content was done using the Kjeldahl method, AOAC (1970) at the Montana State University Nutrition Center.

#### Experiment II. Ewes 1977

Sixty-seven, 3-6 year old grade ewes at the Red Bluff Research Station were randomly divided within age and breed into three treatment groups. The control group contained 23 ewes, with the other two treatment groups containing 22 ewes each. The three breeds were Rambouillet, Targhee and Columbia.

Ewes were weighed on test March 24, 1977, approximately one month before the predicted lambing date. Each ewe was given a paint number 1, 2 or 3, indicating which treatment she was to receive. Ewes on

treatment one received no M-analog throughout the trial. Treatment two ewes were fed M-analog only after lambing. M-analog was fed throughout the trial to treatment three ewes (Table 3). Prior to lambing, ewes in each treatment were fed as a group at a rate .45 kg per day per ewe. The rations were as described in Table 1. The design of the feeding portion of the trial is similar to that used for the cows, except for the group feeding, amount fed, and treatment of single versus twin rearing ewes (Table 3).

TABLE 3. DESIGN OF FEEDING TRIAL FOR EWES - 1977.

Treatment Groups:	1	2	3
Supplement type:			
Prepartum	Control	Control	M-analog
Postpartum	Control	M-analog	M-analog
Supplement fed: kg/hd./day			
Prepartum	.225	.225	.225
Postpartum			
Single	.225	.225	.225
Twin <sup>a</sup>	.340	.340	.340
Amount of M-analog: g/day			
Prepartum	0	0	2.50
Postpartum			
Single	0	2.50	2.50
Twin <sup>a</sup>	0	3.75	3.75

<sup>a</sup>It should be noted that ewes rearing twins were fed more supplement after lambing because the station sheep manager required the added supplementation to help twin rearing ewes.

All ewes were shorn about three weeks before lambing. Wool weights were recorded along with fleece grade and length. Once shorn, the ewes were renumbered with the appropriate paint number brand. Treatment ewes were grouped together with the main band during actual

lambing. This meant 30 days off treatment feeding. After lambs had nursed, been eartagged, weighed, docked and number branded, ewes and lambs were returned to the proper treatment group.

The ewes with lambs were weighed off the feeding portion of the test on June 1, 1977. Ewes and lambs grazed with the main band of sheep on native range from June 1 until weaning in the fall. All sheep were weighed again on June 28 and at weaning on August 24, 1977. Variations in age, sex and type of birth and rearing, made it necessary to adjust all lamb weights were adjusted to a common level. The Sheepman's Production Handbook (SID) (1975) formula for standardizing lamb weights was used. It was decided to use the SID formulas for lamb sex, age, birth and rearing because of its easy accessibility to producers and researchers. In order to standardize lamb weights to a single lamb of the same age and sex, each lamb's age was calculated at the time of weighing. Once a mean age for that weighing was obtained, the lamb's weight could be adjusted by using the following formula from SID.

$$\frac{\text{Lamb's wt}}{\text{Lamb's age}} = X \cdot \text{Mean age} = Y \cdot \text{SID adj. factor} = \text{Adj. Lamb Weight}$$

The above formula adjusts the lamb's weight for age, sex, birth and rearing and age of dam. Table 4 illustrates the factors used in the SID adjustment variable.

The term, twin in type of birth was used to indicate ewes rearing two lambs regardless of either lamb's sex at each data collection. Ewes having two lambs could be considered single rearing if one lamb

was missing at ewe milkings or lamb weighings.

Lamb rearing combinations were divided into five types. Their purpose was divide twins from singles and sex each lamb. The various types were: 2 = single ewe lamb, 3 = single wether lamb, 4 = twin ewe lambs, 5 = twins (1 ewe and 1 wether lamb) and 6 = twin wether lambs.

TABLE 4. SHEEP INDUSTRY DEVELOPMENT (SID) ADJUSTMENT FACTORS.

Lamb's sex - Female	Age of dam 3 - 6 years
Single	1.00
Twin - raised twin	1.11
Twin - raised single	1.05
Triplet - raised triplet	1.22
Triplet - raised twin	1.17
Triplet - raised single	1.11
Lamb's sex - Male (castrated)	
Single	.97
Twin - raised twin	1.08
Twin - raised single	1.02
Triplet - raised triplet	1.19
Triplet - raised twin	1.14
Triplet - raised single	1.08

#### Milking Procedure

Milking of ewes was done every Wednesday on ewes which had been returned to their treatment for at least five days. Because ewes were not on the treatment when mixed with the main band during lambing, this criteria was used to make sure the ewes had readjusted to the rations. There were six milking periods, each period consisting of 7 days. Ewes were milked according to the period in which they had lambed. Table 5 shows the different periods and the milking dates for each period.

The number of days from birth to first milking was  $8 \pm 3$  days, and from birth to second milking was  $21.5 \pm 3.5$  days. Milk samples were collected by removing lambs from ewes for 2 h. McCance (1959) suggests milk secretion to be faster in the first two hours postnursing. Each milking usually required 2 minutes per ewe. Milk samples were weighed and recorded to the .01 kg. Two samples were poured into 180 ml whirl pacs, along with Dichromate preservative pills to prevent souring. The first tests on sheep milk indicated butterfat contents above the 10% level tested by the normal Babcock fat test. Therefore, a cream fat test was used for the expected higher butterfat levels.

TABLE 5. MILKING PERIODS OF EWES - 1977.

Lambing Intervals	First milking	Second milking
April 16 - 22, 1977	April 27, 1977	May 11, 1977
April 23 - 29, 1977	May 4, 1977	May 18, 1977
April 30 - May 6, 1977	May 11, 1977	May 25, 1977
May 7 - 13, 1977	May 18, 1977	June 1, 1977
May 14 - 20, 1977	May 25, 1977	-
May 21 - 27, 1977	June 1, 1977	-

#### Experiment III. Cows 1978

Cows were fed the same amount of M-analog before and after calving in a comparison of varying levels of M-analog.

Four different protein supplements were made into 0.6 cm pellets balanced for protein, phosphorous and sulfur (Table 6). Elemental sulfur was added to each ration to match the sulfur level of the most concentrated M-analog ration. Table 6 shows the contents of all four

supplements.

TABLE 6. SUPPLEMENTS FOR M-ANALOG STUDY - 1978.

Treatments	1	2	3	4
<u>Ingredients</u>	<u>Contents in Percentages</u>			
Barley	59.985	59.540	59.095	58.650
Wheat Millrun	30.000	30.000	30.000	30.000
Molasses	6.500	6.500	6.500	6.500
Dicalcium Phosphate	3.000	3.000	3.000	3.000
Ruminant Trace Mineral	.200	.200	.200	.200
Elemental Sulfur	.315	.210	.205	.000
M-analog (Hydan)	.000	.550	1.100	1.650
Vitamin A & D <sup>a</sup>	+	+	+	+
	100.000	100.000	100.000	100.00

<sup>a</sup>Provided 22,000 IU of vitamin A per kg and 5,500 IU of vitamin D per kg.

TABLE 7. DESIGN OF FEEDING TRIAL FOR COWS - 1978.

Treatment Groups:	1	2	3	4
Number of Cows	20	20	20	20
Supplement fed: kg/day				
Prepartum	.91	.91	.91	.91
Postpartum	.91	.91	.91	.91
Amount of M-analog: g/day	0	5	10	15

Seventy-nine Hereford-Angus cross cows and one Hereford cow were used in Trial III. Cows were 7 and 8 years old. The cows were randomly divided into four treatment groups of 20 cows per group according to their relative Most Probably Producing Ability Indexes (MPPA) and the treatment they may have been on with the previous study

in 1977. The following design (Table 7) was set up for the cows, and feeding of the rations was initiated January 21, 1978.

Initial (on trial) weights of the cows were taken on January 20, 1978. Each cow was eartagged with the proper colored tag to insure correct feeding. All cows were grazed together on native range and were individually fed 1.82 kgs of the proper supplement every other day. Approximately 15 days before the predicted start of calving, cows were given native grass hay free choice as well as the protein supplements. At birth, calves were weighed, tattooed and eartagged. Cows and calves were weighed off the feeding portion of the trial 117 days after the trial started and turned out to graze native range. Additional weighings of both cows and calves were obtained at 64, 106 and 149 days after cows were turned to grass grazing.

#### Milking Procedure

Milk samples were collected in a fashion similar in some respects to the technique used on cows in the previous year (1977).

Cows and calves were separated a 6:00 am. at  $14 \pm 1$  days after the calf was born. All cows to be milked were fed and retained in a corral located adjacent to a squeeze chute. Actual milking began at 1:00 pm. Each cow was placed in a runway and given a 2 ml IM injection of oxytocin (20 mg/ml). Five minutes after the injection, each cow was placed in the squeeze chute.

A Globe electric milking machine was used to obtain as much milk as possible from the left half of the udder. Vacuum pressure was maintained a 15 psi and hand stripping the two teats were considered

adequated to obtain a representative sample. After milking the cow, cow and calf were reunited and returned to the trial herd.

The milking procedure at days  $28 \pm 1$  and  $42 \pm 1$  postpartum followed the same pattern except that, prior to a calf's release to join the mother, a weight to the nearest .23 kg was obtained. The calf was allowed to nurse until it had finished as indicated by movement from teat to teat. The calf was then recaptured and weighed. The cow and calf were then reunited and returned to the trial herd.

Collected milk samples were weighed to the .01 kg, stirred thoroughly, two 180 ml whirl pacs were filled for subsequent determination of butterfat and protein and a third sample taken in a SNF% beads jar. The number of sunken beads was determined immediately with SNF% calculated later at Montana State University.

Butterfat analysis was completed at the Marsh Laboratory facilities at Montana State University. A Foss Mark III milk-fat-tester was used rather than the Babcock fat test.

The Kjeldahl protein analysis was conducted at the Montana State University Nutrition Center.

#### Experiment IV. Ewes 1978

One hundred twenty-eight grade Rambouillet, Targhee and Columbia ewes were divided into four groups according to breed. All ewes were from 3 to 6 years old and considered mature animals. Each ewe was weighed on test, March 14, 1978, and given a treatment paint brand randomly selected prior to that date.

Design of the feeding portion of the trial was similar to the

1978 cow experiment. Ewes were confined in 10 meter by 10 meter feed lots and fed as a group .227 kg per ewe of the appropriate 0.6 centimeter, pelleted supplement each day. The composition of the rations is shown in Table 6. Table 8 shows the design of the feeding portion of the trials.

Daily, after the M-analog or control supplement was fed, second cutting alfalfa-grass hay was offered free choice to all ewes. Feeding of supplements began March 14, 1978, and continued until May 26, 1978 (63 days).

Sheep were shorn and wool weights were recorded to the .01 kg. and grade and staple length were determined at the Montana Wool Laboratory.

TABLE 8. DESIGN OF FEEDING TRIAL FOR EWES - 1978.

Treatment Groups:	1	2	3	4
Number of Ewes	32	32	32	32
Supplement fed: kg/hd/day				
Prepartum	.227	.227	.227	.227
Postpartum	.227	.227	.227	.227
Amount of M-analog: g/day	0	1.25	2.50	3.75

All ewes were lambled separate from the main band. At birth, lambs were weighed, docked, eartagged and paint number branded. Ewes received the same number next to the treatment paint brand. This allowed for easy lamb and ewe cross identification in the lots and prevented treatment mix up caused by ewes jumping over or lambs.

crawling through fences.

On May 26, 1978 ewes and lambs were weighed and released to graze summer range. All lambs were weighed again June 23, 1978, and at weaning, August 29, 1978. Lamb weights were adjusted for age, sex birth and rearing, using the SID program (1975). All twin estimates were based on the presence of both lambs at each milk or weight collection. Lamb rearing combinations were used to determine number and sex of lambs present.

#### Milking Procedure

Milk samples collected to check treatment effect were obtained from each ewe  $21 \pm 1$  and  $35 \pm 1$  days after parturition. The procedure was as follow: lambs born  $21 \pm 1$  and  $35 \pm 1$  days previously were separated from their dams for two hours at approximately 10:00 am. Ewes were restrained and given .25 ml of oxytocin (20 mg/ml) intravenously to facilitate milk letdown. A mixture of petroleum jelly and bag balm was used to prevent chapping of the udder. The left half of the udder was completely milked out by hand. After milking, ewe and lamb(s) were returned to the proper treatment lot.

Each milk sample was weighed on a 2.27 kg limit Toledo scale to the nearest .01 kg. Milk was stirred and representative samples for protein and butterfat analysis were taken in 180 ml whirl pacs. Protein analysis at Montana State University Nutrition Center was done by the Kjeldahl method. A Foss Mark III milk tester was used with a cream screw in place and readouts multiplied by 2 to give the total butterfat, because the cream screw reduced sample size by one half.

Statistical Analysis

Data analysis involved two separate statistical analysis. Experiment I was analyzed by the Least Squares analysis of variance (Harvey 1975). Effects due to M-analog treatment, calf age and calf sex were singled out as the three parameters most likely to effect experimental observation. To better show differences between individual treatment means, a Duncan Multiple Range Test (DMRT) was used on Experiment II, III and IV means.

## RESULTS AND DISCUSSION

Experiment I. Cows 1977

Weights were recorded for each cow through the trial. Initial on-trial weights suggest a random sample for the three treatment groups. An entire experiment average of 541.4 kgs for the 41 cows was noted. Forty-two cows were randomly selected for trial usage. Cow number 0077 was later dropped from treatment group three because she was not pregnant. Treatment had no effect on cow weights or weight losses throughout the trial. Table 9 shows the cow weights taken at the start of the trial, prepartum and the last day of the trial feeding.

TABLE 9. LEAST SQUARE MEANS (KGS) OF INTIAL (JANUARY 20, 1977) PREPARTUM (MARCH 1, 1977) AND POSTPARTUM (MAY 12, 1977) COW WEIGHTS - 1977.

Weights	Treatments		
	1	2	3
N	14	14	13
	Mean	Mean	Mean
Intial (kgs)	535.2	533.4	553.7
Prepartum (kgs)	565.6	564.2	586.1
Postpartum (kgs)	461.7	458.4	475.8

Table 10 shows average daily losses suffered by cows for the two gain periods in which parturition occurred. Bellows and Thomas (1976) show similar weight losses as cows tended to lose more weight during the first 60 days of lactation than any other period. All dams raising male progeny had greater ( $P < .05$ ) average weight losses. Dam

production losses due to rearing a male calf were also seen by Melton et al. (1967), Jeffery et al. (1971a and 1971b) and Cartwright and Carpenter (1960). No sex by treatment interaction was seen.

TABLE 10. LEAST SQUARE MEANS FOR THE EFFECT OF TREATMENT ON THE AVERAGE DAILY LOSS (KGS/DAY) OF COWS - 1977.

Periods of Loss	Treatments		
	1	2	3
N	14	14	13
<u>January 20. - May 12, 1977</u>	Mean	Mean	Mean
kgs/day	.65	.67	.69
<u>March 4. - May 12, 1977</u>			
kgs/day	1.51	1.53	1.60

Experiment I, Calves 1977

Table 11 illustrates calf birth weights, summer graze turn-out weights (May 12, 1977) and weaning weights (October 13, 1977). All weights were adjusted for differences in age except birth weights.

TABLE 11. LEAST SQUARE MEANS OF CALF WEIGHTS IN (KGS) FOR BIRTH, MAY 12 AND OCTOBER 13, 1977.

Calf Weights	Treatments		
	1	2	3
N	14	10	11
Birth (kgs)	33.2	32.9	33.6
May 12, 1977 (kgs)	62.3	65.4	66.6
October 13, 1977 (kgs)	211.8 <sup>a</sup>	216.7 <sup>a</sup>	231.7 <sup>b</sup>

<sup>ab</sup>Values within the rows with different superscript are significantly different (P<.05).

Feeding M-analog to dams (5 g before and 10 g after parturition) had a significant ( $P < .05$ ) effect on calf weights. Calves reared by dams on treatments one and two weighed 211.8 and 216.7 kgs at weaning. Treatment three cows weaned calves at 231.7 kgs. Varner (1974) demonstrated similar results in calves whose dams were fed 5 and 15 grams of M-analog.

Weight gains on a daily basis were used to check which portion of the growth period from birth to weaning was altered due to treatment effects. Three average daily gains (ADG) were calculated to assist in the evaluation (Table 12).

TABLE 12. LEAST SQUARE MEANS FOR AVERAGE DAILY GAINS (KGS/DAY) OF CALVES BETWEEN BIRTH AND MAY 12 (GAIN 1), MAY 12 AND OCTOBER 13 (GAIN 2) AND BIRTH - OCTOBER 13, 1977, (TOTAL GAIN).

Average Daily Gains	Treatment		
	1	2	3
N	14	10	11
	Mean	Mean	Mean
Gain 1 (kgs/day)	.60	.66	.72
Gain 2 (kgs/day)	.98 <sup>a</sup>	.99 <sup>a</sup>	1.08 <sup>b</sup>
Total Gain (kgs/day)	.89 <sup>a</sup>	.91 <sup>a</sup>	.99 <sup>b</sup>

<sup>ab</sup>Values within rows with different superscript are different ( $P < .05$ ).

M-analog exhibited a significant effect ( $P < .05$ ) on ADG. The effect was on calves whose dams were fed M-analog pre and postpartum. The periods from the summer grazing turnout date (May 12, 1977) until weaning and from birth until weaning showed the significant effect of M-analog supplementation of the dam. It should be noted that cows

were no longer on M-analog supplementation after May 12, 1977. Therefore, it is unclear why gains were affected by M-analog supplement from May 12, to October 13, 1977. Calves reared by control and treatment two dams gained .98 and .99 kgs per day during the May-October gain period, compared to 1.08 kg per day by calves whose dams were fed M-analog pre and post parturition. This resulted in a significant difference ( $P < .05$ ) in weight gain for the period from birth to weaning for treatment three.

Varner (1974) checked birth to weaning gains of calves whose dams were fed 0, 5 and 15 grams of M-analog pre and postpartum. His study showed an effect ( $P < .01$ ) beneficial to calf gain with the 15 grams of M-analog supplementation to dams.

Calf sex significantly affected ( $P < .01$ ) ADG of calves as steers gained more than heifers. This was expected as researchers, Brinks et al. (1961), Marlowe et al. (1965) and Kress and Webb (1972) have shown calf sex to affect ADG with steers out gaining heifers.

#### Experiment I - Milk Data, Cows 1977

Explanation of the increased ADG of calves whose dams were feed M-analog pre and postcalving can not be supported by milk data obtained during the 1977 trial. Analysis of variance was computed for all milkings and showed no difference between treatments (Table 13).

Similar results on milk quantity or quality are reported by Burgos and Olson (1970), Hutjens and Schultz (1971) Whiting et al. (1972), Bouchard and Cousad (1974), Williams and Whithurd (1975), Varner et al. (1975) and Lesperance et al. (1977). However, studies

in beef cows by Varner (1974) did show increased milk production and significant increases in butterfat with M-analog supplemental feeding.

TABLE 13. LEAST SQUARE MEANS OF MILK PRODUCTION AND COMPOSITION FOR COWS - 1977.

Treatment	1	2	3
<b>First Milking 14±1 Day</b>			
No. of Observations	11	11	10
Milk (kgs)	1.97	1.80	2.12
Butterfat %	6.11	4.52	4.81
SNF %	8.78	8.55	8.63
Protein %	2.74	3.44	3.13
<b>Second Milking 28±1 Day</b>			
No. of Observations	13	14	14
Milk (kgs)	1.90	1.74	1.90
Butterfat %	5.07	4.45	5.38
SNF %	8.76	8.59	8.86
Protein %	2.84	3.02	3.25
WSW (kgs)	1.92	1.74	1.85

Explanations for the lack of difference in the study is possible. Milking two and four weeks postpartum, could have been an insufficient time period into each cow's lactation curve to show beneficial effects of M-analog supplementation. Particularity in view of the fact that significant differences in calf weight was not observed until the second gain period.

Comparison of weigh suckle weigh (WSW) difference to actual milk received at the same milking have a correlation of only .21; yet actual means are almost equivalent between WSW differences and milk weights. The correlation is low when compared to the .92 calculated by Totusek et al. (1973) using similar collection techniques at 70

days postpartum.

Varner milked the entire udder of beef cows an average of 56 days postpartum with a 12 h average separation time of the nursing calf, this study only one half the udder was milked, two and four weeks postpartum with an 8 h separation time. Neither milking procedure seems to be the optimum and WSW may be the more accurate but it may limit the collection of a representative milk sample if WSW was done prior to sampling on the same day. However, Totusek et al. (1973) milking one half the udder while the calf nursed the other half did show a very high correlation between the amount of milk obtained by hand and the WSW technique.

#### Experiment I. Discussion

The beneficial effect of M-analog, if consistent, is thus more likely to be realized with proper supplementation before and after parturition. The use of M-analog after parturition had no effect in this trial. Calves reared by and weaned from dams on treatment three did out gain and out weigh calves from treatment one and two cows at weaning. No treatment by sex interaction was observed.

Milk production and composition remained unchanged throughout all treatments with M-analog. Speculation of a significant alteration can only be made when based on the weaning weights and gains of calves reared by cows feed M-analog pre and postpartum.

#### Experiment II. Ewes 1977

Treatment with M-analog did not affect on or off trial weights of ewes. However, treatment one ewes (no M-analog) lost significantny

less ( $P < .05$ ) weight than ewes on treatments two or three. Table 14 shows the treatment effect on average daily weight loss.

Ewe ADG was altered significantly ( $P < .05$ ) by treatment. Ewes fed M-analog before and after parturition lost .15 kg per day, significantly more than the .11 kg per day lost by ewes fed no M-analog throughout the entire feed trial. Ewes fed M-analog only after lambing lost .14 kg per day as compared to control ewes .11 kg.

TABLE 14. MEANS OF EWE WEIGHTS (KGS) AND WEIGHT LOSS (KGS/DAY) FOR THE FEEDING PERIOD WITH RESPECT TO TREATMENT, TYPE OF BIRTH AND LAMB REARING COMBINATION MARCH 24 AND JUNE 1, 1977.

Variables	N	March 24	N	June 1	N	Loss
<u>Treatment</u>		kgs		kgs		kgs/day
1	21	81.17	18	73.16	18	.11 <sup>a</sup>
2	20	79.74	20	70.82	18	.14 <sup>ab</sup>
3	20	81.27	18	69.91	20	.15 <sup>b</sup>
<u>Type of Birth</u>						
Single	41	79.71	36	72.28	36	.10 <sup>a</sup>
Twin	20	83.02	20	69.48	20	.20 <sup>b</sup>
<u>Lamb Rearing Combinations<sup>b</sup></u>						
Type 2	17	78.91 <sup>a</sup>	15	72.43	15	.09 <sup>a</sup>
3	21	78.81 <sup>a</sup>	20	71.77	20	.10 <sup>a</sup>
4	6	81.76 <sup>ab</sup>	6	68.75	6	.19 <sup>b</sup>
5	9	86.68 <sup>b</sup>	8	73.46	8	.18 <sup>b</sup>
6	8	82.71 <sup>ab</sup>	7	67.10	7	.23 <sup>b</sup>

<sup>ab</sup>Values within columns and headings with different superscript are significantly different ( $P < .05$ ).

<sup>b</sup>Lamb Rearing Combination Types were set as follows: 2 = single ewe lamb, 3 = single wether lamb, 4 = twin ewe lambs, 5 = 1 ewe and 1 wether twin lambs, 6 = twin wether lambs.

Type of birth and rearing was significant ( $P < .05$ ) as ewes rearing twins lost more weight per day than ewes raising a single lamb.

Ewes carrying type 5 twins were heavier than ewes carrying single

lambs. Type 4 and 6 twin rearing ewes were not heavier than single rearing ewes (types 2 and 3) ewes. However, single rearing combinations 2 and 3 ewes did not lose as much weight ( $P < .05$ ) as ewes with twin rearing combinations.

The ewe treatment did not affect any of the three wool parameters measured or scored (Table 15).

TABLE 15. MEANS FOR WOOL WEIGHT, GRADE (SCORES) AND LENGTH (SCORES) BY TREATMENT OF EWES - 1977.

Wool Measurements Means	Treatments		
	1	2	3
Wool Weight (kg)	4.62	4.73	4.43
Grade	2.10	2.16	1.90
Length	2.90	2.89	3.00

Wool grade scores were set to indicate fine = 1, 1/2 blood = 2, 3/8 blood = 3 and 1/4 blood = 4. Length was defined as clothing = 1, french comb = 2 and staple = 3.

#### Experiment II, Lambs 1977

Lamb weights were recorded at birth, June 1, June 28 and August 28, 1977 (Table 16).

Lamb weights for birth indicated no effects due to ewe treatment. Control group lambs weighed 5.05 kgs compared to treatment three weighing 4.94 kgs and treatment two 4.85 kgs. A treatment effect ( $P < .05$ ) and a treatment by breed interaction ( $P < .05$ ) were seen for the 32 day of age lamb weights (Table 16). The 59 day weights were not affected by treatment. The treatment by breed interaction was still present at the 59 day weights. No significant effect of treatment or treatment by breed interaction was observed for August 24, 1977

weaning weights.

TABLE 16. MEANS FOR TREATMENT AND TREATMENT BY BREED OF LAMB WEIGHTS (KGS) AT 32 DAYS (JUNE 1, 1977), 59 DAYS (JUNE 28, 1977) AND 116 DAYS (AUGUST 24, 1977).

Weights (kgs)	Treatments					
	1		2		3	
	N	Mean	N	Mean	N	Mean
<u>32 Days of Age</u>						
Overall	27	15.6	19	13.7	26	13.7
Rambouillet	14	14.3	6	13.6	8	14.4
Targhee	9	14.5	6	14.5	9	13.6
Columbia	4	22.4	7	13.1	9	13.1
<u>59 Days of Age</u>						
Overall	26	21.6	18	20.7	25	21.0
Rambouillet	14	20.2	5	22.5	8	20.6
Targhee	9	21.4	6	20.3	8	21.5
Columbia	3	29.0	7	19.7	9	20.4
<u>116 Days of Age</u>						
Overall	23	38.0	16	36.5	23	37.2
Rambouillet	11	37.1	5	37.0	8	37.2
Targhee	9	37.6	4	34.9	7	37.5
Columbia	3	42.7	7	37.1	8	36.9

TABLE 17. MEANS (KGS) FOR TREATMENT ON AVERAGE GAINS: BIRTH - JUNE 1, (GAIN 1), JUNE 1 - JUNE 28 (GAIN 2), JUNE 28 TO AUGUST 24 (GAIN 3) AND BIRTH TO AUGUST 24 (TOTAL GAIN) OF LAMBS - 1977.

Gains (kgs)	Treatments					
	1		2		3	
	N	Mean	N	Mean	N	Mean
Gain 1	27	10.60	19	8.84	26	8.69
Gain 2	26	6.04	18	7.11	25	7.31
Gain 3	23	15.79	16	15.66	23	16.25
Total Gain	23	32.94	16	31.75	23	32.25

Four lamb gain periods were computed: gain 1, from birth to June 1, 1977; gain 2, from June 1 to June 28, 1977; gain 3, from June 28 to August 24, 1977; and total gain period, from birth to August 24, 1977 (weaning). Gains were not affected by treatment (Table 17).

#### Experiment II - Milk Data, Ewes 1977

Milk samples obtained  $8 \pm 3$  days after lambing were weighed and analyzed for butterfat and protein content (Table 18).

Treatment proved to be significant ( $P < .05$ ) as ewes fed no M-analog milked .39 kg compared to .29 and .26 kgs for ewes on treatment two and three at the  $8 \pm 3$  day milking. Treatment did not affect butterfat or protein levels for the first ewe milking.

Lamb rearing combinations significantly affected ( $P < .05$ ) milk production, butterfat and protein content. Type 6 lamb rearing combination ewes produced .44 kg of milk as compared to types 2 and 3 ewes production at .25 and .28 kgs, respectively. Type 3 rearing combination ewes had a 9.99% butterfat for  $8 \pm 3$  day milking, significantly ( $P < .05$ ) above the 8.19% produced by type 5 ewes. Type 2 and 3 ewes with 4.996 and 4.947% protein in milk were higher ( $P < .05$ ) than the 4.491 and 4.480% turned in by types 6 and 4, respectively.

Type of birth showed a significant effect as single ewes produced significantly higher ( $P < .05$ ) protein levels in milk (9.77%), than ewes with twins (8.56%) for the  $8 \pm 3$  day milking.

The Effect due to treatment, lamb rearing combination or type of birth was not noted on ewe milks taken from the same ewes  $21.5 \pm 3.5$  days after lambing.

TABLE 18. MEANS OF MILK PRODUCTION AND COMPOSITION COLLECTED DURING EWE MILKING AS AFFECTED BY TREATMENT, LAMB REARING COMBINATION AND TYPE OF BIRTH - 1977.

Variables		Milk (kgs)	Butterfat (%)	Protein (%)
<u>First Milking (8±3 Days)</u>				
<u>Treatments</u>	N			
1	18	.39 <sup>a</sup>	9.27	4.76
2	18	.29 <sup>b</sup>	9.34	4.93
3	20	.26 <sup>b</sup>	9.46	4.79
<u>Lamb Rearing Combinations</u>				
2	15	.25 <sup>a</sup>	9.05 <sup>ab</sup>	4.996 <sup>a</sup>
3	20	.28 <sup>a</sup>	9.99 <sup>a</sup>	4.947 <sup>a</sup>
4	6	.37 <sup>ab</sup>	9.67 <sup>ab</sup>	4.480 <sup>b</sup>
5	7	.35 <sup>ab</sup>	8.19 <sup>b</sup>	4.779 <sup>ab</sup>
6	8	.44 <sup>b</sup>	9.18 <sup>ab</sup>	4.491 <sup>b</sup>
<u>Type of Birth</u>				
Single	37	.30	9.77 <sup>a</sup>	4.941
Twin	19	.33	8.56 <sup>b</sup>	4.595
<u>Second Milking (21.5±3.5 Days)</u>				
<u>Treatment</u>				
1	16	.37	7.45	4.67
2	17	.31	7.91	4.64
3	19	.28	8.31	4.73
<u>Lamb Rearing Combinations</u>				
2	14	.29	7.79	4.69
3	19	.28	8.01	4.72
4	6	.31	7.62	4.82
5	7	.42	7.91	4.64
6	6	.36	8.22	4.49
<u>Type of Birth</u>				
Single	34	.29	7.97	4.71
Twin	18	.37	7.81	4.63

<sup>ab</sup>Values within same columns and milkings with different superscript are different (P<.05).

Experiment II. Discussion

M-analog supplementation of ewes was not beneficial as the significant effects seen were control ewes (no M-analog) out performing supplemented ewes. Explanation of the significant difference between treatment one and treatments two and three in the first milking amounts may be attributed to the number of twins present. Nine ewes were rearing twins when the first milk data were collected. Davis (1958) showed that the milk yield of the ewes was influenced by the number of lambs suckling the ewe and not the number of lambs born to the ewe. Treatment two and three ewes did have significantly lower milk production, but each group had an average of five sets of twins compared to group one's 9.

Type of birth and lamb rearing combinations tended to expose the draining effects of raising two lambs and also the increased production (milk) required to maintain two healthy growing lambs. Single rearing ewes eventually began to produce milk at levels comparable to their twin rearing counterparts (milk production  $21.5 \pm 3.5$  days). Twin type of birth did not affect ewe milk production at the  $21.5 \pm 3.5$  day milking as loss of progeny forced two high producing ewes which bore twins to be considered singles.

The sampling technique may have had some effect on results obtained from milking ewes. McCance (1959) felt that the yield of milk depended on the interval between milking, as the apparent rate of milk secretion was faster in the first 2 hours after milking. Yields reported by McCance (1959) were independent of the time of day or speed of milking. Moore (1963) suggested that the use of oxytocin injection might be a better estimate of the lamb's intake than a WSW

technique.

The absence in the second milk data of the significant changes noted at the first milking may be explained by the probability of error. Another possible explanation is that the ewes rearing twins may have started producing at a higher level on their lactational curve, and after three weeks, single lambs had grown sufficiently to force their dams to the higher production level. Wallace (1948) indicated, in a comparison of varying ages and breeds of ewes, the peak of the lactational period to be from three to four weeks postpartum. Although there were variations in the lactational curve, the differences were not significant enough to indicate a variation in twin versus single-rearing ewes.

#### Experiment III. Cows 1978

Average initial weight of the 1978 cows was 549 kgs. Throughout the course of the feed trial, cows lost an average of 40.8 kgs. per cow for an off trial mean weight of 508 kgs. The weight loss was expected as all cows underwent parturition during the feeding portion of the trial. Bellows and Thomas (1976) showed similar effects as cows lost more weight during the first 60 days of lactation. Calf sex affected the off trial weight. Dams of steers lost significantly ( $P < .05$ ) more weight 50.7 kgs than dams of heifers, 29.4 kgs. Similar results are reported by Cartwright and Carpenter (1960), Melton et al. (1967) and Jeffery et al. (1971a and 1971b).

#### Experiment III. Calves 1978

Calves were born weighing an average of 34.5 kgs. Sex of calf

significantly affected ( $P < .01$ ) calf weights from birth to weaning in agreement with Brinks et al. (1961), Kress and Webb (1972) and Nelsen (1976).

TABLE 19. MEANS FOR CALF WEIGHTS (KGS) AT BIRTH, 28 DAY, 60 DAY, 80 DAY, 125 DAY, 164 DAY, AND 204 DAY MEAN AGE BY TREATMENT - 1978.

Age at Weighing	Treatments			
	1	2	3	4
N	20	20	20	21
Birth	34.6	34.5	33.6	34.8
28 Days	60.7	60.2	57.3	57.9
60 Days	85.2 <sup>a</sup>	85.4 <sup>a</sup>	77.2 <sup>b</sup>	80.2 <sup>ab</sup>
80 Days	106.5 <sup>a</sup>	106.5 <sup>a</sup>	97.7 <sup>b</sup>	101.0 <sup>ab</sup>
125 Days	148.5 <sup>a</sup>	147.2 <sup>ab</sup>	138.7 <sup>b</sup>	138.0 <sup>b</sup>
164 Days	187.8 <sup>a</sup>	188.5 <sup>a</sup>	177.8 <sup>ab</sup>	176.7 <sup>b</sup>
204 Days	225.5 <sup>a</sup>	225.7 <sup>a</sup>	212.5 <sup>b</sup>	213.5 <sup>b</sup>

<sup>ab</sup>values within rows with different superscript are different ( $P < .05$ ).

Treatment of cows did not affect their calves birth weight or weight at 28 days of age. Treatment was significant ( $P < .05$ ) on the 60 day weight of calves. Calves born to cows fed control or 5 g M-analog per day were heavier than calves on treatment three cows fed 10 grams M-analog per day. Calves on treatment four cows were intermediate between treatment one and two versus treatment three. The treatment effect was also noted at 80 day weight. Calves on treatments one and two were heavier ( $P < .05$ ) than treatment three calves, with treatment four calves intermediate between treatment one and two versus

treatment three. A change in treatment effect was noticed at the 125 day weight. Calves from treatment one cows were significantly heavier ( $P < .05$ ) than treatment three and four calves. Treatment two calves were no longer heavier than either treatments three or four calves at 125 days. Treatment weight means recorded at 164 days showed that calves of treatment one and two cows were significantly heavier ( $P < .05$ ) than treatment four calves, with treatment three intermediate between the two. Treatment means of calf weaning weights showed cows on rations one and two weaned calves equivalent in weight. These calves weaned significantly heavier ( $P < .05$ ) than calves reared by cows on rations three and four (Table 19).

TABLE 20. MEANS FOR AVERAGE DAILY GAINS (KGS) FOR GAIN PERIODS FROM BIRTH TO 28 DAYS, 60 DAYS, 80 DAYS, 125 DAYS, 164 DAYS AND 204 AVERAGE DAYS OF AGE OF CALVES - 1978.

Average Daily Gains	Treatments			
	1	2	3	4
N	20	20	20	20
28 Days	.92	.92	.85	.82
60 Days	.83	.86	.79	.77
80 Days	.87	.89	.83	.83
125 Days	.91	.91	.89	.84
164 Days	.93 <sup>a</sup>	.92 <sup>ab</sup>	.90 <sup>ab</sup>	.87 <sup>b</sup>
204 Days	.91 <sup>ab</sup>	.92 <sup>a</sup>	.89 <sup>ab</sup>	.87 <sup>b</sup>

<sup>ab</sup>Values within columns and headings with different superscript are different ( $P < .05$ ).

Average daily gains computed throughout the trial showed that the

sex of the calf was again significant ( $P < .05$ ) for each ADG in the trial period. Supporting the work of Brinks et al. (1961), Kress and Webb (1972) and Nelsen (1976).

Trends in calf ADG followed the calf weights (Table 20). Treatment was significant ( $P < .05$ ) for ADG periods of the first 164 days of age (birth to August 31, 1978) and for the total gain (from birth to weaning on October 12, 1978).

#### Experiment III - Milk Data, Cows 1978

The 81 cows produced 2.13 kg of milk that contained 3.69% butterfat at  $14 \pm 1$  day postpartum milking. The same cows produced 2.18 kg of milk 3.77% butterfat  $28 \pm 1$  day postpartum and 2.22 kg of milk with 4.74% butterfat concentration  $42 \pm 1$  day after parturition.

A significant treatment affect ( $P < .05$ ) was noted at the  $42 \pm 1$  day milking (Table 21). Treatment two cows milked 2.45 kg of milk, out producing treatment four cows production at 1.96 kg of milk. Treatment one and three cows averaged 2.19 and 2.28 kgs of milk and were not different from treatment two or four milk production means. Failure of M-analog treatment to increase milk production over controls are not unlike the results of Varner et al. (1975) showing no increase in milk production of beef cows with M-analog supplementation. M-analog supplemented at 15 g per day increased milk production and butterfat concentration on beef cows at Miles City, Montana (Varner 1974).

Calf sex had no effect on milk production or composition throughout all three milkings. Other workers reported that steer

calves usually caused an increase in milk production by the dam (Cartwright and Carpenter 1960, Melton et al. 1967, and Jeffery et al. 1971a and 1971b).

TABLE 21. MEANS FOR MILK PRODUCTION AND COMPOSITION AT 14±1 DAYS, 28±1 DAYS AND 42±1 DAYS AFTER PARTURITION OF COWS - 1978.

Observations	Treatments			
	1	2	3	4
<u>Milking at 14+1 days</u>				
Milk (kgs)	1.92	2.27	2.27	2.06
Butterfat %	3.29	3.49	4.00	4.02
SNF %	7.34	7.29	6.87	6.76
SNF No. of Beads	2.80	2.80	3.70	4.10
Protein %	3.61	3.61	3.74	3.78
<u>Milking at 28+1 Days</u>				
Milk (kgs)	2.20	2.27	2.17	1.99
Butterfat %	3.92	4.06	3.75	3.37
SNF %	6.59	6.66	6.61	7.18
SNF No. of Beads	4.80	4.40	4.90	3.30
Protein %	3.25	3.27	3.29	3.43
WSW Difference (kgs)	2.19	2.10	2.30	2.12
<u>Milking at 42+1 Days</u>				
Milk (kgs)	2.19 <sup>ab</sup>	2.45 <sup>a</sup>	2.28 <sup>ab</sup>	1.96 <sup>b</sup>
Butterfat %	5.06	4.58	4.78	4.55
SNF %	5.68	6.25	5.94	6.09
SNF No. of Beads	6.80	6.30	6.17	5.89
Protein %	3.17	3.26	3.22	3.26
WSW Difference (kgs)	2.06	2.14	2.53	2.19

<sup>ab</sup>Values within rows with different superscript are different (P<.05).

Weigh-suckle-weigh (WSW) in terms of amount of milk produced showed no difference due to treatment or calf sex at the 28±1 or 42±1 day milk collections (Table 21). Milk production means for WSW and mechanical milking were similar. Correlations of -.02 and .39 for

the respective milkings varied greatly from that of Totusek (1973) with .94 for milk production at 70 days using a similar sampling technique. Table 21 illustrates production parameters measured during the three postpartum milk samplings.

#### Experiment III. Discussion

Discussion of weights and gains of calves can be summarized by treatment. M-analog supplementation did have an effect upon the final weights and gains of calves. The effect may show an oversupplementation of M-analog during the pre and postpartum period of the cow, resulting in a reduced weaning weight or decreased gain of the calf. However, at more appropriate levels of supplementation, M-analog seems to be equal to straight sulfur supplementation in the production of beef. Varner (1974) reported significant ( $P < .05$ ) effects on gains and weaning weight with M-analog supplementation of beef cows. This study expressed only a slight difference between supplementation with 5 grams of M-analog pre and postpartum and a similar (sulfur-containing) control ration fed at the same time, level and environmental conditions.

Treatment effect due to M-analog supplementation was noted only during the last or  $42 \pm 1$  day milk samples, and may suggest an oversupplementation of M-analog. Calves on treatment two cows were among the heaviest weaned, indicating the increased milk production is probably a real value and that M-analog treatment may be affective. The possibility that the increase was due to chance cannot be eliminated and the possibility the milk data were not collected for a

sufficient length of time must be considered. Varner (1974) showed increases in milk production and butterfat percentage of beef cows. Milk samples were collected at 56 days postpartum average. The added two week period may have been required to generate an obvious effect due to M-analog supplementation. Streeter et al. (1974) felt the highest milk producing time in the beef cow lactation was 60 days postpartum. However, Abadia and Brinks (1975) felt maximum milk production occurred from 30 to 45 days postpartum in beef cows.

The fact that the 5 and 10 g M-analog supplementation levels pre and postpartum were not more beneficial than the control sulfur ration still remains apparent by the data collected and analyzed for the 1978 milk samples.

#### Experiment IV. Ewes 1978

Weights of all ewes were recorded on March 14, 1978, the start of the feeding portion of the trial. Treatment of ewes had a significant effect ( $P < .05$ ) for the off trial weights. Ewes fed treatment two weighed 68.3 kgs versus 63.5 kgs for control ewes. Treatment three and four ewes were intermediate between the two means at 65.2 and 65.6 kgs respectively. Treatment means for ADG of ewes exhibited a similar significant trend. Treatment two ewes lost an average .09 kg per day, significantly less ( $P < .05$ ) than control ewes loss of .17 kg per day or treatment three and four losses of .14 and .16 kgs per day (Table 22).

Ewes with twin type of birth lost more weight during the feeding period than ewes with a single lamb ( $P < .01$ ). This supports the Davis (1958) theory that production output and subsequent weight loss

depends not on the number of lambs born to each ewe but the number of lambs nursing each ewe.

TABLE 22. MEANS OF EWE ON TRIAL (MARCH 14), OFF TRIAL (MAY 26) WEIGHTS AND AVERAGE DAILY WEIGHT LOSS (KGS) - 1978.

Observations	March 14		May 26		Loss	
	N	kgs	N	kgs	N	kgs/day
<b>Treatments</b>						
1	32	76.5	28	63.5 <sup>a</sup>	28	.17 <sup>a</sup>
2	31	75.2	30	68.3 <sup>b</sup>	30	.09 <sup>b</sup>
3	32	75.7	32	65.2 <sup>ab</sup>	32	.14 <sup>a</sup>
4	32	76.9	32	65.6 <sup>ab</sup>	32	.16 <sup>a</sup>
<b>Type of Birth</b>						
Single	76	75.7	71	67.0 <sup>a</sup>	71	.12 <sup>a</sup>
Twin	51	76.7	51	63.9 <sup>b</sup>	51	.18 <sup>c</sup>

<sup>ab</sup>Values within columns and headings with different superscript are different (P<.05).

<sup>ac</sup>Values within columns and headings with different superscript are different (P<.01).

TABLE 23. MEANS OF EWE WOOL PRODUCTION (KGS), GRADE (SCORES) AND LENGTH (SCORES) - 1978.

Wool Data	Treatments			
	1	2	3	4
N	30	31	31	30
Wool Weight (kg)	4.5	4.7	4.6	4.5
Grade	1.87	2.10	2.00	2.00
Length <sup>o</sup>	3.00	2.94	2.97	3.00

<sup>o</sup>Wool grade scores were set to indicated fine = 1, 1/2 blood = 2, 3/8 blood = 3 and 14 blood = 4. Length was defined as clothing = 1, french comb = 2 and staple = 3.

All ewes produced an average of 4.6 kgs of wool for a 12 month

period. Analysis of variance showed no effect by treatment or treatment by breed interaction for any of the three parameters.

Experiment IV. Lambs 1978

Lamb weights recorded four times during the year were adjusted for lamb sex, type of birth, lamb rearing combination and lamb age. Once adjustments were completed, analysis for ewe treatment effect was completed. Treatment of ewes with a ration containing 3.75 g of M-analog per day significantly increased ( $P < .05$ ) the weights of the lamb(s) nursing them. Lambs from ewes fed 3.75 g M-analog per day weighed 23.8 and 37.3 kgs at June 23, and August 29, 1978. Lamb weight means for each treatment and each collection date can be seen in table 24.

TABLE 24. MEANS (KGS) OF LAMB WEIGHTS AS AFFECTED BY TREATMENT AND EWE BREED AT BIRTH, MAY 26, JUNE 23 AND AUGUST 29, 1978.

Weights (kg)	Birth		May 26		June 23		August 29	
	N	Mean.	N	Mean	N	Mean	N	Mean
Treatment								
1	50	5.33	39	14.9	38	21.5 <sup>a</sup>	38	35.0 <sup>a</sup>
2	50	5.21	44	16.5	41	21.9 <sup>a</sup>	41	35.0 <sup>a</sup>
3	48	5.32	44	15.4	43	21.7 <sup>a</sup>	41	34.8 <sup>a</sup>
4	44	5.53	40	15.9	36	23.8 <sup>b</sup>	37	37.3 <sup>b</sup>
Breed								
Rambouillet	68	5.07 <sup>a</sup>	60	15.5	56	21.3 <sup>a</sup>	55	34.6 <sup>a</sup>
Targhee	64	5.60 <sup>b</sup>	53	16.2	50	23.1 <sup>b</sup>	51	37.4 <sup>b</sup>
Columbia	60	5.38 <sup>ab</sup>	54	15.5	52	22.3 <sup>ab</sup>	51	34.4 <sup>a</sup>

<sup>ab</sup> Values within columns and headings with different superscript are different ( $P < .05$ ).

Breed was significant in the final two weighing periods. Targhee reared lambs were born heavier ( $P < .05$ ) and remained heavier ( $P < .05$ )

throughout the entire trial. Targhee ewes were the heaviest throughout the trial. It would seem that because adult Targhee sheep in the trial were slightly larger, and they tended to have larger progeny.

Lamb gains computed for each of the weigh periods are listed in table 25. Significant treatment effect ( $P < .05$ ) showed treatment four lambs gained more weight throughout the entire trial and were definitely faster growing than the other groups during the Birth to June 23, 1978 gain period and also the period from birth to weaning (total gain). This trend was expected, as these same lambs had the heaviest weaning weights. Breed gains do show that Targhee-reared lambs tend to grow faster.

TABLE 25. MEANS OF LAMB GAINS (KGS) FOR GAIN 1 (BIRTH - MAY 26), GAIN 2 (MAY 26 - JUNE 23), GAIN 3 (JUNE 23 - AUGUST 29) AND TOTAL GAIN (BIRTH - AUGUST 29) - 1978.

Observations (kg)	Gains							
	1		2		3		Total	
Treatment	Mean	N	Mean	N	Mean	N	Mean	
1	39	9.60	38	6.6 <sup>ab</sup>	36	13.4	38	29.6 <sup>a</sup>
2	44	11.05	41	5.3 <sup>a</sup>	41	13.0	41	29.5 <sup>a</sup>
3	44	10.05	43	6.4 <sup>ab</sup>	40	12.9	41	29.5 <sup>a</sup>
4	40	10.36	36	7.8 <sup>b</sup>	34	13.8	37	31.6 <sup>b</sup>
<b>Breeds</b>								
Rambouillet	60	10.26	56	5.7 <sup>a</sup>	53	13.3 <sup>ab</sup>	55	29.4 <sup>a</sup>
Targhee	53	10.42	50	7.0 <sup>b</sup>	49	14.3 <sup>a</sup>	51	31.7 <sup>b</sup>
Columbia	54	10.18	52	6.8 <sup>ab</sup>	49	12.2 <sup>b</sup>	51	29.2 <sup>a</sup>

<sup>ab</sup>Values within columns with different superscript are different ( $P < .05$ ).

Experiment IV - Milk Production, Ewes 1978

Feeding of M-analog did significantly alter two milk

TABLE 26. MEANS OF EWE MILK PRODUCTION AND COMPOSITION FOR TREATMENT, TYPE OF BIRTH AND LAMB REARING COMBINATIONS TAKEN 21±1 AND 35±1 DAYS POSTPARTUM - 1978.

Milking at 21±1 Days					
		Milk	Butterfat	Protein	SNF <sup>u</sup>
	N	kgs Mean	% Mean	% Mean	Beads ( % ) Mean (Mean)
<b>Treatments</b>					
1	26	.19	8.07	4.80	5.3 (8.17)
2	21	.20	8.45	4.95	4.7 (8.51)
3	27	.21	8.14	4.79	4.6 (8.36)
4	29	.20	8.13	4.77	5.2 (8.19)
<b>Type of Birth</b>					
Single	58	.19	7.93	4.88	5.0 (8.27)
Twin	45	.21	8.51	4.75	5.0 (8.22)
<b>Lamb Rearing Combinations</b>					
2	24	.20	7.71	4.71 <sup>a</sup>	5.1 (8.26)
3	25	.18	8.07	5.00 <sup>b</sup>	4.8 (8.31)
4	22	.20	8.15	4.88 <sup>ab</sup>	4.4 (8.42)
5	20	.21	8.80	4.73 <sup>a</sup>	5.3 (8.11)
6	12	.21	8.38	4.72 <sup>a</sup>	5.3 (8.14)
Milking at 35±1 Days					
<b>Treatments</b>					
1	18	.16 <sup>a</sup>	6.86	4.75	4.1 <sup>a</sup> (8.62)
2	15	.21 <sup>b</sup>	7.02	4.82	4.2 <sup>ab</sup> (8.58)
3	20	.16 <sup>a</sup>	7.27	4.79	5.4 <sup>ab</sup> (8.21)
4	26	.15 <sup>a</sup>	7.38	4.79	5.5 <sup>b</sup> (8.17)
<b>Type of Birth</b>					
Single	48	.16	7.16	4.77	5.2 (8.28)
Twin	31	.17	7.18	4.80	4.4 (8.50)
<b>Lamb Rearing Combinations</b>					
2	21	.16	6.88	4.61 <sup>a</sup>	5.5 <sup>a</sup> (8.22)
3	20	.15	7.30	4.89 <sup>b</sup>	5.1 <sup>ab</sup> (8.29)
4	17	.18	7.58	4.90 <sup>b</sup>	4.8 <sup>ab</sup> (8.36)
5	12	.17	7.07	4.78 <sup>ab</sup>	3.7 <sup>b</sup> (8.71)
6	9	.18	6.93	4.77 <sup>ab</sup>	5.1 <sup>ab</sup> (8.33)

<sup>ab</sup> Values within columns and subheadings with different superscript are different (P<.05).

<sup>u</sup> note: SNF = 10.38 - .286 (beads down) + .086% (butterfat %) The formula was used due to the high butterfat levels seen in the ewes milk.

observations. Treatment two ewes produced significantly ( $P < .05$ ) more milk than control, treatment three or four ewes for the  $35 \pm 1$  day milking. Ewes fed 3.75 g of M-analog per day produced milk with a higher ( $P < .05$ ) number of SNF beads sunk and a lower ( $P < .05$ ) calculated SNF % than milk produced by the control ewes at the  $35 \pm 1$  day milking. Treatment two and three ewes produced milk with number of SNF beads sunk and calculate SNF % intermediate to treatments one and four. No other treatment effects were noted and the treatment by breed interaction was not significant.

Lamb rearing combination significantly ( $P < .05$ ) affected the protein % of milks taken at  $21 \pm 1$  and  $35 \pm 1$  days postpartum. Type 3 rearing ewes produced a higher protein containing milk than ewes rearing types 2, 5 and 6 lamb rearing combinations at the first milking. Types 3 and 4 had higher protein % milk than type 2 at the second milking. Lamb rearing combination also affected the number of SNF beads sunk and SNF % as type 2 had a significantly higher ( $P < .05$ ) number of beads sunk and a corresponding lower ( $P < .05$ ) SNF % than type 5 rearing ewes.

Parturition date had a significant effect ( $P < .05$ ) upon the ewe milk data, but because of the large variation in dates of lambing, the small number of observations per day and the use of common milking dates, the significance of the birth date remains unclear.

#### Experiment IV. Discussion

M-analog supplementation to range ewes pre and postpartum does significantly increase the amount of lamb weaned. Observations used

to measure treatment effect on ewe milk quantity and composition (exception of SNF bead count or SNF %), wool quality and quantity, ewe weights and gains do not reveal where significant effects were occurring. Davis (1958) did report that potential milk yield of Australian Merino ewes was not a factor in lamb growth. Group two ewes may have helped substantiate the point. The increased weight of group four lambs cannot be explained by an increase in any of the milk parameters. The possibility that number of SNF beads or SNF % is the key element in the estimation of lamb weights and gains still seems unlikely. More research is required to understand fully why M-analog feeding pre and post partum to ewes improved lamb weights.

## SUMMARY

Feeding M-analog to dams in an attempt to improve progeny weaning weights proved to be beneficial only if feeding occurred both pre- and postpartum. The extent of treatment benefits was dependent not only on sex of progeny but also on breed of dams, as indicated by experiment IV. The increased weaning weights seen in Experiment I were remarkable, but, because of failure to reproduce similar results in Experiment III, massive M-analog supplementation of improved weaning weights in calves needs to be studied more closely. Lamb weight improvements, in Experiment IV were best explained by M-analog supplementation. Determining how the increases came about, in light of milk data for the treatment group, would require extensive research into ewe production correlated to lamb weight gain.

In conclusion, M-analog may be effective in improving weaning weights of the progeny of supplemented cows and ewes. The degree and kind of effect cannot at this time be predicted because measurement tools are not accurate enough and technical skills have not been developed sufficiently to warrant a valid prediction.

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## LITERATURE CITED

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