FEEDING TECHNIQUES TO ENHANCE THE GROWTH IN CALVES

By
RENY K. OOMMEN

THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Livestock Production Management
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR
KERALA, INDIA

1999

DECLARATION

I hereby declare that this thesis entitled "**FEEDING TECHNIQUES TO ENHANCE THE GROWTH IN CALVES**" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy
9-7-1999.

RENY K. OOMMEN

CERTIFICATE

Certified that this thesis entitled **"FEEDING TECHNIQUES TO ENHANCE THE GROWTH IN CALVES"** is a record of research work done independently by Sri. Reny K. Oommen, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Dr. C.K. Thomas
(Chairman, Advisory Committee)
Professor & Head
Department of Livestock-
Production Management
College of Veterinary &
Animal Sciences, Mannuthy

Mannuthy
9-7-1999

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Sri. Reny K. Oommen,** a candidate for the degree of Master of Veterinary Science in Livestock Production Management, agree that this thesis entitled "**FEEDING TECHNIQUES TO ENHANCE THE GROWTH IN CALVES**" may be submitted by Sri. Reny K. Oommen, in partial fulfilment of the requirement for the degree.

Dr. C.K. Thomas
Professor & Head
Department of Livestock Production Management
(Chairman, Advisory Committee)

Dr. T.G. Rajagopalan
Professor and Head (Retd.)
Department of Livestock
Production Management
(Member)

Dr. George Mathen
Associate Professor
Department of Animal Nutrition
(Member)

Dr. P. Kuttinarayanan
Associate Professor & Head i/c
Meat Technology Unit
(Member)

External Examiner

ACKNOWLEDGEMENT

It gives me immense pleasure to record my sincere thanks to Dr. C.K. Thomas, Professor and Head, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy and Chairman of the Advisory Committee for his able guidance, extensive advice and encouragement through out this work.

My grateful thanks are due to Dr. T.G. Rajagopalan retired Professor and Head, Department of Livestock Production Management, Dr. George Mathen, Associate Professor, Department of Animal Nutrition and Dr. P. Kuttinarayanan, Associate Professor and Head i/c, Meat Technology Unit for the valuable help and guidance as Advisory Committee members.

I owe my deep sense of gratitude to Dr. Anil. K.S. Assistant Professor, Department of Livestock Production Management for the help rendered in completing this work, when he was in charge of Cattle Breeding Farm, Thumburmuzhy.

My Sincere thanks are due to Dr. P.C. Saseendran, Dr. K.S. Sebastian, Dr. Francis Xavier, Dr. Joseph Mathew and Dr. A. Kannan of Department of Livestock-Production Management for their suggestions and help.

I gratefully acknowledge the help rendered by Dr. J. Abraham, Meat Technology Unit and Dr. D. Sreekumar, Associate Professor, Department of Livestock Production Management, Rajiv Gandhi College of Veterinary and Animal Sciences, Pondicherry., as former members of the Advisory Committee.

I Wish to express my gratitude to the Dean, College of Veterinary and Animal Sciences for providing facilities to carry out this research work.

Grateful acknowledgement is made to Sri. Purushothaman, permanent labourer and other staff of Cattle Breeding Farm, Thumburmuzhy.

I sincerely acknowledge the invaluable help and encouragement rendered by Dr. K.C. George, retired Professor and Head, Smt. Santha Bai, Senior Programmer and other staff of the Department of Statistics.

Special thanks are due to my colleagues and friends for the assistance with out which the research work would not have been successful.

With immense pleasure, I place on record the unstinted encouragement and moral support extended by my family in fulfilling this endeavour.

Reny K. Oommen

CONTENTS

Chapter No.	Title	Page No.
I	INTRODUCTION	1
II	REVIEW OF LITERATURE	5
III	MATERIALS AND METHODS	24
IV	RESULTS	31
V	DISCUSSION	82
VI	SUMMARY	99
	REFERENCES	104
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1.	Details of temperature recorded for the year 1997	32
2.	Monthly average relative humidity and THI values	32
3.	Multiple regression of body weight gain on maximum temperature and relative humidity (2 pm)	33
4.	Multiple regression of body weight gain on minimum temperature and relative humidity (2 pm)	33
5.	Multiple regression of body weight gain on average temperature and average relative humidity	38
6.	Weekly intake of water (kg) - Mean and standard error	39
7.	Analysis of variance of weekly intake of water	41
8.	Effect of environmental variables on water intake	41
9.	Weekly consumption of milk (kg) - Mean and standard error	42
10.	Analysis of variance of weekly milk consumption	43
11.	Weekly intake of concentrate (kg) - Mean and standard error	45
12.	Analysis of variance of weekly intake of concentrate	47
13.	Effect of environmental variables on intake of concentrate	47

Table No.	Title	Page No.
14.	Weekly intake of roughage (kg) - Mean and standard error	48
15.	Analysis of variance of weekly intake of roughage	50
16.	Effect of environmental variables on intake of concentrate	52
17.	Monthly live weight of calves (kg) mean and standard error	53
18.	Analysis of variance of monthly live weight	53
19.	Increase in live weight (kg) in relation to 1st month	54
20.	Multiple regression of body weight gain on the basis of feed intake	59
21.	Average daily weight gain (g/day)	60
22.	Feed efficiency and cost involved per kg live weight gain	60
23.	Monthly length of calves (cm) - Mean and standard error	61
24.	Analysis of variance of monthly length of calves	61
25.	Increase in length (cm) in relation to 1st month	62
26.	Monthly measurement of height (cm) of calves - Mean and standard error	65
27.	Analysis of variance of monthly height of calves	65
28.	Monthly increase in height (cm) in relation to 1st month	66
29.	Monthly measurement of chest girth (cm) of calves - Mean and standard error	67

Table No.	Title	Page No.
30.	Analysis of variance of monthly chest girth of calves	67
31.	Monthly increase in chest girth (cm) in relation to 1st month	68
32.	Disease incidence in calves during the experiment	71
33.	Monthly values of packed cell volume (PCV) - Mean and standard error	72
34.	Analysis of variance of monthly values of packed cell volume	72
35.	Monthly values of haemoglobin - Mean and standard error	73
36.	Analysis of variance of monthly values of haemoglobin	73
37.	Monthly values of erythrocyte sedimentation rate - Mean and standard error	75
38.	Analysis of variance of monthly values of etythrocyte sedimentation rate	75
39.	Monthly values of serum glucose (SG) - Mean and standard error	76
40.	Analysis of variance of monthly values of serum glucose	76
41.	Monthly values of serum cholesterol (SC) - Mean and standard error	77
42.	Analysis of variance of monthly values of serum cholesterol	77
43.	Monthly values of plasma protein - Mean and standard error	78
44.	Analysis of variance of monthly values of plasma protein	78
45.	Carcass characteristics - Mean and standard error	80
46.	Analysis of variance of carcass characteristics	81

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Air temperature during the experiment	34
2.	Average relative humidity and average temperature during the experiment	35
3.	Average THI and average temperature during the experiment	35
4.	Climograph of Thumburmuzhy for the year 1997	36
5	Pattern of water intake	56
6.	Consumption pattern of roughage, concentrate and water	56
7.	Monthly increaase in live weight over initial weight	57
8.	Monthly increase in body length over initial length	63
9.	Monthly increase in height over initial height	69
10.	Monthly increase in chest girth over initial chest girth	69

Introduction

INTRODUCTION

The population of Kerala is by and large, beef eating. Among the various kinds of meat available, beef is the cheapest and therefore its consumption is higher in percentage as well as in daily quantity. Presently not much consideration is being given to the quality of meat in general and beef in particular. However, the people of Kerala are becoming more affluent, quality conscious, and willing to spend money on good products. Return of many people after different periods of stay abroad, who have experienced the advantage of quality products are looking forward to the introduction of quality products like bob-veal, veal, slaughter calf and high quality beef. Even now, some firms to a limited extent are catering to the market needs of these products in a small scale. Their experience is encouraging.

The total bovine population in Kerala is 35.6 lakhs (Nair, 1997) which is beyond the carrying capacity of the land available. The number of calvings recorded in the year 1995-96 is 3.24 lakhs of which 1.59 lakhs are males (Nair, 1997). Irrespective of the sex of calf, Kerala farmers rear the young ones throughout the lactation period of dam mainly for using for let-down of milk and male calves are later sold at nominal prices. A male calf during this rearing period consumes on an average 90 litres of milk during the first

three months (Shaji, 1994). The calves continue to suck and it is reasonable to assume that they consume 130-140 litres of milk during the lactation period. The cost of milk consumed by a calf thus works out to about Rs.1500/-.

Weaning of calf at birth and feeding them on milk, skim milk and milk replacers is the standard practice followed in modern calf management. This not only saves part of the milk for human consumption but also ensures proper feeding of the calves. In the case of surplus male calves, sold either as bob veal, veal or slaughter calves, the period of rearing will be much shorter than the lactation period. Thus, there is scope for considerable savings in this respect provided farmers are educated in weaning and let-down without calves. The above mentioned products are highly valued and if, properly popularised can capture the consumer market at a substantially higher rate than the present beef price on their own merit. This can substantially add to the income of dairy farmers.

Veal industry, is very well developed in western countries. However, in India, it may not be possible to adopt in toto the veal calf rearing packages due to various reasons. We may have to evolve a new system for veal calf rearing suitable to the prevailing conditions.

The importance of rumen escape protein in ruminant diet is well recognised. In early calf hood, the rumen bypass occurs at the time of milk feeding through the closure of the oesophageal groove through which milk and such liquid diets bypass the rumen and reticulum. By continuing with liquid feeding for a longer time through which high quality non milk proteins are introduced in a suspended form or soluble form in liquid, the beneficial action of oesophageal groove reflex is expected to be extended over a longer period. In the present study one of the objectives is to verify whether such liquid feeding really benefit the calves in terms of better growth rate.

Calf rearing is an area which is highly neglected, the main constraint being the non availability of good quality feed. Even if it is available the cost is very high. Any method to establish a cheeper good quality feed to the livestock population will improve the return from livestock sector to the farmer.

Blood is a slaughter house byproduct with good nutrient content and if properly used, can be a good source of protein, with a high percentage of bypass protein. However, problems like the madcow disease-bovine spongiform encephalopathy (Wells *et al.*, 1987). warrant very careful handling of this product to render it free from disease organisms of any kind.

With the meat industry getting more organised in the state with scientifically constructed abattoirs it will be easy to collect and utilise the blood from the animals slaughtered. In the present study, therefore, it is proposed to investigate the effect of incorporating blood meal at a suitable level in the ration of growing calves in dry mash form as well as in liquid form administered through a nipple.

Meat quality as discussed earlier is gaining more and more significance in a quality conscious market, in highly literate Kerala. Because of this any study on meat animals will not be complete without assessing the quality of the product. The present study therefore includes a detailed investigation on the carcass characteristics and quality. It is expected that the results of the study will throw light on whether, some of the feeding management practices investigated will result in greater growth and production of better quality meat as well as open avenues for utilisation of byproducts like blood meal for calf feeding which are mostly wasted in the country at present.

Review of Literature

REVIEW OF LITERATURE

Like the adult ruminant, the young calf at birth has a stomach of four parts, although only the abomasum or fourth stomach, with a capacity about twice that of the other compartments, is functional (Grossman, 1949). In the adult ruminant, however, only about eight per cent of the total capacity is in the abomasum, whereas the volume of the rumen represents 80 per cent of the total (Getty, 1975). In young calf, liquid food can pass straight into the abomasum, avoiding the reticulo-rumen through the oesophageal groove.

2.1 Protein digestion in calves

In the normal young calf given fresh milk, which go straight to the abomasum, clotting of the casein with the entrapped fat due to the action of rennin occurs within three to four minutes of a meal being ingested (Mortenson *et al.*, 1935). Assisted by motility of the abomasum, the clot contracts and the whey is released into the duodenum. complete passage of the whey fluid which contains lactose, whey proteins including small amount of immunoglobulins and much of the minerals, requires about seven to nine hours (Mylrea, 1966; Hill *et al.*, 1970 and Ternouth *et al.*, 1974), but 85 per cent of the whey passes into the duodenum within six hours of feeding. The casein retained in the abomasum is

degraded as a result of the action of rennin (chymosin) and/or pepsin and hydrochloric acid, the produdcts being released only slowly during the first six hours after a feed but thereafter at a more rapid rate as the curd disintegrates (Mylrea, 1966). The age at which transition to the ruminant mode of digestion occurs is largely dependent on the type of diet that the calf receives.

2.2 Oesophageal groove and rumen bypass

Major portion of calves' diet consists of milk, which is readily attacked by the rumen microflora and degraded to amino acids, ammonia, nitrates and nitrites (Van Straalen and Tamminga, 1990). Eventhough, a simultaneous synthesis of amino acids and microbial protein takes place in the rumen and some of the ammonia recycled through the urea cycle, considerable wastage of the milk protein takes place in the rumen. This process increases parallel to the functional development of the rumen. Nature's method of avoiding this wastage is activation of the reflex when the calf sucks milk in which the sides of the oesophageal groove close to form a tunnel connecting oesophagus to abomasum, bypassing rumen reticulum and omasum. Feeding trials to assess the extent of closure of reticular groove, as estimated by the blood glucose and rumen strontium indicated a high degree of groove closure with bottle feeding (Robinson *et al.*, 1977).

The natural stimulus for the reflex is sucking of milk from the teats. It has been long understood that this reflex can be exploited to feed high quality soluble proteins bypassing the wasteful rumen digestion by suspending these in water and feeding these in the liquid form through a nipple bucket.

Using a strontium tracer method, liquid diet given through bottle feeding was shown always to bypass the rumen (Hedde *et al.*, 1974).

2.3 Liquid feeding

Reviewing the work on liquid feeding of calves, Pryor and Ternouth (1972) observed that the general concensus was that, calves fed liquid diet gained higher live weight than groups on solid diet. They quoted the observation that calves on liquid feeding had higher energy and nitrogen acretion in the edible carcass and higher efficiency of feed conversion as the reason for better gain in body weight. Citing literature they also concluded that the superiority of liquid diet was mainly due to avoidance of ruminal fermentation of milk.

For the first 11 weeks calves on dry feed using automatic feeders gained more weight than that of the bucket-fed (liquid feed) calves, but were then overtaken by the latter. The

former drank more milk, but their feed conversion was lower than with bucket feeding (Gallasz *et al.*, 1973).

Dry matter content of faeces from liquid fed calves were significantly lower than in those from dry fed calves. There was no significant interaction between the diet composition and diet dry matter content in respect of feed intake or live weight gain (Hinks and Whittemore, 1976). They also found that calves on dry diet drank significantly less water than those on liquid diet.

Group of calves fed on dry diet had more volatile fatty acids in the rumen, ammonia in the large intestine, glycogen in the liver, ketone bodies and total nitrogen in plasma, less total lipids in liver and triglycerides and phospholipids in plasma than the groups given liquid suspension (Abe *et al.*, 1979b).

Calves on liquid feed had significantly more developed caecum and large intestine but less developed reticulorumen and omasum than dry feeding (Abe *et al.*, 1978).

Teat feeding can be advantageous where problems arise with bucket feeding and that modified teats can give drinking times similar to bucket feeding (Stewart, 1976).

On the other hand Abe *et al.* (1979a) found that there seemed to be no difference in functioning of oesophageal groove closure between nipple pail or open bucket feeding in calves. Continuing bucket feeding effected an efficient closure of the oesophageal groove at least upto 16 weeks of age.

Similarly Morrill and Dayton (1981) found that method of milk feeding (open pail vs. nipple pail) during three weeks test period did not significantly affect the weight gain, grain consumption and incidence of diarrhoea.

There was little difference between bucket and nipple feeding in plasma glucose, and insulin at any age. Bucket feeding from an early age led to an efficient closure of oesophageal groove (Kobayashi *et al.*, 1984).

Feed consumption and nutrient intake were not influenced by feeding method (from nipple pail or from buckets). During the milk feeding periods, calves fed from nipple pails had lower total weight gain and average daily weight gain than calves fed from buckets, but there were no difference in weight gain after weaning and the difference over the whole period were not significant and nutrient conversion was better in calves fed from buckets (Szucs *et al.*, 1983).

Compared with small increases, when glucose solutions were infused into the rumen, there were rapid increase in blood glucose in 15 of 19 cows when solutions of 500 g glucose in 4 per cent milk or water was sucked; the increase after 2 h averaging 32.6 mg/100 ml. Normal drinking of glucose solutions by trained cows did not generally lead to rumen bypass (Huber *et al.*, 1982).

Calves fed from bucket had a significantly higher mean daily gain of body weight than those fed from nipple bottle. Cheapest method is to feed young cattle on milk at the rate of five per cent of body weight from a bucket and to offer liberal amounts of good quantity calf starter (Nuwagaba and Kayongo-Male, 1983).

The live weight gain of calves receiving the liquid concentrate was depressed by 34 per cent. The digestibility of total drymatter, protein, starch and energy was lower in the liquid concentrate feeding than in the dry concentrate group (BenAsher *et al.*, 1981).

Quigley *et al.* (1994) observed no effect of treatment (feeding from plastic bucket or from nipple bottle) on intake, rates of gain, feed efficiency, plasma glucose, urea nitrogen and that calf starter fed from a plastic nipple bottle

promoted starter intake as effectively as did starter fed from plastic buckets.

Serum gammaglobulin was lower in calves given colostrum by stomach tube, than in calves given the same amount through free access to nipple feeders as colostrum given by stomach tube went straight to the rumen, rather than into the abomasum (Zaremba, 1983). They were of the opinion that young calves should be fed colostrum and milk by means of nipple feeders.

In feeding trials where calves were given milk by bucket and automatic machine, calves fed by machine gained on average 82 g more in body weight than bucket fed calves, (Podkowka *et al.*, 1994).

Warner (1984) observed that calf relies heavily on milk protein during the first five to six weeks and often on forage protein after 10 weeks of age. He was of the opinion that crucial aspect of a calf starter may be its total intake rather than its specific protein characteristic. It is suggested that the use of technique to increase starter intake by the calf is of great significance.

The ruminal function of the young calf reaches mature levels within a few weeks after the beginning of dry feed intake (Lalles and Poncet, 1990). Thus there is a distinct

possibility of delaying rumen development through continuing liquid feeding and withholding introduction of dry feed.

2.4 Ruminal escape

Slowly degraded proteins in blood meal, meat meal and maize gluten meal had protein efficiency values 2 to 3 times that of soyabean meal (Klopfenstein, 1981).

Loerch *et al.* (1983) reported that supplementation with blood meal caused greater nitrogen flow to the duodenum than supplementation with soyabean meal, meat and bone meal and that true digestibility of blood meal was greater than meat and bone meal.

Calves on diet containing a non-degradable (rumen-bypass) protein source (blood meal 150 g, yeast 75 g) had a better weight gain and feed conversion for the first two months (Drevjany *et al.*, 1989).

Addition of 2 per cent supplemental ruminal escape protein (REP) increased the net energy of the diet by 6.6 per cent. In a digestion trial, supplemental REP linearly increased ($P<0.01$) passage of non ammonia and amino acid nitrogen to the small intestine (Zinn and Owens, 1993).

In an experiment on calves it was observed that feed efficiency increased with increasing rumen undegradable protein for weeks 14 to 25 of age. Carcass composition was not affected by dietary treatment for either 9-10-11 rib section or the half carcass (Swartz *et al.*, 1991). On the basis of the study they concluded that the amount of undegradable intake protein currently recommended for growing dairy replacements may not be justified when intake is *ad libitum*. On the other hand Iriki *et al.* (1992) were of the openion that rumen undegradable protein is needed by calves above 3 months of age when given a low crude protein diet containing protein of low rumen degradability due to reduced microbial protein synthesis.

Abe *et al.* (1985) observed that the degradation properties of feed protein appeared to have little influence on the growth of the calves when they were given a diet with more than 16 per cent crude protein.

Supplemental protein is best provided as a combination of rumen soluble protein (soyabean meal, urea) and less soluble rumen bypass protein (RBP) (feather meal, blood meal, maize gluten meal) instead of all soluble or all RBP. Pasture protein is often highly rumen soluble and therefore liquid protein supplements for grazing ruminants should contain high

proportion of RBP and it is suggested that atleast half supplemental protein should be RBP (Perry, 1988).

Orskov (1994) concluded that optimal feed utilization and health of animals can be achieved by ensuring optimal conditions for cellulolysis in the rumen, and that except for protein and fat there is little or no advantage in encouragement of post ruminal digestion of carbohydrate.

2.5 Blood meal

Supplementation with blood meal increased ruminal escape nitrogen and duodenal flows of total and most essential amino acids (Rangngang *et al.*, 1997).

Zinn and Owens (1993) observed that a two per cent supplementation of ruminal escape protein blend consisting of 1/3 blood meal, 1/3 meat and bone meal, and 1/3 feather meal to feed lot steers increased the rate and efficiency of gain by 13.4 and 8.4 per cent respectively over that of basal diet. Protein supplementation had a quadratic effect ($P<0.05$) on the net energy value of diet as the addition of 2 per cent supplemental blend containing blood, meat, bone and feather meal increased the net energy of diet by 6.6 per cent. In a digestion trial they also observed that these blood-meat-bone-feather meal linearly increased ($P<0.01$)

passage of ammonia, and amino acid nitrogen to the small intestine.

Heifers given blood and bone meal had higher ($P<0.05$) live weight gain compared to similar weight groups given urea alone or urea and bone meal. Dry matter digestibility was higher ($P<0.05$) in experimental groups, compared with controls, but there was no significant difference between groups given blood meal and bone meal (Iwuanyanwu *et al.*, 1990).

In a growth trial with urea, feather meal, and blood meal, the most efficiently used protein supplement was 100 per cent blood meal (protein efficiency 2.45 ± 0.19). There was a quadratic ($P<0.01$) response to the level of blood meal indicating a complementary effect the largest being at the 12.5 per cent level of blood meal addition (Blasi *et al.*, 1991).

Bani *et al.* (1993) observed that blood meal can be profitably fed to beef cattle particularly in the first phase of rapid growth, especially if associated with rumen undegradable protein sources, in order to improve the amino acid composition of intestinally available proteins.

With the addition of blood meal, daily gain and feed to gain ratio tended to improve (Macolm-Callis *et al.*, 1994).

The dry matter efficiency was higher for heifers fed high energy and high REP diets and apparent total digestible nutrient efficiency was higher in heifers fed high REP diets (Bethard *et al.*, 1997).

The rate and efficiency of nitrogen use for growth improved with addition of an amino acid balanced undegradable protein mixture (meat and bone meal, blood meal, fish meal and hydrolysed feather meal) to the diet of finishing holstein steers (Knaus *et al.*, 1998).

Ayangbile *et al.* (1993) observed that protein in fermented blood is readily available and fermentation with molasses improves nutrient digestibility. They also found that combining of blood meal and poultry litter provide the ruminal ammonia nitrogen needed by the microbes for increased digestibilities.

Fermentation of blood is superior to cooking because fermented dried blood meal supported a higher performance than cooked dried blood meal when they supplied equal nitrogen levels especially at higher levels of nitrogen supply (King'ori *et al.*, 1998).

On the other hand Harvey and Spears (1989) observed that average daily gain and feed efficiency were similar for calves given ring dried blood meal and soyabean meal.

Vardevanyan (1977) indicated that starting concentrate feeding of young cattle with albumin, blood and meat and bone meal were ineffective compared to dried skim-milk.

2.6 Special-fed veal

In western markets veal with paler colours has a preference. Because of this, veal producers withhold the feeding of iron to these calves to the barest minimum resulting in pale coloured veal.

But often such diets caused severe anaemea and affected the health of these calves. This has prompted some of these governments to come forward with legislation insisting a minimum level of iron in the diets of veal calves.

Milk replacers (MR) containing only 10 mg iron/kg caused marked anaemia and reduced growth performance. Feeding MR with only 20 mg iron/kg is not necessarily sufficient to prevent development of severe anaemia. Feeding MR with 50 mg iron/kg would seem to be physiologically the most appropriate amount of iron for veal calves, but was too high for

acceptable carcass taxation in western countries (Lindt and Blum, 1994). However, no such restrictions exist in India.

On the basis of the demand for pale meat as well as healthy high producing calves, legislation in Switzerland concerning iron supply in veal calf rations has fixed a minimum dietary norm of 22.7 mg iron/kg dry matter (Morel, 1996).

Commercial milk replacers supplemented with iron can improve finishing performance without a detrimental effect on the colour of veal. It must be noted that, meat colour depends on the amount of non supplemented and on the duration of supplementation (Knaus *et al.*, 1997).

Bobveal had less fat (internal, external and intermuscular) and a higher bone percentage than special fed veal ($P<0.05$) (Specht *et al.*, 1994).

As developing countries like India do not have such consumer preferences, it will be a good practice to base veal-calf feeding on sound nutritional principles including optimum level of iron in the veal calf diet and `train' the growing, albeit infant, veal market to accept the slightly darker coloured veal.

2.7 Sucking behaviour

Incidence of cross sucking was observed to be lower in the nipple pail group compared to bucket feeding (Szucs *et al.*, 1983).

The duration of sucking at the nipple bucket was longer than at the open bucket and the duration of non-nutritive sucking was less. Duration of non nutritive sucking increased if the bucket was left after feeding and also if the number of daily feeds increased (Mees *et al.*, 1984).

Sambraus (1984) observed that sucking for an average duration of two minutes occurred in almost all animals monitored, when they were released immediately after feeding. Teathering for 30 minutes reduced the rate to about 20 per cent and the duration to less than one minute.

Time spend on non nutritive oral behaviour increased with age. Bucket fed calves spent more time in sniffing a focal object than bottle fed calves. Calves with access to pacifiers sucked other objects more than calves without pacifiers. The more curious animals spent more time, involved in non nutritive oral behaviour (Kopp *et al.*, 1986).

Sucking behaviour was stimulated by the availability of the floating teat. Tongue playing was less frequent in treatment with floating rubber teat (Wee-E-ter *et al.*, 1989).

El-Sayed *et al.* (1994) compared natural sucking of the dam with artificial sucking from nipple-pail. Absolute rate of daily growth was significantly higher in the suckled group. Tail wagging, butting, contented snoring and playing were traits shown only by sucking calves. Butting associated with natural sucking was a common problem with artificially suckled calves.

The impact of teathering on preputial sucking was studied in group housed calves. Calves teathered for first two weeks displayed no preputial sucking (Hanekamp *et al.*, 1994).

2.8 Disease incidence

Fluid intake, and dry matter concentration affected average daily gain, intakes of dry matter and total water. Dry matter concentration affected incidence and duration of diarrhoeas and intake of water. Dry matter concentration was of greater importance in control of diarrhoea than was fluid intake (Jenny *et al.*, 1978).

Presence of glycinin and beta conglycinin in soluble and undenatured form in soyabean flour fed to pre-ruminant calves

was associated with the development of digestive disturbances and production of serum antibodies (Kilshaw and Sissons, 1979).

Occurrence of diarrhoea, was three times greater for weaned calves than for nursed calves (Rajala and Castren, 1995).

2.9 Environment and growth

Rate of surface evaporation had a highly significant positive correlation with air temperature and a significant negative relation to humidity (McDowell *et al.*, 1961).

Cutting off direct solar radiation by providing shelter and sprinkling water twice a day during summer on the animals exerted positive effect on gain in live weight and rate of increase in length, in murrah buffalo heifers (Tripathi *et al.*, 1972). Increase in ambient temperature and humidity had adverse effect on gain in weight and most other growth parameters (Bianca, 1965; Tripathi *et al.*, 1972).

Stress of hot environment lowers productive and reproductive efficiency in farm animals and increasing nutrient intake to support a higher level of production will render animals more sensitive in terms of productive

efficiency and to environmental modifications that improve comfort (Fuquay, 1981).

Weather is a constraint on efficient livestock production system. The functional relationship between animal performance and weather parameters permit prediction of the reduction in animal performance under natural conditions or of the benefits to be derived from proposed housing or management practices (Hahn, 1981).

Climatic factors that influence metabolisable energy intake or heat production will influence, productivity and utilization of dietary energy (Young, 1981; Kibler *et al.*, 1966; Nauheimer-Thoniek *et al.*, 1988).

The better ventilation and air movement in the conventional shed due to high roof and half walled open type construction might have resulted in better thermolysis and thermal comfort favouring better feed intake and utilization and growth (Saseendranath *et al.*, 1983).

Thermal stress impact negatively on performance of intensively managed livestock in southern United States and other subtropical and tropical regions of the world. Physical protection by intercepting incoming solar radiation, genetic development of less heat sensitive breeds and nutritional

management strategies were proposed for enhancing productivity (Beede *et al.*, 1986).

Control of body temperature is a consequence of the thermoregulatory mechanism of an animal and the resistance to energy exchanges between it and the environment. If air temperature exceeds skin temperature, there is a net inward flow of heat through the coat to the skin and here the resistance of the animal to environmental heat flow is of great importance to the control of body temperature (Finch, 1986).

Materials and Methods

MATERIALS AND METHODS

3.1 Location of the experiment/study area and period of experiment

The experiment was carried out at Cattle Breeding Farm, Thumburmuzhi, located 76°25′ East-longitude and 10°18′ North-latitude and elevation of 45 metres above Mean Sea Level. The place is having hilly terrain with 3213 mm of rainfall spread over nine months from April to December. The experimental period was from 1st of April, 1997 to 30th of September, 1997.

3.2 Experimental animals

Twenty four crossbred calves of mixed heritage below one month of age were selected in quadruplets depending upon nearness in date of birth, sex and similarity in body weight. The selected calves were the progenies of interse mating between 50 per cent crossbreds. The indigenous stock to begin with were of local origin with some of them having a certain percentage of Red Sindhi inheritance, but mostly were non-descript cattle of Kerala. The *Bos taurus* breeds used for crossbreeding were Jersey, Brown Swiss and Holstein-Friesian. The exact percentage of inheritance from any of these breeds is difficult to assess. However, semen used to produce the

calves was of sires of 50 per cent Holstein-Freisian inheritance.

The calves were dewormed and dipped in dilute butox (deltamethrin 1.25%) before housing. Periodic deworming and spraying of ectoparasiticides were carried out throughout the study.

3.3 Treatments

There were two main treatments namely, types of feeding and supplementation. The two types of feeding included dry and liquid feeding and the supplementation being no addition of blood meal and addition of blood meal. Thus the treatment combinations were:

T_1 - dry feeding and no supplementation with blood meal (control)

T_2 - dry feeding and supplementation with blood meal

T_3 - liquid feeding and no supplementation with blood meal

T_4 - liquid feeding and supplementation with blood meal

The 24 calves selected and made ready were allotted at random to one of the four treatment combinations taking care that one animal from each quadruplet went to one of the treatment combination.

3.4 Preparation of blood meal

Blood from cattle as well as pigs was hygienically collected from the Meat Technology Unit of Kerala Agricultural University. This was dried in metal trays kept in hot air oven initially at 100°C for 1 h and later at 60°C until the blood was dried. The dried blood was scraped out and ground in a hammer mill and immediately used for mixing with other ingredients to prepare the calf starter.

3.5 Feeding of calves

The starter rations for the calves were formulated satisfying the Indian Standards Specifications (1970). For supplemented groups, blood meal was added to the feed at 30 per cent replacement of protein. In dry feeding the starter was fed in the dry form with coarsely ground particles. In the case of liquid feeding, the same amount of calf starter was ground to a paste form using a wet grinder and was made into a suspension in water using a wearing blender. The dry feed was offered to the calves individually in feeding baskets whereas the liquid feed was fed through nipple buckets. *Ad libitum* feeding of the calf starter was resorted to in the beginning. However, on progress of the experiment it was observed that some calves developed diarrhoea due to

overfeeding. Because of this, the feeding time was reduced to fifteen minutes each in the morning and evening.

In the ration containing blood meal, the ingredients including blood meal were ground in a hammer mill and blended well in a mixture. Approximately the feed required for a week was prepared and stored in gunny bags. This was fed as such in the case of calves receiving feed in the dry form. For calves receiving feed in liquid form, the same was mixed in water into a fine suspension using a blender. The dry feed was mixed with water at a ratio of 4:10.

3.6 Ration composition

Ration containing no blood meal		Ration containing blood meal	
Ingredient	Percentage	Ingredient	Percentage
1. Maize	43	1. Maize	49
2. Soyabean	35	2. Soyabean	18
3. Rice polish	10	3. Blood meal	11
4. Fish meal	10	4. Rice polish	10
5. Mineral mixtures	1.5	5. Fish meal	10
6. Salt	0.5	6. Mineral mixtures	1.5
		7. Salt	0.5
	---		---
	100		100

Nitrogen in each individual feed ingredient was estimated using Kjeldahls method (AOAC, 1990). The crude protein content in the total ration was estimated mathematically using these values.

3.7 Observations

Observations on environmental variables, growth, feed efficiency, disease incidence and carcass characteristics were made.

3.8 Environmental variables

Environmental variables, namely, maximum and minimum air temperature and relative humidity (from dry and wet bulb thermometer readings) were recorded daily. Using these observations average air temperature was estimated and climograph plotted. Similarly the temperature humidity index (THI) values for different periods were also estimated.

The relationship between the environmental variables and the consumption of feed and water were investigated. Similarly the relationship between environmental variables and growth were also studied.

3.9 Growth

In order to study the growth, gains in body weight and body measurements like length, height at withers and chest girth were measured at monthly intervals of time. Using standard procedures, calves were weighed on a fixed date in a

month on a platform balance. Monthly weight gains were estimated from the observations for progressive periods, namely, 1 to 2 month, 1 to 3 month, 1 to 4 month, 1 to 5 month and 1 to 6 month.

3.10 Feed intake

Feed intake i.e., consumption of milk, water, roughage and calf starter was estimated two days in a week.

From the observations on feed intake and gain in weight, the feed efficiency was estimated.

3.11 Disease incidence

The types of disease of common occurrence were classified as:

A. Diarrhoea (mainly due to overfeeding)
B. Coccidiosis
C. Bacterial and viral infectious disease
D. Non infectious disease

Incidence of disease to calves in the four treatments during the experiment period was recorded.

3.12 Blood picture

In order to study the blood picture, haematocrit, haemoglobin, erythrocyte sedimentation rate, serum glucose, plasma protein and serum cholesterol were estimated. Wintrobe method was employed for estimation of haematocrit (Benjamin, 1985). Haemoglobin was estimated according to Sahli's acid hematin method (Benjamin, 1985). Erythrocyte sedimentation rate was estimated according to Wintrobe method (Benjamin, 1985). GOD/POD method using kit supplied by Agappe was used to estimate serum glucose while the Biuret method for total protein. Serum albumin was estimated by Brom cresol green method using kit supplied by Agappe. Serum cholesterol was estimated according to oxidase peroxidase method using kit supplied by Agappe.

3.13 Carcass characteristics

Three animals from each treatment group was slaughtered on completion of experiment. Carcass characteristics such as slaughter weight, carcass weight, weight of bone, weight of deboned meat, dressing percentage, bone to meat ratio and weight of edible internal organs were studied.

Results

RESULTS

4.1 Environmental variables

The monthly average values of maximum temperature, minimum temperature and mean temperature for the year 1997 are shown in Table 1 and the graphical representation of the same is shown in Fig.1.

The monthly average values of relative humidity and Temperature Humidity Index (THI) values are presented in Table 2 and the graphical representation of the same in Fig.2 and 3.

The climograph of Thumburmuzhy for the year 1997 is given in Fig.4.

4.2 Effect of environmental variables on body weight gain

Regression equation and values of R^2 and adjusted R^2 for multiple regression of body weight gain on maximum temperature and the relative humidity (afternoon) are shown in Table 3.

Regression equation and values of R^2 and adjusted R^2 for multiple regression of body weight gain on minimum temperature and relative humidity (forenoon) are shown in Table 4.

Table 1. Details of temperature recorded for the year 1997

Sl. No.	Particulars	Months											
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Maximum temperature	33.06	34.19	35.64	35.26	34.41	30.65	27.68	28.66	28.68	31.77	30.13	32.85
2.	Minimum temperature	20.60	21.39	23.76	24.92	23.73	27.24	26.21	23.63	23.93	22.93	23.44	20.69
3.	Mean temperature	26.83	27.79	29.70	30.09	29.09	28.95	26.95	26.15	26.31	27.35	26.79	26.77

Table 2. Monthly average relative humidity and THI values

Sl. No.	Particulars	Months											
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Relative humidity	74.20	71.84	73.91	74.62	75.98	70.13	76.03	83.12	79.54	76.89	77.97	78.45
2.	THI values	77.71	78.87	82.52	82.85	83.06	79.64	76.86	78.42	79.39	80.83	78.77	81.78

Table 3. Multiple regression of body weight gain on maximum temperature and relative humidity (2 pm)

	R^2	Adjusted R^2
$Y_{1i} = 15.361906 - 0.43819 \ MA \pm 0.098697 \ RHA$	0.88	0.811
$Y_{2i} = 17.902567 - 0.15905 \ MA \pm 0.074763 \ RHA$	0.54	0.233
$Y_{3i} = 5.881937 - 0.034908 \ MA \pm 0.018939 \ RHA$	0.022	-0.63
$Y_{4i} = 11.950716 - 0.29143 \ MA \pm 0.059459 \ RHA$	0.665	0.44

Y - Body weight gain
MA - Minimum temperature
RFA - Relative humidity afternoon

Table 4. Multiple regression of body weight gain on minimum temperature and relative humidity (2 pm)

	R^2	Adjusted R^2
$Y_{1ii} = -11.506576 - 1.4677 \ MI + 0.63266 \ FHF$	0.534	0.223
$Y_{2ii} = -17.696772 + 0.16905 \ MI + 0.24278 \ RHF$	0.516	0.194
$Y_{3ii} = 3.746506 - 0.45935 \ MI + 0.15483 \ RHF$	0.077	-0.53
$Y_{4ii} = -10.024157 - 1.1153 \ MI + 0.017 \ RHF$	0.569	0.282

Y - Body weight gain
MI - Minimum temperature
RFF - Relative humidity afternoon

Fig.1 AIR TEMPERATURE DURING THE EXPERIMENT

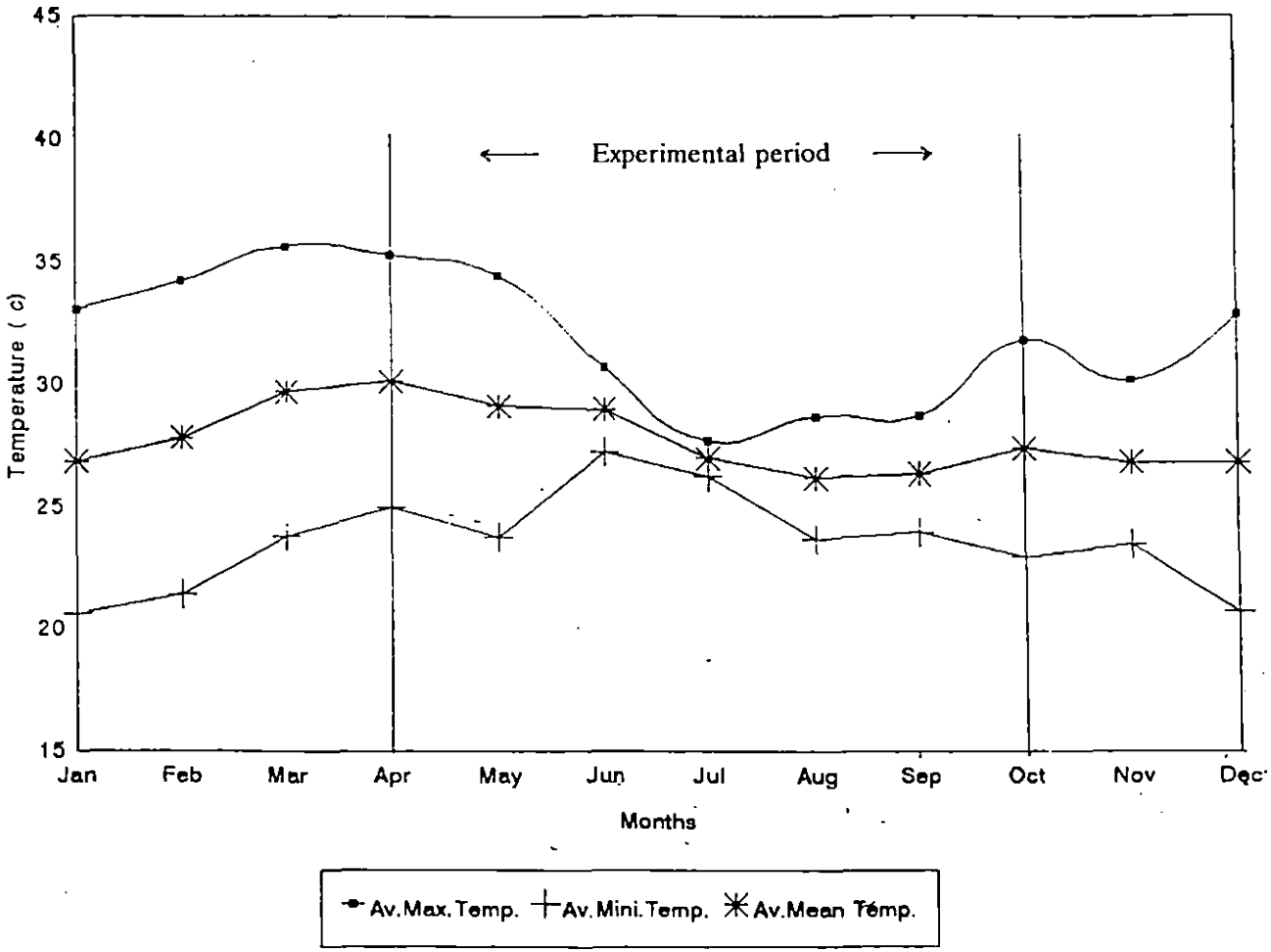


Fig.2 AVERAGE RELATIVE HUMIDITY AND AVERAGE TEMPERATURE DURING THE EXPERIMENT

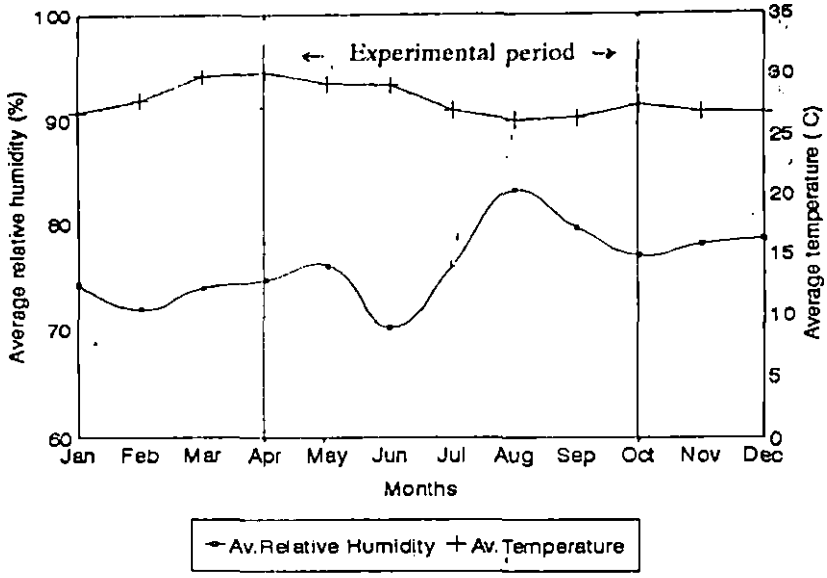


Fig.3 AVERAGE THI AND AVERAGE TEMPERATURE DURING THE EXPERIMENT

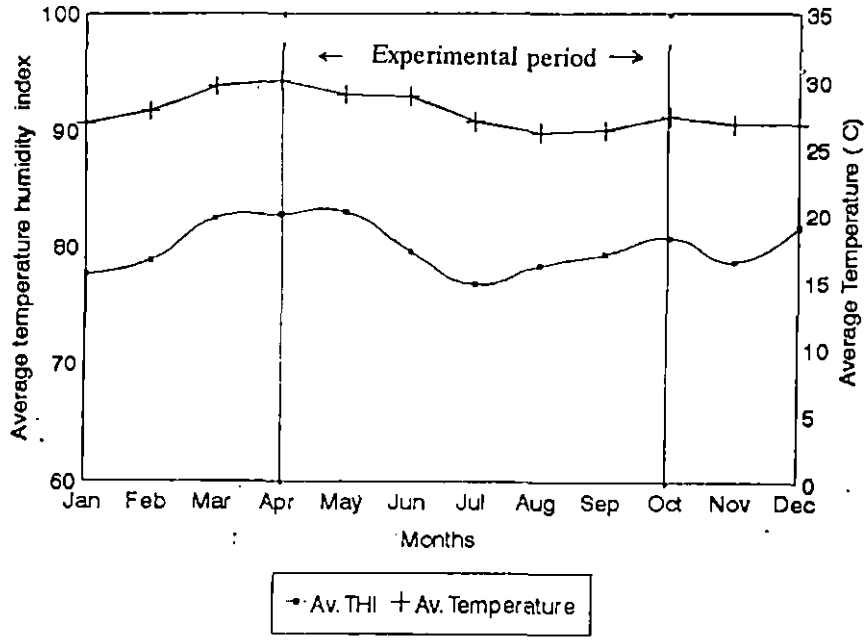
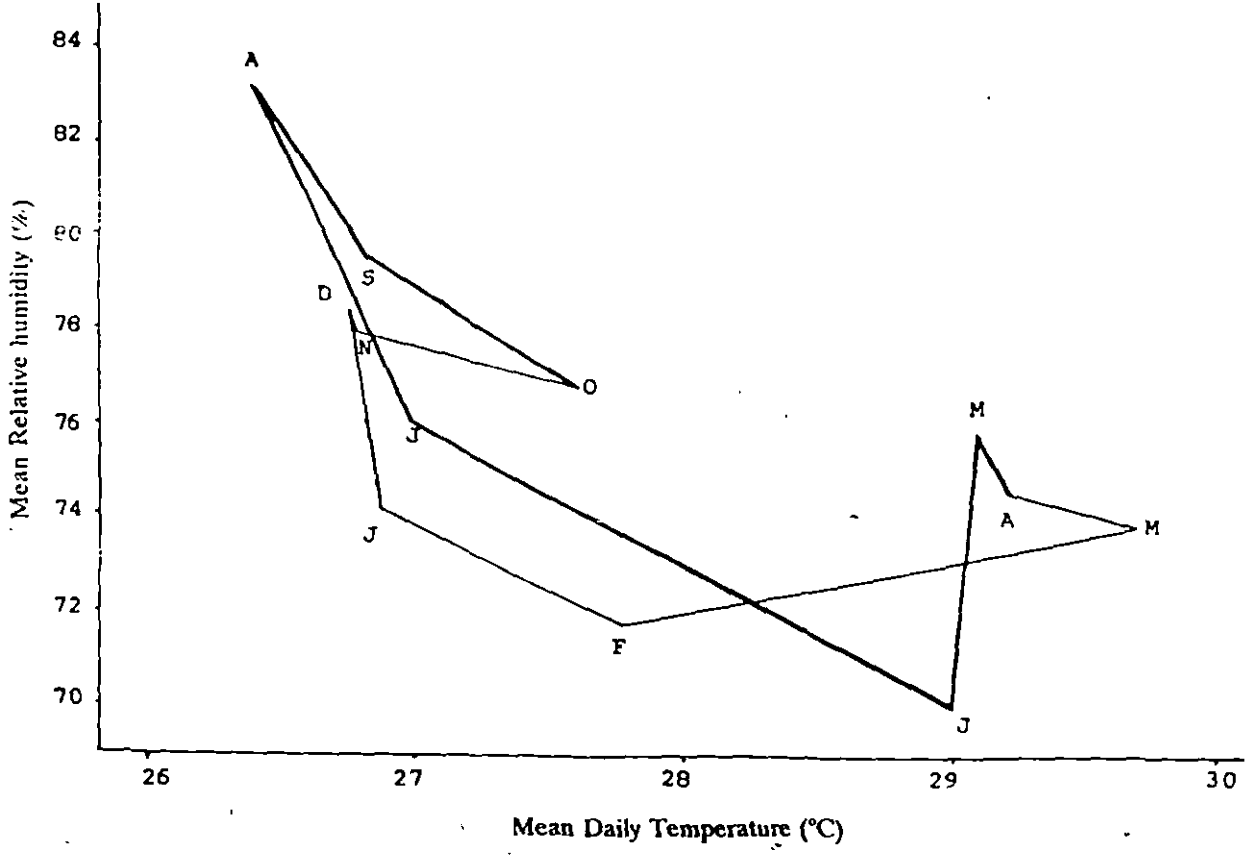


FIG.4 CLIMOGRAPH OF THUMBURMUZHY FOR THE YEAR 1997
(Darkened line indicate the period of experiment from April to September 1997)



Regression equation and values of R^2 and adjusted R^2 for multiple regression of body weight gain on average temperature and average relative humidity are presented in Table 5.

4.3 Water intake

Weekly water intake for 26 weeks of experimental period is shown in Table 6.

The results of analysis of variance is presented in Table 7. There was no significant difference in water intake between the four treatment groups.

The effect of environmental variables on water intake was investigated through multiple regression analysis results of which are presented in Table 8. Highly significant R^2 and adjusted R^2, values for all the four treatments indicate the profound influence of climatic elements on water intake.

4.4 Consumption of milk

Data on consumption of milk collected on two days in a week was transformed into weekly consumption of milk and is presented in Table 9. Results of analysis of variance is presented in Table 10. Though the consumption of milk for the total period of 8 weeks showed no significant difference

Table 5. Multiple regression of body weight gain on average temperature and average relative humidity

					R^2	Adjusted R^2
Y_{1iii} =	29.518743	- 1.0727	AVT + 0.10926	AVRH	0.88	0.811
Y_{2iii} =	-54.842681	- 0.82008	AVT - 0.31163	AVRH	0.661	0.434
Y_{3iii} =	18.846335	- 0.36633	AVT - 0.03430	AVRH	0.054	-0.576
Y_{4iii} =	32.05211	- 0.93219	AVT - 0.0095809	AVRH	0.759	0.598

Y - Body weight gain
AVT - Average temperature
AVR - Relative humidity

6. Weekly intake of water (kg) - Mean and standard error

Treatment	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T_1	1.667± 0.32	2.183± 0.37	2.657± 0.33	3.325± 0.35	3.833± 0.32	4.350± 0.29	4.608± 0.35	5.158± 0.36	6.152± 0.43	6.917± 0.44	6.967± 0.49	7.750± 0.18	8.292± 0.67
T_2	1.492± 0.16	2.058± 0.24	2.550± 0.20	2.967± 0.24	3.567± 0.30	4.500± 0.22	4.408± 0.25	5.833± 0.37	6.367± 0.40	7.050± 0.45	7.383± 0.63	8.100± 0.44	8.700± 0.50
T_3	1.117± 0.19	1.450± 0.11	1.992± 0.21	2.633± 0.14	3.283± 0.21	3.892± 0.21	4.400± 0.22	4.925± 0.23	5.992± 0.42	6.267± 0.46	6.717± 0.42	7.092± 0.35	7.167± 0.55
T_4	1.283± 0.08	1.850± 0.09	2.300± 0.17	2.933± 0.28	3.708± 0.27	4.225± 0.33	4.775± 0.36	5.608± 0.45	6.133± 0.49	6.683± 0.47	7.142± 0.39	7.592± 0.35	8.458± 0.44
	1.390± 0.188	1.885± 0.203	2.352± 0.228	2.965± 0.273	3.598± 0.275	4.242± 0.263	4.673± 0.295	5.381± 0.353	6.154± 0.435	6.729± 0.455	7.052± 0.483	7.633± 0.330	8.154 0.540

Contd.

Table 6 (Contd.)

Treatment	Weeks														
		14	15	16	17	18	19	20	21	22	23	24	25	26	Mean
T_1	8.667±	9.342± 0.91	9.983± 0.90	10.558± 0.96	10.892± 1.15	12.320± 1.07	12.450± 0.75	12.500± 0.71	12.590± 0.48	12.320± 0.55	12.540± 0.37	12.920± 0.41	12.670± 0.38	8.212± 0.36	0.54
T_2	9.358± 0.67	10.075± 0.71	10.725± 0.54	10.817± 0.75	12.000± 0.84	12.342± 0.58	12.525± 0.37	12.775± 0.46	12.783± 0.40	12.542± 0.37	12.717± 0.35	12.625± 0.29	12.767± 0.31	8.424± 0.43	
T_3	8.100± 0.35	8.633± 0.36	9.467± 0.38	9.892± 0.60	10.392± 0.71	10.825± 0.70	11.208± 0.83	11.600± 0.82	11.567± 0.85	12.530± 0.34	12.290± 0.26	12.380± 0.29	12.460± 0.24	7.626± 0.40	
T_4	9.000± 0.40	9.583± 0.49	10.092± 0.51	10.833± 0.65	10.950± 0.58	12.042± 0.56	12.125± 0.45	12.592± 0.29	12.375± 0.36	12.392± 0.34	12.300± 0.27	12.400± 0.27	12.508± 0.24	8.149± 0.37	
	8.781± 0.583	9.408± 0.615	10.067± 0.61	10.525± 0.79	11.058± 0.79	11.863± 0.68	12.061± 0.59	12.361± 0.51	12.317± 0.54	12.448± 0.36	12.466± 0.32	12.575± 0.31	12.605± 0.29	8.106± 0.44	

Table 7. Analysis of variance of weekly intake of water

Source	d.f.	Mean square												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Between	3	0.346	0.619	0.436	0.481	0.335	0.403	0.289	0.010	0.146	0.708	0.475	1.053	2.769
Error	20	0.259	0.318	0.334	0.409	0.472	0.430	0.535	0.010	0.142	1.239	1.448	1.084	1.784

Source	d.f.	Mean square													Mean
		14	15	16	17	18	19	20	21	22	23	24	25	26	
Between	3	1.716	2.160	1.602	1.165	2.741	3.025	2.145	1.640	1.692	0.062	0.242	0.328	0.113	1.027 NS
Error	20	2.316	2.518	2.516	4.000	4.018	2.411	2.154	1.770	1.920	0.704	0.587	0.514	0.465	1.321

NS - Non-significant

Table 8. Effect of environmental variables on water intake

		R^2	Adjusted R^2
W_1 =	125.363902 - 3.4675 AvT - 0.27055 AvRH	0.906	0.843
W_2 =	134.656224 - 3.7051 AvT - 0.30082 AvRH	0.895	0.825
W_3 =	125.086881 - 3.4627 AvT - 0.27492 AvRH	0.866	0.776
W_4 =	130.275220 - 3.5928 AvT - 0.28834 AvRH	0.89	0.817

W_1 - Water intake T_1, W_2 - Water intake T_2, W_3 - Water intake T_3, W_4 - Water intake T_4
AvT Average temperature, AvRH Averge relative humidity

Table 9. Weekly consumption of milk (kg) - Mean and standard error

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
T_1	2.855± 0.19	2.500± 0.19	2.255± 0.14	2.062± 0.18	1.795± 0.07	1.480± 0.11	1.022± 0.09	0.500± 0.00	1.809± 0.121
T_2	2.313± 0.16	2.145± 0.13	2.083± 0.14	1.862± 0.07	1.695± 0.08	1.292± 0.12	0.792± 0.08	0.417± 0.08	1.575± 0.108
T_3	2.312± 0.10	2.062± 0.10	1.958± 0.08	1.793± 0.07	1.600± 0.05	1.292± 0.08	0.875± 0.06	0.500± 0.00	1.549± 0.068
T_4	2.292± 0.55	2.103± 0.128	1.917± 0.05	1.728± 0.05	1.560± 0.05	1.167± 0.05	0.833± 0.05	0.500± 0.00	1.512± 0.108
	2.443± 0.55	2.203± 0.125	2.053± 0.103	1.861± 0.37	1.663± 0.058	1.307± 0.09	0.880± 0.07	0.479± 0.02	1.611± 0.173

Table 10. Analysis of variance of weekly milk consumption

Source	d.f.	Mean square								Mean
		1	2	3	4	5	6	7	8	
Between	3	0.453*	0.243	0.139	0.125	0.066	0.100	0.060	0.010	0.15 NS
Error	20	0.122	0.104	0.072	0.066	0.022	0.051	0.031	0.010	0.06

* Significant at 5%
NS - Non-significant

between treatments, the consumption of milk during the 1st week showed significant difference ($P<0.05$).

4.5 Consumption of concentrates

Weekly average concentrate consumption by calves are presented in Table 11. Results of the analysis of variance is presented in Table 12. The concentrate intake for the whole period of experiment (26 weeks) did not show any significant difference between treatments, but values for consumption of concentrates during week 7 and 12 were significant at 5 per cent and that of week 11 at 1 per cent.

The effect of environmental variables on concentrate intake was analysed using multiple regression and the equations are presented in Table 13. On the basis of R^2 and adjusted R^2 it can be interpreted that regression equations fits well for all the four treatments.

4.6 Consumption of roughage

Table 14 depicts the weekly consumption of roughage. Analysis of variance of the data showed no significant difference in roughage intake between the four treatments (Table 15).

Table 11. Weekly intake of concentrate (kg) - Mean and standard error

Treatment	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T_1	0.113± 0.04	0.153± 0.04	0.208± 0.05	0.233± 0.04	0.350± 0.05	0.467± 0.06	0.542± 0.06	0.633± 0.06	0.725± 0.06	0.858± 0.45	0.992± 0.02	1.067± 0.01	1.117± 0.03
T_2	0.083± 0.03	0.138± 0.04	0.197± 0.05	0.300± 0.05	0.367± 0.05	0.442± 0.04	0.583± 0.05	0.683± 0.05	0.808± 0.03	0.908± 0.03	1.017± 0.05	1.133± 0.05	1.200± 0.06
T_3	0.063± 0.03	0.105± 0.03	0.138± 0.03	0.217± 0.03	0.258± 0.04	0.342± 0.04	0.408± 0.02	0.517± 0.04	0.617± 0.05	0.708± 0.05	0.775± 0.05	0.858± 0.07	0.988± 0.07
T_4	0.050± 0.02	0.190± 0.03	0.127± 0.04	0.192± 0.04	0.267± 0.05	0.308± 0.05	0.417± 0.06	0.492± 0.08	0.617± 0.09	0.742± 0.09	0.833± 0.07	0.942± 0.09	1.050± 0.1
	0.078± 0.03	0.122± 0.035	0.168± 0.043	0.235± 0.04	0.310± 0.048	0.390± 0.048	0.487± 0.048	0.581± 0.058	0.692± 0.058	0.804± 0.155	0.904± 0.048	1.000± 0.055	1.089± 0.043

Contd.

Table 11 (Contd.)

Treatment	Weeks													Mean
	14	15	16	17	18	19	20	21	22	23	24	25	26	
T_1	1.142± 0.05	1.167± 0.08	1.233± 0.08	1.358± 0.09	1.442± 0.10	1.630± 0.06	1.750± 0.08	1.860± 0.09	1.970± 0.09	2.100± 0.16	2.170± 0.16	2.200± 0.16	2.290± 0.17	1.145± 0.09
T_2	1.317± 0.07	1.417± 0.09	1.467± 0.06	1.475± 0.07	1.583± 0.08	1.642± 0.07	1.750± 0.08	1.892± 0.09	2.033± 0.13	2.117± 0.13	2.258± 0.10	2.292± 0.09	2.392± 0.12	1.126± 0.068
T_3	1.063± 0.08	1.108± 0.08	1.183± 0.07	1.208± 0.10	1.292± 0.10	1.387± 0.13	1.475± 0.15	1.625± 0.14	1.700± 0.15	1.870± 0.06	2.010± 0.08	2.210± 0.13	2.190± 0.09	1.012± 0.074
T_4	1.133± 0.11	1.133± 0.11	1.275± 0.11	1.333± 0.13	1.367± 0.11	1.442± 0.11	1.567± 0.14	1.708± 0.11	1.750± 0.12	1.808± 0.10	1.942± 0.14	1.975± 0.13	2.050± 0.09	1.027± 0.089
	1.164± 0.018	1.206± 0.09	1.290± 0.08	1.344± 0.10	1.421± 0.10	1.515± 0.09	1.630± 0.11	1.767± 0.11	1.859± 0.12	1.973± 0.11	2.097± 0.12	2.166± 0.13	2.230± 0.12	1.097± 0.077

Table 12. Analysis of variance of weekly intake of concentrate

Source	d.f.	Mean square												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Between	3	0.005	0.005	0.010	0.013	0.019	0.035	0.047*	0.051	0.052	0.054	0.084**	0.091*	0.049
Error	20	0.006	0.008	0.011	0.010	0.014	0.012	0.015	0.020	0.022	0.021	0.016	0.024	0.027

Source	d.f.	Mean square													Mean
		14	15	16	17	18	19	20	21	22	23	24	25	26	
Between	3	0.070	0.121	0.092	0.072	0.093	0.109	0.109	0.093	0.156	0.140	0.122	0.110	0.126	0.074 NS
Error	20	0.035	0.046	0.042	0.058	0.061	0.060	0.081	0.076	0.092	0.076	0.081	0.086	0.082	0.042

* Significant at 5%
** Significant at 1%
NS - Non-significant

Table 13. Effect of environmental variables on intake of concentrate

			R^2	Adjusted R^2
C_1	=	20.408405 - 0.57836 AvT - 0.041644 AvRH	0.819	0.698
C_2	=	22.426892 - 0.63038 AvT - 0.048032 AvRH	0.824	0.707
C_3	=	19.317128 - 0.55045 AvT - 0.039018 AvRH	0.785	0.641
C_4	=	20.518232 - 0.57581 AvT - 0.045281 AvRH	0.841	0.734

C_1 - Intake of concentrate T_1, C_2 - Intake of concentrate T_2, C_3 - Intake of concentrate T_3, C_4 - Intake of concentrate T_4
AvT Average temperature, AvRH Averge relative humidity

Table 14. Weekly intake of roughage (kg) - Mean and standard error

Treatment	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
T_1	0.145± 0.03	0.205± 0.04	0.258± 0.04	0.325± 0.04	0.395± 0.45	0.467± 0.05	0.517± 0.04	0.592± 0.05	0.633± 0.06	0.698± 0.06	0.762± 0.05	0.887± 0.11	1.080± 0.18
T_2	0.127± 0.02	0.177± 0.02	0.247± 0.02	0.308± 0.03	0.387± 0.45	0.460± 0.05	0.512± 0.05	0.575± 0.05	0.630± 0.05	0.698± 0.06	0.770± 0.08	0.932± 0.14	1.212± 0.26
T_3	0.053± 0.02	0.110± 0.02	0.173± 0.03	0.225± 0.04	0.288± 0.02	0.352± 0.03	0.420± 0.02	0.470± 0.02	0.540± 0.02	0.617± 0.03	0.690± 0.03	0.747± 0.03	0.798± 0.04
T_4	0.092± 0.02	0.153± 0.02	0.197± 0.02	0.262± 0.02	0.335± 0.02	0.413± 0.02	0.483± 0.02	0.547± 0.02	0.607± 0.03	0.638± 0.03	0.762± 0.03	0.847± 0.03	0.897± 0.03
	0.104± 0.023	0.161± 0.025	0.219± 0.028	0.280± 0.033	0.351± 0.235	0.423± 0.038	0.483± 0.028	0.546± 0.035	0.602± 0.04	0.674± 0.045	0.746± 0.048	0.851± 0.078	0.997± 0.128

Contd.

Table 14 (Contd.)

Treatment	Weeks													Mean
	14	15	16	17	18	19	20	21	22	23	24	25	26	
T_1	1.233± 0.20	1.460± 0.28	1.622± 0.26	1.992± 0.27	2.208± 0.28	2.590± 0.31	2.760± 0.26	2.890± 0.21	2.870± 0.22	3.080± 0.24	3.390± 0.26	3.490± 0.31	3.650± 0.38	1.546± 0.18
T_2	1.377± 0.31	1.562± 0.33	1.815± 0.38	2.138± 0.37	2.363± 0.42	2.717± 0.46	2.942± 0.40	3.092± 0.38	3.167± 0.34	3.317± 0.26	3.558± 0.27	3.717± 0.31	3.842± 0.35	1.640± 0.225
T_3	0.862± 0.03	0.985± 0.04	1.280± 0.12	1.500± 0.17	1.700± 0.18	2.075± 0.22	2.158± 0.20	2.183± 0.16	2.250± 0.17	2.560± 0.09	2.750± 0.11	2.890± 0.09	2.980± 0.17	1.218± 0.081
T_4	1.030± 0.05	1.358± 0.15	1.627± 0.21	1.913± 0.22	2.267± 0.24	2.350± 0.27	2.467± 0.23	2.550± 0.20	2.717± 0.14	3.042± 0.14	3.208± 0.10	3.425± 0.10	3.425± 0.12	1.447± 0.095
	1.125± 0.148	1.341± 0.20	1.586± 0.243	1.886± 0.26	2.135± 0.28	2.426± 0.32	2.574± 0.27	2.670± 0.24	2.746± 0.22	3.016± 0.18	3.241± 0.19	3.398± 0.20	3.489± 0.26	1.464± 0.146

Table 15 Analysis of variance of weekly intake of roughage

Source	d.f.	Mean square												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Between	3	0.010	0.010	0.010	0.012	0.015	0.017	0.012	0.017	0.011	0.009	0.008	0.035	0.205
Error	20	0.004	0.004	0.005	0.005	0.007	0.008	0.007	0.009	0.011	0.015	0.017	0.053	0.149

Source	d.f.	Mean square												Mean	
		14	15	16	17	18	19	20	21	22	23	24	25	26	
Between	3	0.307	0.380	0.298	0.449	0.528	0.472	0.697	0.939	0.874	0.536	0.642	0.649	0.732	0.303 NS
Error	20	0.216	0.312	0.404	0.443	0.521	0.632	0.474	0.378	0.311	0.220	0.232	0.291	0.420	0.198

NS - Non-significant

The multiple regression equations showing the effect of environmental variables on roughage intake are presented in Table 16. The R^2 and adjusted R^2 values suggest that the regression equations for all the four treatments fit well.

Figure 5 presents the consumption of water per unit metabolic body size by the four different treatment groups. As there is no significant difference between the four treatments with respect to consumption of concentrates and roughage and water, the consumption pattern of these parameters for all the animals is presented in Fig.6.

4.7 Live weight of calves

Monthly observations on the live weight of calves are shown in Table 17. The analysis of variance (Table 18) indicates that during the first month, there was a significant difference in live weight between treatments but when the full experimental period of 6 months was considered there were no differences in live weight between treatments.

The monthly increase in live weight from the start of the experiment is presented in Table 19 and as a bar diagram in Fig.7.

Table 16. Effect of environmental variables on intake of *roughage*

			R^2	Adjusted R^2
R_1	= 23.440441	- 0.80556 AvT - 0.0065229 AvRH	0.850	0.750
R_2	= 24.645830	- 0.86232 AvT + 0.012992 AvRH	0.824	0.706
R_3	= 17.461837	- 0.61741 AvT + 0.012187 AvRH	0.770	0.616
R_4	= 21.546244	- 0.75403 AvT + 0.011562 AvRH	0.800	0.667

R_1 - Intake of roughage T_1, R_2 - Intake of roughage T_2, R_3 - Intake of roughage T_3, R_4 - Intake of roughage T_4

AvT Average temperature, AvRH Averge relative humidity

Table 17. Monthly live weight of calves (kg) mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	38.667± 2.47	44.667± 4.69	51.500± 5.56	59.833± 5.82	71.200± 6.05	80.000± 7.42	57.645± 5.335
T_2	35.750± 1.62	43.000± 4.57	52.000± 5.89	60.833± 7.24	67.500± 7.91	76.667± 9.43	55.958± 6.11
T_3	32.083± 1.38	38.333± 3.30	43.000± 4.16	49.667± 3.84	53.833± 4.23	62.600± 3.81	46.586± 3.45
T_4	32.083± 1.57	37.333± 2.91	42.833± 3.02	49.833± 4.13	57.333± 4.63	66.333± 5.76	47.625± 3.67
	34.346± 1.76	40.833± 3.868	47.333± 4.658	55.042± 5.258	62.087± 5.705	71.409± 6.605	57.842± 4.642

Table 18. Analysis of variance of monthly live weight

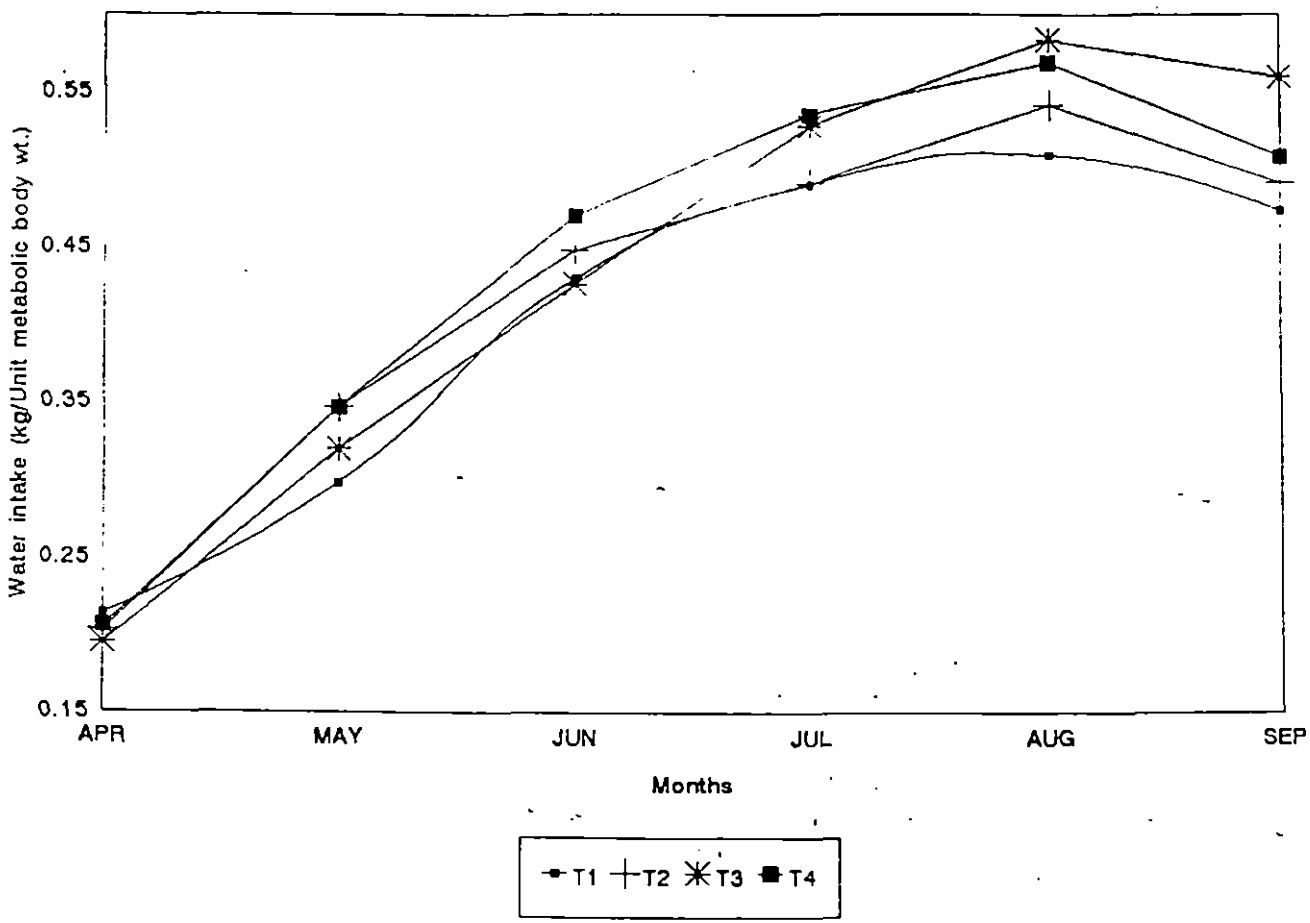
Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	61.038*	75.778	156.333	225.042	378.453	359.151	209.299
Error	20	19.681	93.300	138.017	177.192	199.393	281.104	151.448

* Significant at 5% (P<0.05)
NS - Non-significant

Table 19. Increase in live weight (kg) in relation to 1st month

Treatment	Weight at Ist month	Months				
		I&II	I&III	I&IV	I&V	I&VI
T_1	38.667	6.000	12.833	21.166	32.533	41.333
T_2	35.750	7.250	16.250	25.083	31.75	40.917
T_3	32.083	6.250	10.917	17.584	21.75	30.517
T_4	32.083	5.250	10.750	17.75	25.25	34.250

Fig.5 PATTERN OF WATER INTAKE



T1- Dry feeding without blood meal. T2- Dry feeding with blood meal
T3- Liquid feeding without blood meal. T4- Liquid feeding with blood meal

Fig.6 CONSUMPTION PATTERN OF ROUGHAGE, CONCENTRATE AND WATER
(average of all experimental animals irrespective of treatments)

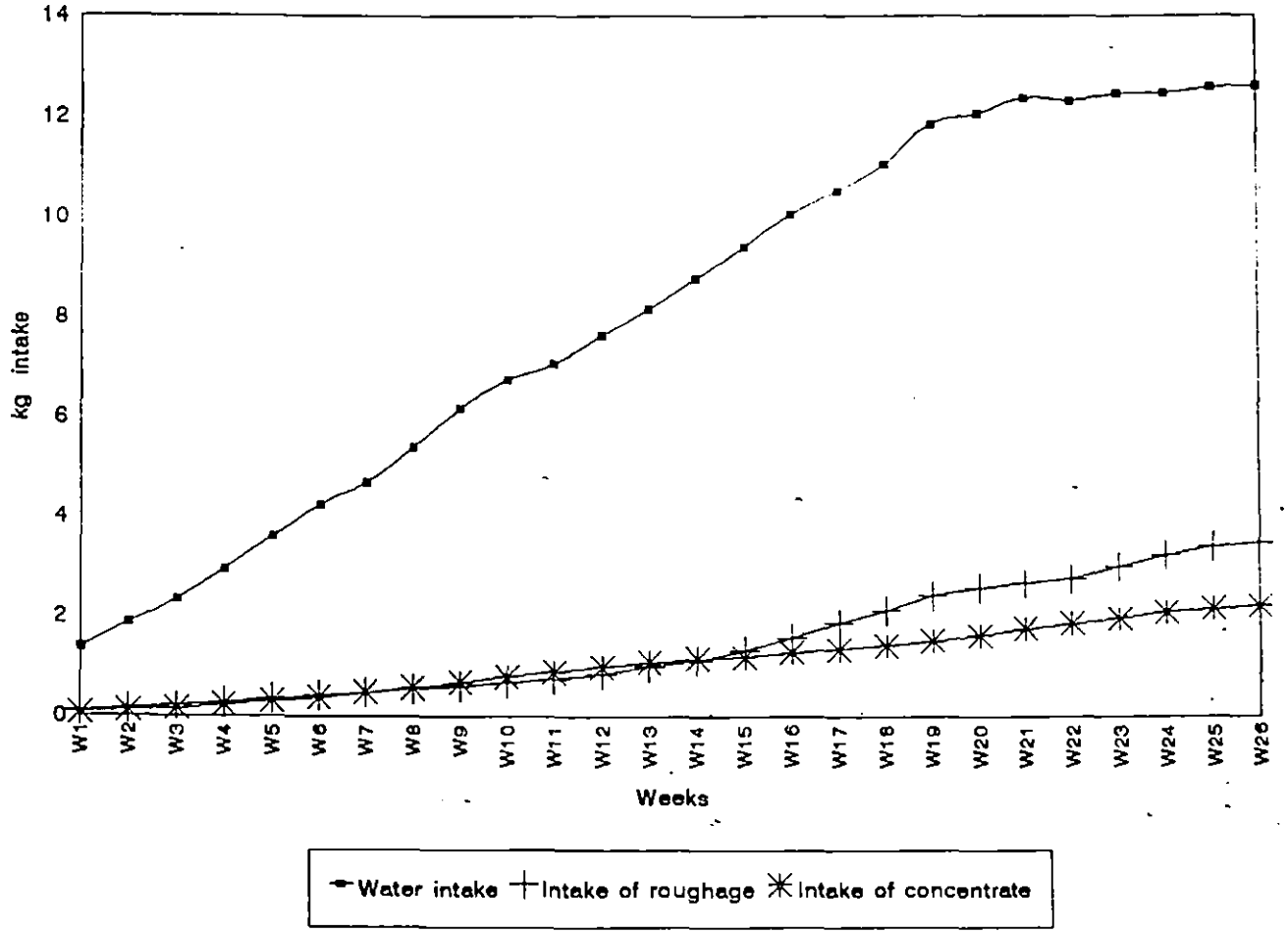
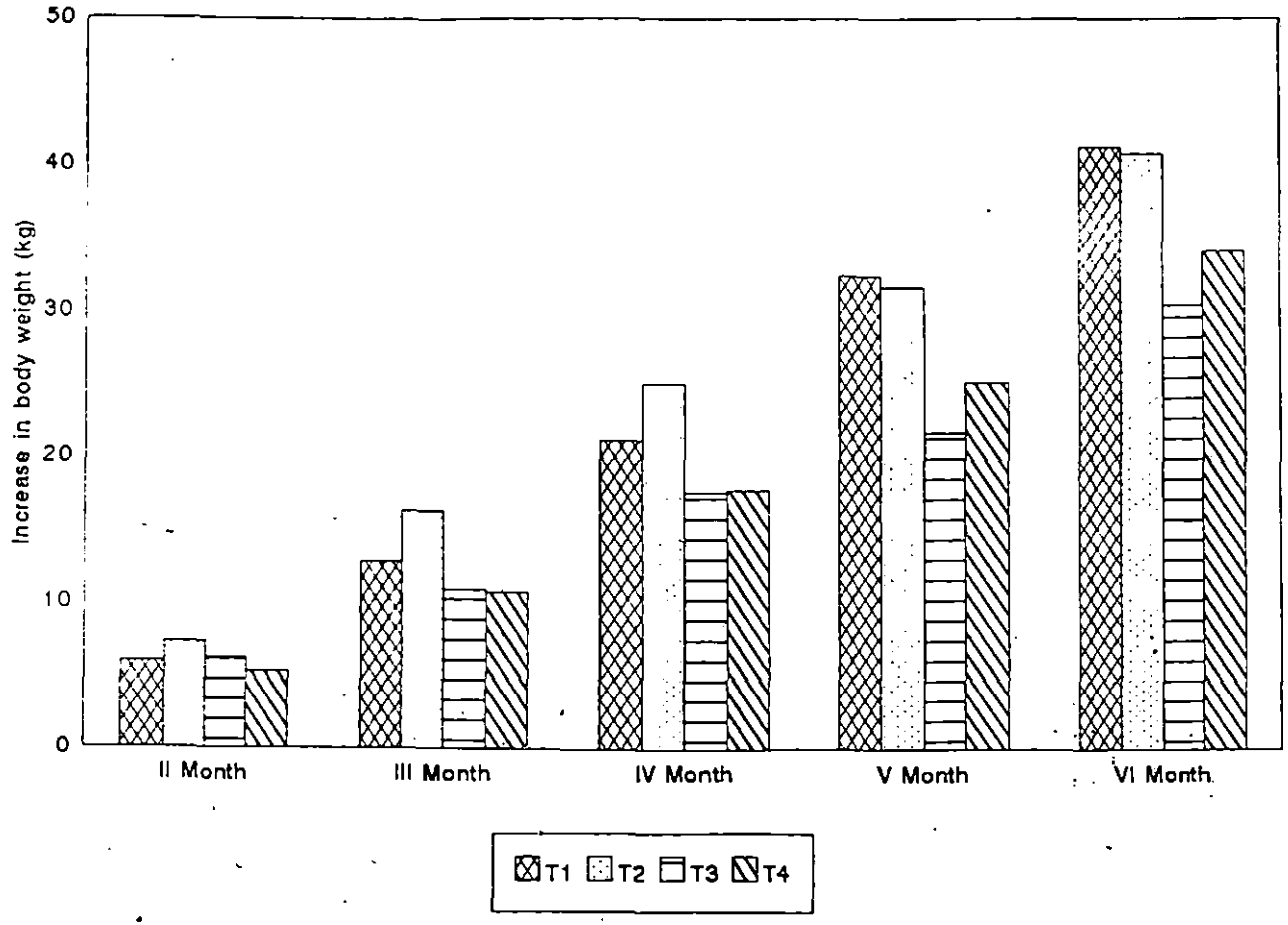


Fig.7 MONTHLY INCREASE IN LIVE WEIGHT OVER INITIAL WEIGHT



T1- Dry feeding with out blood meal, T2- Dry feeding with blood meal
T3- Liquid feeding with out blood meal, T4- Liquid feeding with blood meal

The multiple regression equations and the R^2 and adjusted R^2 values are shown in Table 20. On the basis of R^2 and adjusted R^2 values it is observed that treatment number 4 (T4) followed by treatment number 1 (T1) gave the best fit equations for body weight gain while taking water intake, concentrate and roughage intake as the independent contributing variables.

The average daily weight gain for each treatment group is presented in Table 21.

The feed efficiency and cost involvement per kg live weight gain is presented in Table 22.

4.8 Body length of calves

Data on average monthly body length of calves for the 6 month is presented in Table 23.

Analysis of variance (Table 24) showed no significant difference in length due to treatments.

Monthly increase in length in relation to length at 1st month is presented in Table 25 and depicted by bar diagram in Fig.8.

Table 20. Multiple regression of body weight gain on the basis of feed intake

	R^2	Adjusted R^2
$Y_1 = 4.257459 + 1.2460\ w - 10.00\ C + 3.1791\ R$	0.934	0.834
$Y_2 = 8.07233 - 0.81279\ w + 9.6069\ C - 2.7954\ R$	0.881	0.703
$Y_3 = 7.276234 - 1.5454\ w + 13.476\ C - 2.4798\ R$	0.696	0.239
$Y_4 = 5.622319 - 0.3085\ w + 1.7969\ C + 1.2097\ R$	0.966	0.914

Y_1 - Body weight gain T_1, Y_2 - Body weight gain T_2
Y_3 - Body weight gain T_3, Y_4 - Body weight gain T_4

w - Water intake
C - Intake of concentrate
R - Intake of roughage

Table 21. Average daily weight gain (g/day)

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	216.67	193.55	227.77	268.81	366.68	293.33	261.14
T_2	258.33	233.87	300.00	284.94	215.06	305.57	266.29
T_3	183.33	201.61	155.57	215.06	134.39	292.23	197.03
T_4	186.1	169.35	183.33	225.81	241.94	300.00	217.76

Table 22. Feed efficiency and cost involved per kg live weight gain

Parameter	Treatments			
	T_1	T_2	T_3	T_4
Feed efficiency	4.25	4.40	4.98	4.57
Cost per kg live weight gain (Rs.)	40.47	37.00	46.93	38.54

Table 23. Monthly length of calves (cm) - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	66.667± 3.39	68.167± 3.38	71.500± 3.59	77.333± 3.48	84.000± 3.17	88.400± 5.59	76.011± 3.767
T_2	65.500± 3.04	69.500± 3.09	73.000± 3.20	77.000± 3.78	80.500± 4.45	83.333± 4.45	74.806± 3.668
T_3	63.333± 2.76	65.500± 2.79	67.833± 2.89	70.667± 2.58	74.667± 1.73	76.200± 1.98	69.700± 2.455
T_4	62.500± 2.43	65.833± 2.93	70.000± 3.36	73.333± 3.44	77.833± 3.06	82.500± 2.79	72.000± 3.002
	64.500± 2.91	67.250± 3.05	70.583± 3.26	74.583± 3.32	79.043± 3.103	82.636± 3.703	73.099± 3.224

Table 24. Analysis of variance of monthly length of calves

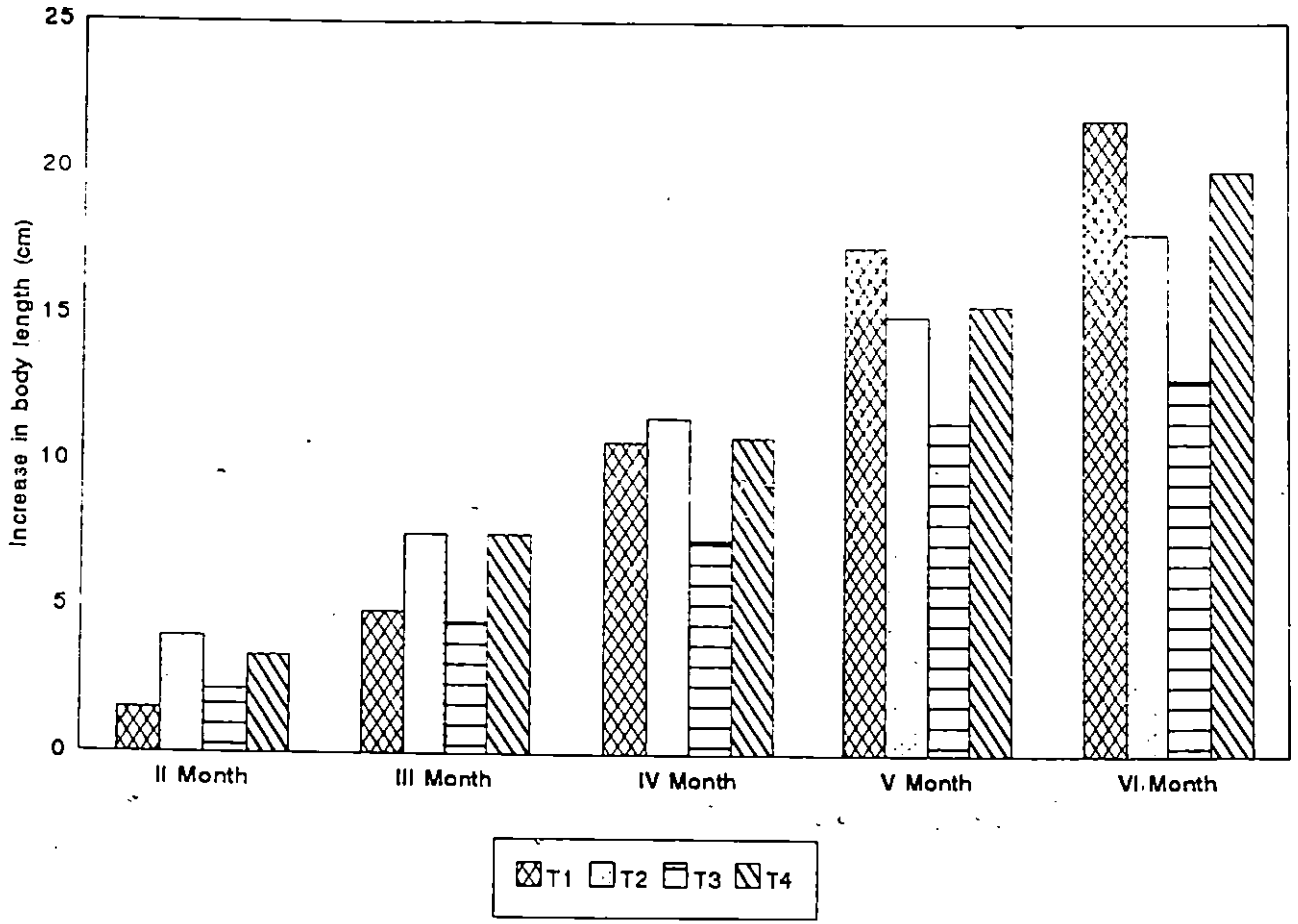
Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	22.111	21.944	29.167	60.611	86.430	125.419	NS 57.137
Error	20	51.483	55.933	64.217	67.300	61.351	57.380	59.611

NS - Non-significant

Table 25. Increase in length (cm) in relation to 1st month

Treatment	Weight at Ist month	Months				
		I&II	I&III	I&IV	I&V	I&VI
T_1	66.667	1.5	4.833	10.666	17.333	21.733
T_2	65.5	4	7.5	11.5	15	17.833
T_3	63.333	2.167	4.5	7.334	11.334	12.867
T_4	62.500	3.333	7.5	10.833	15.333	20

Fig.8 MONTHLY INCREASE IN BODY LENGTH OVER INITIAL LENGTH



T1- Dry feeding with out blood meal, T2- Dry feeding with blood meal
T3- Liquid feeding with out blood meal, T4- Liquid feeding with blood meal

4.9 Height of calves

Monthly means of height at whithers of calves for 6 months is presented in Table 26. Table 27 gives the results of the analysis of variance of the same.

There was no significant difference in height between the four treatment groups.

Values of monthly increase in height in relation to 1st month height is shown in Table 28 and presented as bar diagram in Fig.9.

4.10 Chest girth of calves

Monthly mean chest girth measurements is shown in Table 29.

Table 30 shows the results of corresponding analysis of variance. No significant difference in chest girth between the treatment groups could be observed.

Monthly increase in chest girth from the 1st month is presented in Table 31 and the bar diagram depicting this in Fig.10.

Table 26. Monthly measurement of height (cm) of calves - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	69.167± 2.27	72.833± 2.23	76.667± 1.98	81.333± 1.71	85.000± 1.54	87.000± 1.51	78.667± 1.873
T_2	67.667± 1.69	73.500± 1.87	76.833± 1.56	79.333± 2.15	82.000± 2.35	84.667± 2.82	77.333± 2.073
T_3	64.167± 1.56	68.500± 1.50	73.000± 1.97	77.333± 1.93	80.167± 1.66	81.800± 1.77	74.161± 1.732
T_4	68.500± 1.84	71.500± 1.82	75.000± 2.05	78.000± 1.98	81.333± 1.82	83.167± 1.85	76.250± 1.893
	67.375± 1.84	71.583± 1.855	75.375± 1.89	79.000± 1.943	82.000± 1.843	84.136± 1.988	76.578± 1.893

Table 27. Analysis of variance of monthly height of calves

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	29.708	29.500	19.153	18.667	22.611	25.208	NS 24.141
Error	20	20.725	21.067	21.608	22.800	20.851	25.054	22.018

NS - Non-significant

Table 28. Monthly increase in height (cm) in relation to 1st month

Treatment	Weight at Ist month	Months				
		I&II	I&III	I&IV	I&V	I&VI
T_1	69.167	3.666	7.5	12.166	15.833	17.833
T_2	67.667	5.833	9.166	11.666	14.333	17.000
T_3	64.167	4.333	8.333	13.166	16.000	17.633
T_4	68.500	3.000	6.5	9.5	12.833	14.667

Table 29. Monthly measurement of chest girth (cm) of calves - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	77.167± 1.68	81.000± 2.35	84.500± 2.92	89.000± 3.20	94.600± 2.35	99.200± 3.36	87.577± 2.643
T_2	74.833± 0.75	78.833± 2.51	85.000± 3.53	89.500± 3.86	92.667± 4.13	96.500± 4.57	86.222± 3.225
T_3	73.333± 1.09	76.667± 2.00	79.833± 2.60	83.667± 2.08	86.833± 2.40	92.000± 2.34	82.056± 2.085
T_4	72.667± 1.33	76.333± 1.47	79.500± 1.86	84.000± 2.08	87.833± 2.56	91.833± 2.69	81.944± 1.998
	74.500± 1.213	78.208± 2.083	82.208± 2.728	86.542± 2.805	90.304± 2.86	94.818± 3.24	84.430± 2.488

Table 30. Analysis of variance of monthly chest girth of calves

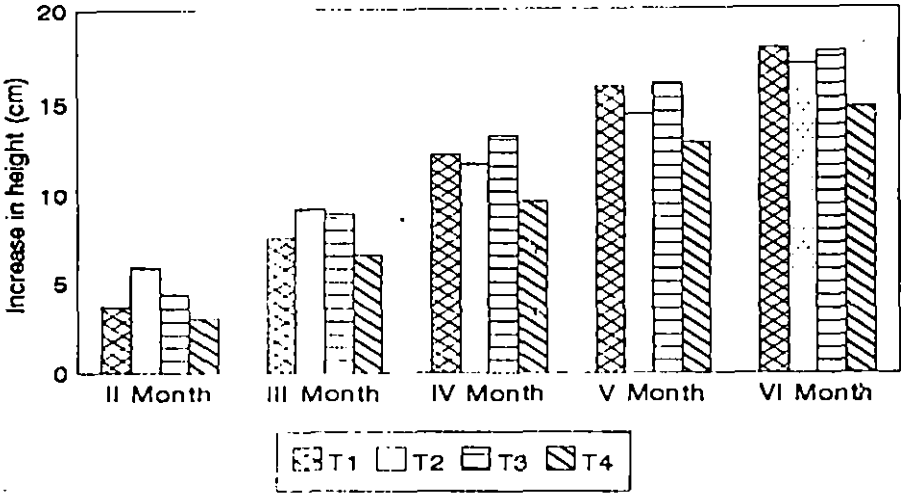
Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	23.889	28.153	52.042	59.042	78.223	68.713	5.677 NS
Error	20	9.517	26.975	43.792	50.742	52.221	65.619	41.978

NS - Non-significant

Table 31. Monthly increase in chest girth (cm) in relation to 1st month

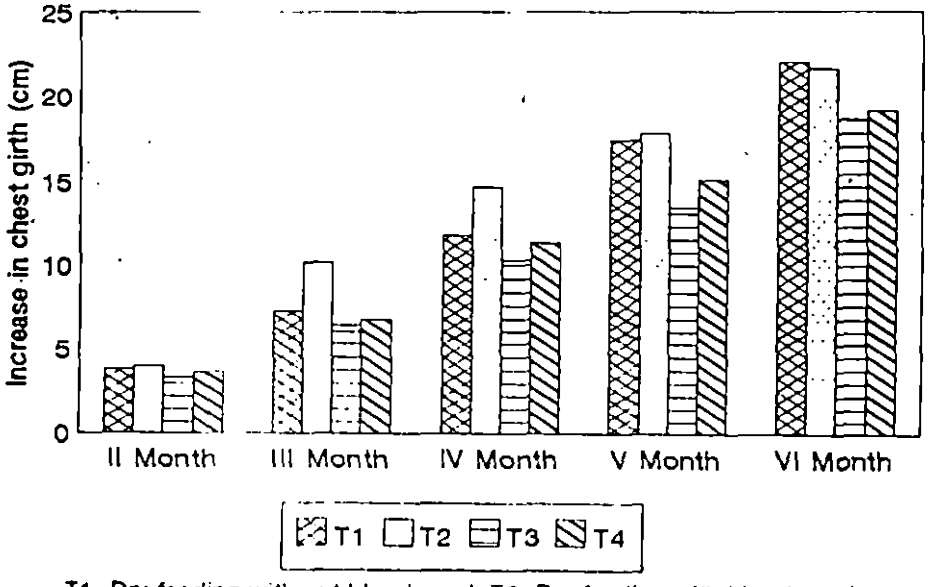
Treatment	Weight at Ist month	Months				
		I&II	I&III	I&IV	I&V	I&VI
T_1	77.167	3.833	7.333	11.833	17.433	22.033
T_2	74.833	4	10.167	14.667	17.834	21.667
T_3	73.333	3.334	6.5	10.334	13.5	18.667
T_4	72.667	3.666	6.833	11.333	15.66	19.163

Fig.9 MONTHLY INCREASE IN HEIGHT OVER INITIAL HEIGHT



T1- Dry feeding with out blood meal, T2- Dry feeding with blood meal
T3- Liquid feeding with out blood meal, T4- Liquid feeding with blood meal

Fig.10 MONTHLY INCREASE IN CHEST GIRTH OVER INITIAL CHEST GIRTH



T1- Dry feeding with out blood meal, T2- Dry feeding with blood meal
T3- Liquid feeding with out blood meal, T4- Liquid feeding with blood meal

4.11 Disease incidence

Monthly observations on incidence of disease in the four treatment groups during the expeirmental period is presented in Table 32.

4.12 Haematological parameters

4.12.1 Haematocrit - Packed cell volume (PCV)

The monthly mean values of PCV during the experiment period is shown in Table 33.

The analysis of variance showed that the influence of the four treatments on haematocrit values were non-significant (Table 34).

4.12.2 Haemoglobin

Monthly mean values of haemoglobin is presented in Table 35.

Analysis of variance showed that there was no significant difference on the haemoglobin content of blood due to different treatments (Table 36).

Table 32. Disease incidence in calves during the experiment

Month		1				2				3				4				5				6				Total			
Type of disease		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Treatment groups	T_1	2				1									4											3	4		
	T_2	3								1					3											4	3		
	T_3	6				4				2				1	4											13	4		
	T_4	6				3				2					4											11	4		

A - Diarrhoea (mainly due to overfeeding)
B - Coccidiosis
C - Bacterial and viral infectious disease
D - Non infectious disease

Table 33. Monthly values of packed cell volume (PCV) - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	37.233± 0.89	36.000± 0.89	35.200± 0.95	34.483± 1.03	35.420± 0.41	35.180± 0.42	35.586± 0.765
T_2	38.333± 1.54	37.650± 1.38	36.300± 1.59	34.950± 1.62	34.400± 1.49	34.317± 1.08	35.992± 1.45
T_3	35.967± 1.07	35.050± 1.18	33.333± 1.26	33.367± 1.48	34.083± 1.18	34.440± 1.13	34.373± 1.217
T_4	38.533± 1.09	37.017± 1.26	36.717± 1.08	35.283± 1.00	35.167± 0.69	34.750± 0.82	36.245± 0.990
	37.577± 1.148	36.429± 1.178	35.387± 1.22	34.521± 1.283	34.739± 0.923	34.659± 0.863	35.552± 1.103

Table 34. Analysis of variance of monthly values of packed cell volume

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	8.367	7.844	13.708	4.198	2.228	0.783	6.188 NS
Error	20	8.237	8.558	9.252	10.326	6.632	4.660	7.944

NS - Non-significant

Table 35. Monthly values of haemoglobin - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	11.300± 0.35	10.967± 0.35	10.733± 0.33	10.483± 0.38	10.380± 0.42	10.280± 0.37	10.691± 0.367
T_2	11.667± 0.16	11.400± 0.26	11.183± 0.38	10.967± 0.34	10.767± 0.38	10.633± 0.42	11.103± 0.323
T_3	10.533± 0.37	10.350± 0.33	10.100± 0.37	9.917± 0.51	9.650± 0.32	9.520± 0.34	10.012± 0.373
T_4	11.383± 0.25	11.100± 0.29	10.883± 0.29	10.486± 0.18	10.467± 0.3	10.167± 0.34	10.748± 0.275
	11.221± 0.283	10.954± 0.308	10.725± 0.343	10.463± 0.303	10.313± 0.355	10.173± 0.368	10.642± 0.327

Table 36. Analysis of variance of monthly values of haemoglobin

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	1.408	1.170	1.252	1.106	1.345	1.154	1.239 NS
Error	20	0.515	0.578	0.706	0.584	0.718	0.770	0.645

NS - Non-significant

4.12.3 Erythrocyte sedimentation rate (ESR)

The mean ESR values during 6 months is shown in Table 37 and the results of the analysis of variance in Table 38. No significant difference in ESR values due to treatments could be observed.

4.12.4 Serum glucose (SG)

Monthly means of SG values are presented in Table 39 and the results of analysis of variance in Table 40. There was no significant difference in SG values due to the treatments.

4.12.5 Serum cholesterol (SC)

Monthly means of SC values are presented in Table 41. Analysis of variance (Table 42) showed no significant difference in SC values due to treatments.

4.12.6 Plasma protein

Monthly means of plasma protein values are shown in Table 43. The analysis (Table 44) showed that the influence of the different treatments on plasma protein values were non-significant.

Table 37. Monthly values of erythrocyte sedimentation rate - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	2.650± 0.19	2.617± 0.18	2.567± 0.2	2.600± 0.15	2.460± 0.17	2.360± 0.15	2.542± 0.173
T_2	2.050± 0.11	2.017± 0.09	2.167± 0.08	2.283± 0.07	2.117± 0.06	2.050± 0.07	2.114± 0.08
T_3	2.450± 0.14	2.383± 0.14	2.317± 0.16	2.417± 0.13	2.350± 0.16	2.160± 0.13	2.346± 0.143
T_4	2.283± 0.21	2.300± 0.17	2.317± 0.13	2.200± 0.10	2.167± 0.08	2.167± 0.11	2.239± 0.133
	2.358± 0.135	2.329± 0.145	2.342± 0.143	2.375± 0.113	2.265± 0.118	2.177± 0.115	2.308± 0.128

Table 38. Analysis of variance of monthly values of etythrocyte sedimentation rate

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	0.388	0.358	0.165	0.183	0.141	0.089	0.222 NS
Error	20	0.166	0.139	0.130	0.086	0.086	0.071	0.113

NS - Non-significant

Table 39. Monthly values of serum glucose (SG) - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	49.450± 1.43	50.433± 1.17	51.833± 1.38	51.167± 1.51	51.960± 1.5	51.800± 1.02	51.107± 1.335
T_2	50.950± 1.62	51.417± 0.88	51.417± 1.55	51.617± 0.96	51.667± 0.96	51.833± 1.11	51.484± 1.18
T_3	49.983± 1.38	50.667± 1.11	51.467± 0.93	51.333± 0.67	51.500± 0.43	50.880± 0.34	50.972± 0.81
T_4	52.883± 1.85	52.733± 1.37	51.833± 1.62	52.167± 1.42	52.383± 1.83	57.667± 1.52	52.278± 1.602
	50.817± 1.57	51.303± 1.133	51.637± 1.37	51.571± 1.14	51.874± 1.18	51.564± 0.998	51.463± 1.232

Table 40. Analysis of variance of monthly values of serum glucose

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	13.702	6.439	0.309	1.154	0.897	1.039	3.923 NS
Error	20	15.028	7.875	11.600	8.540	9.425	7.181	9.942

NS - Non-significant

Table 41. Monthly values of serum cholesterol (SC) - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	131.067± 3.32	134.967± 4.05	138.733± 3.40	140.433± 2.02	138.000± 3.28	141.280± 2.76	137.413± 3.138
T_2	139.317± 5.09	139.883± 3.93	148.867± 4.87	152.400± 6.29	152.610± 6.78	150.217± 5.83	146.716± 4.465
T_3	143.033± 4.12	147.667± 4.37	150.267± 4.48	151.700± 4.01	156.300± 4.69	169.160± 4.46	153.021± 4.355
T_4	138.550± 4.8	141.500± 3.27	146.000± 2.00	147.000± 3.67	148.000± 2.05	151.317± 1.84	145.395± 2.938
	137.992± 4.333	141.004± 3.905	145.217± 3.688	147.883± 3.998	149.196± 4.20	150.518± 3.723	145.302± 3.975

Table 42. Analysis of variance of monthly values of serum cholesterol

Source	d.f.	Mean square						Mean	
		1	2	3	4	5	6		
Between	3	150.883	164.685	137.144	182.500	336.114	268.165	206.582	NS
Error	20	115.479	92.662	89.080	109.802	125.345	93.011	104.229	

NS - Non-significant

Table 43. Monthly values of plasma protein - Mean and standard error

Treatment	Months						Mean
	1	2	3	4	5	6	
T_1	5.900± 0.14	6.067± 0.17	6.267± 0.17	6.417± 0.18	6.680± 0.22	6.860± 0.19	6.365± 0.178
T_2	5.883± 0.15	6.017± 0.13	6.283± 0.18	6.433± 0.14	6.617± 0.12	6.783± 0.09	6.336± 0.135
T_3	5.783± 0.14	5.983± 0.12	6.050± 0.12	6.133± 0.13	6.350± 0.15	6.600± 0.07	6.150± 0.123
T_4	5.900± 0.13	6.033± 0.14	6.200± 0.15	6.383± 0.11	6.560± 0.07	6.717± 0.07	6.299± 0.112
	5.867± 0.14	6.025± 0.14	6.200± 0.158	6.342± 0.14	6.548± 0.14	6.741± 0.104	6.287± 0.137

Table 44. Analysis of variance of monthly values of plasma protein

Source	d.f.	Mean square						Mean
		1	2	3	4	5	6	
Between	3	0.019	0.007	0.068	0.118	0.118	0.062	0.065 NS
Error	20	0.116	0.119	0.151	0.126	0.119	0.070	0.117

NS - Non-significant

4.13 Carcass characteristics

The mean values of different carcass characteristic parameters are shown in Table 45.

Analysis of variance for each parameter was performed and there were no significant differences due to treatments (Table 46.

Table 45. Carcass characteristics - Mean and standard error

Sl. No.	Particulars	Treatments			
		T_1	T_2	T_3	T_4
1.	Slaughter weight (kg)	71.333± 12.46	62.667± 14.16	53.000± 7.51	47.333± 3.85
2.	Carcass weight (kg)	33.433± 6.24	29.167± 7.83	24.000± 4.50	22.233± 2.73
3.	Dressing percentage	46.657± 0.82	45.383± 2.96	44.747± 1.91	46.673± 1.87
4.	Deboned meat (kg)	19.900± 5.32	17.117± 5.82	13.100± 2.79	12.027± 2.74
5.	Bone (kg)	13.000± 1.16	11.333± 1.77	10.200± 1.20	8.427± 0.55
6.	Liver (kg)	1.347± 0.29	1.033± 0.21	0.927± 0.05	0.817± 0.04
7.	Heart (kg)	0.373± 0.08	0.283± 0.04	0.303± 0.05	0.247± 0.02
8.	Kidney (kg)	0.330± 0.06	0.280± 0.02	0.257± 0.04	0.287± 0.02
9.	Diaphragm (kg)	0.160± 0.05	0.127± 0.03	0.133± 0.05	0.127± 0.03
10.	Bone meat ratio	4.905± 0.62	4.971± 0.58	5.175± 0.35	4.923± 0.36

Table 46. Analysis of variance of carcass characteristics

Source	d.f.	Mean square of parameters									
		Slaughter weight	Carcass weight	Dressing percentage	Deboned meat	Bone	Liver	Heart	Kidney	Diaphragm	Bone meat ratio
Between	3	NS 336.972	NS 77.630	NS 2.763	NS 39.793	NS 11.103	NS 0.156	NS 0.009	NS 0.005	NS 0.001	NS 0.046
Error	8	319.500	95.790	12.399	57.955	4.626	0.098	0.007	0.004	0.005	0.722

NS - Non-significant

Discussion

DISCUSSION

5.1 Environmental variables

5.1.1 Ambient temperature

The maximum temperature at Thumburmuzhy varied from 27.68°C in July to 35.64°C in March during the experimental period. The lowest temperature recorded was during August (23.63°C) and highest temperature in the minimum bulb was in June (27.24°C). The mean daily temperature varied from 26.15°C in August to 30.09°C in April. The ambient temperature during the experimental period was therefore neither too high nor too low and the diurnal variation was within a narrow range typical of hot humid tropics.

5.1.2 Relative humidity

Relative humidity (RH) during the experimental period varied from 70.13 in June to 83.12 in August. Thus, throughout the experimental period, the RH was above 70 per cent which is also typical of hot lhumid climate. Thus the place can be classified as hot humid (Lee, 1953).

5.1.3 Temperature-humidity index (THI)

THI values were estimated from morning and evening values of dry and wet bulb thermometer readings. They were averaged

to arrive at mean monthly values. The THI values ranged from 76.86 during July to 83.06 in May. It can be seen that, eventhough the ambient temperature did not rise to very high levels during the period, the THI values were above 75 indicating that the environment was stressful because of the combined effect of high temperature and high humidity. This might have affected the growth of calves adversely in all the four treatment groups; which is in accordance with the findings of Tripathi *et al.* (1972).

The climograph of Thumburmuzhy, given in Fig.4 indicates that from April to June, the ambient temperature was very high but the RH was relatively low. On the other hand from July onwards upto end of September, eventhough the ambient temperature was relatively low the RH remained very high. Thus, throughout the experimental period the animals had to confront either high ambient temperature or high humidity which adversely affect the productivity and dietary energy intake (Kibler *et al.*, 1966; Young, 1981 and Nauheimer-Thoniek *et al.*, 1988).

5.2 Water intake

Table 6 contain the weekly water intake of calves in the four treatment groups. Analysis of variance reveal that,

there were no significant differences between the four treatment groups.

Water intake was estimated on the basis of unit metabolic body size and presented in Fig.5.

Perusal of these, indicates a trend of higher water intake by calves in the groups receiving liquid feeding (T3 and T4). This is in accordance with the findings of Hinks and Whittemore (1976) that calves on dry diet drank significantly less water than those on liquid diet. In the first two months when all the animals were receiving milk feeding, the differences were not very evident, however when they grew older and when milk feeding was dispensed with the difference in the intake of water between groups became evident, eventhough not statistically significant. The lowest water intake per kg metabolic body size was observed in the control group, followed by the group receiving dry feed with supplementation of blood meal in the ration. The higher intake of water by the liquid feeding group is as per expectations because they were rather `forced' to consume more water as part of feeding process as feed ingredients were suspended in water.

5.3 Intake of milk

Table 9 gives the weekly consumption of milk by various groups. They were subjected to limited milk feeding on the basis of their body weight and as such no differences were noticed.

5.4 Intake of concentrates

Concentrates were fed *ad libitum* to the calves. This resulted in diarrhoea during initial adjustment period. This was more so with the group on liquid diet. Jenny *et al.* (1978) observed that the dry matter concentration affected the incidence and duration of diarrhoea and intake of water. On the basis of this experience, the concentrate feeding was limited to 15 minutes/time (twice a day). The calves were allowed to eat as much as they could during this period. No significant differences could be observed.

Concentrate intake expressed per kg $W^{0.75}$ showed no significant difference between treatments.

5.5 Roughage intake

Roughage was fed *ad libitum* and it was made available throughout the day. Inspite of that, there were not much

difference between the groups in roughage intake per metabolic body size. This indicates that, the form of concentrate feeding with the incorporation of blood meal in the ration did not affect roughage intake in any significant manner.

From the above results it was observed that the treatments did not significantly influence water intake, or concentrate and roughage intake.

5.6 Regression analysis

5.6.1 Water intake

Multiple regressions of environmental variables on water intake were worked out treatment-wise. The adjusted R^2 values were highly significant ranging from 0.776 to 0.843. Thus, it can be concluded that average temperature and average relative humidity had a significant influence on water intake.

5.6.2 Intake of concentrates

Multiple regressions of environmental variables on intake of concentrates showed values ranging from 0.785 to 0.841. This indicates a strong influence of the environmental variables on concentrate intake. The R^2 value was maximum in the T_4 group. These observations also indicate that the

intake of concentrates was influenced considerably by ambient temperature and relative humidity.

5.6.3 Intake of roughage

Roughage intake also showed dependence on environmental variables like ambient temperature and relative humidity. R^2 values ranged from 0.77 to 0.85 indicating that these environmental variables influenced roughage intake significantly. The adjusted R^2 values ranged from 0.616 to 0.750.

5.7 Growth

5.7.1 Live weight

Table 17 gives the mean monthly live weights of the calves in different treatments. Analysis of variance revealed that, during the first month, the average weight of T_1 group (control) was significantly higher ($P<0.05$) than the other three groups. Thereafter, from months two to six, there were no significant differences in body weight between the four treatment groups. However, the general trend indicated that, the body weights in different months were lower in the T_3 and T_4 groups, where liquid feeding was resorted. One of the reasons for the lower live weight in these two groups may be the incidence of diarrhoea in early life due to over feeding.

However, diarrhoea was controlled by reducing overfeeding by limiting feeding time and thereafter the groups on liquid feed had better weight gain. Table 19 and Fig.7 represents, the increment in live weight as a function of time in the 1st month.

It can be seen that, from the third month onwards, the gain in weight was more in the groups which received dry feeding, which is in accordance with the findings of Ben Asher *et al.* (1981) and Bani *et al.* (1993). In the first three months, incorporation of blood meal appears to increase the weight gain in the dry fed groups. Drevjany *et al.* (1989) also reported similar findings. On the contrary, in the groups receiving liquid feeding, incorporation of blood meal showed a trend of higher body weight gain during the last two weeks of the experiment. Swartz *et al.* (1991) also reported better growth in calves receiving blood meal. This may indicate perhaps that feeding of ingredients like blood meal having low degradability in rumen, in liquid feeding regime, was more effective in older calves.

Multiple regression analysis revealed very high degree of relationship between weight gain and water intake, concentrate intake and roughage intake. Equations were developed with body weight as dependent variable and water, concentrates and roughage intakes as independent variables. This indicate that

one may be able to predict the growth rate if we have information on water intake, concentrate intake and roughage intake.

An equation developed on the basis of the regression analysis was to predict body weight gain from intakes of water concentrates and roughages which was having the maximum fit and R^2 values.

Multiple regression of maximum temperature and relative humidity in the afternoon on body weight gain was significant only in the case of controls.

Minimum temperature and relative humidity in the morning did not infleunce body weight gain significantly.

Average ambient temperature and average relative humidity influenced body weight gain significantly in T1 and T4, that is, in control as well as liquid feeding group receiving blood meal.

It was observed from the data that intake of concentrates, roughages as well as intake of water were significantly influenced by environmental variables. The influence of these environmental variables on gain in body weight might be at least partially through influencing feed and water intakes (Young, 1981).

Perusal of Table 19 indicates that animals which received dry feeding (T1 and T2) had a better average gain (41.125 kg) compared to the liquid feeding groups (T3 and T4) (32.384 kg). This is in accordance with the findings of Ben Asher *et al.* (1981) but contradicts the findings of Pryor and Ternouth (1972) and Gallasz *et al.* (1973). Partially this may be attributed to the set back the liquid feeding group suffered due to diarrhoea. According to Jenny *et al.* (1978) the dry matter concentration affected the incidence and duration of diarrhoea. Supplementation with blood meal, a rumen bypass protein did not show much influence in live weight gain when dry feeding was given. On the other hand, in liquid feeding there was a trend in favour of the group that received blood meal in their ration. May be the oesophageal reflex which might have been induced by the liquid feeding coupled with the inherent quality of blood meal as a bypass protein might have jointly helped better average gain in T_4 group than T_3, which is in agreement with the findings of Klopfenstein (1981), Loerch *et al.* (1983), Drevjany *et al.* (1989) and Zinn and Owens (1993).

Examination of Fig.7 indicates that in the liquid feeding group, beneficial effect of inclusion of blood meal was evident only from 5th month of age. On the contrary, in the dry feeding group, the beneficial effect of feeding blood meal was evident only upto fourth month of age. The beneficial

trend in favour of blood meal-fed group in liquid feeding regimen was evident only from 5th month onwards probably because more of the protein from blood meal could bypass the rumen when it was given in the liquid form. It may be noted that from the 5th month onward the rumen of the calf was nearing full function. The beneficial effect of bypass proteins and physiological bypass through stimulation of the oesophageal groove reflex through liquid feeding need be expected only when the rumen becomes functional.

5.7.1.1 Average daily weight gain

The maximum average daily weight gain occurred in T_2 group i.e. dry feeding of ration with supplementation of blood meal (266.29 g/day). The average daily weight gain for the dry feeding group was 263.715 g compared to 207.395 g in the wet feeding regimen. The trend here also is in favour of the dry feeding group. The blood-meal-fed groups had an average daily weight gain of 242.025 compared to 229.085 in the groups not receiving blood meal.

Here again the trend is in favour of dry feeding as well as the blood meal supplementation group. These findings are in agreement with those of Kloptenstein (1981), Loerch *et al.* (1983), Drevjany *et al.* (1989) and Zinn and Owens (1993).

5.7.2 Body length

Calves in T_1 group increased their body length by 21.733 cm compared to 17.833 cm in T_2, 12.867 cm in T_3 and 20.000 cm in T_4. Maximum increase in length has taken place in T_1 (21.733 cm) followed by T_4 (20.000 cm). Here there is not much difference between the dry-fed group and liquid-fed groups. Addition of blood meal seems to benefit only the T_4 group Fig.8 gives the monthly increase in body length. It shows that, initially, there is a beneficial trend due to feeding blood meal. This trend has been sustained upto the last except in dry feeding during the last two months where the blood meal supplemented group fared inferior to the other.

5.7.3 Height

Height increased steadily from month one to six in all the groups and the increase in height was almost identical in three groups i.e. T_1, T_2 and T_3. In T_4 it was lower.

Figure 9 shows that initially, the maximum increase in height was observed in T_2 group ie. dry feeding with blood meal. However this superiority could not be sustained as the calves grew.

5.7.4 Chest girth

Figure 10 shows that maximum increase in chest girth occurred in T_1 followed by T_2, T_4 and T_3 in that order. The chest girth was showing the trends for higher values in the first too groups that is T_1 and T_2. In liquid feeding, the group which received blood meal in the rations seems to do better.

In general, the dry feeding group had better chest girth than the liquid feeding group and this might have reflected in their live weight gain also.

From the results, it can be concluded that liquid feeding might have resulted in less chest girth and less body weight than the dry fed groups. However, such a difference is not evident in the case of height and length. It almost appears that there was no difference in true growth between the groups of animals because the skeletal growth as represented by body length and body height, did not vary between the groups.

5.8 Disease incidence

Non specific diarrhoea was the only disease encountered among the calves in the first three months. The incidence of diarrhoea among calves receiving liquid feeding was higher (24 episodes) compared to those receiving dry feeding (7

episodes). These groups also tended to consume more water due to the liquid mode of feeding. Over-feeding and higher water intake may account for the greater incidence of diarrhoea in the liquid feeding groups. When the time of feeding was restricted, thereby limiting the intake, the incidence of diarrhoea was almost completely controlled.

In the fourth month 3 calves in T_2 group and 4 calves each in the other 3 groups developed Coccidiosis. Fourth month is a critical stage in the life of calves. The passive immunity transferred through colostrum feeding is waning and the calves' immunological systems have not started producing immunoglobins in sufficient quantities against many pathogens. However, the rate of incidence was almost similar in the different groups and no difference due to treatments could be observed.

5.9 Haematologic parameters5.9.1 Hematocrit

Haematocrit values of the four groups did not vary significantly. They range from 33.33 to 38.53. The overall average value was 35.55. These values compare with normal value of 24-48 previously reported by Benchamin (1985).

The results indicate that the type of feeding or the incorporation of blood meal did not have any significant effect on the haematocrit value.

5.9.2 Haemoglobin

Monthly values of Haemoglobin given in Table 35 also did not show any significant difference between the treatment groups. However there was a trend favouring those groups receiving blood meal in their ration. These groups of calves (T_2 and T_4) had an average Hb per cent in blood of 10.93 as against 10.35 in calves not receiving blood meal in their ration.

Another trend that was evident was that as the calves advanced in age, the Hb per cent of blood gradually decreased. The average Hb per cent of the first month was 11.22 followed by 10.95 in second 10.73 in third 10.46 in the fourth 10.31 in the fifth and 10.17 in the sixth months.

5.9.3 Monthly values of erythrocyte sedimentation rate (ESR)

The ESR also did not vary between the treatments significantly. They range from 2.114 to 2.542 mm/24 h. The overall average value was 2.308. These values compare with normal value of 2.25-4.00 mm/24 h as reported by Benjamin (1985).

5.9.4 Serum glucose

The values of serum glucose estimated every month indicated no significant difference between the treatments. However, there was a trend showing slightly higher values in the groups receiving blood meal.

The overall average value of serum glucose was 51.46 mg% which is in agreement with the normal values of 45-75 mg% reported by Benjamin (1985).

5.9.5 Monthly values of serum cholesterol (SC)

The values of serum cholesterol is of interest because, the cholesterol content of meat may be of nutritional interest to the consumers. Table 41 shows monthly values of SC. Although there were no significant differences, the cholesterol levels were found to be lowest in the control group.

5.9.6 Plasma protein

The monthly values of the plasma proteins presented in Table 43 did not vary significantly between treatments. An overall average of 6.29 conform to previously reported normal values for the species (Benjamin, 1985). Eventhough there was no significant difference there was a trend showing higher

plasma protein values in the groups receiving ration in the dry form. The same groups also had higher daily weight gain.

5.10 Carcass characteristics

The results of carcass characteristics studied are presented in Table 45. There were no significant differences between treatments with respect to any of these. However, there was a clear trend indicating higher slaughter weight, carcass weight, weight of deboned meat, and weights of bones and liver in the treatment groups where dry feeding was given. But this difference may not be having much significance because, mostly males were slaughtered and some bias might have crept in because of this. Overall it can be concluded that the treatments did not affect the carcass traits.

A study was conducted on growing crossbred calves to assess the effect of continued liquid feeding as well as incorporation of feed ingredients like blood meal which contained more of rumen undegradable proteins. By and large, the treatments did not produce any significant effects on the feed and water intake, growth, as well as blood parameters. The trend was often against liquid feeding, but feeding of blood meal had marginal advantage. The premises under which the experiment was conducted was that, feeding concentrates in a suspended form in water might help the oesophageal groove

closure reflex to extend later in life and help the animal in protecting the proteins by bypassing the rumino-reticulum. One of the reasons why much beneficial effect due to the treatments could not be observed is that even the control ration contained fish meal as an ingredient which is known to bypass the rumen considerably. Some indication of beneficial effect was observable only towards the end of the experiment when the calves were five to six months old and had a near-fully developed rumen. If the treatment of liquid feeding and incorporation of blood meal were continued beyond 6 months age, their beneficial effects might have become more evident.

However, on the basis of the results of the present study, it can be stated that feeding concentrates as a suspension in water did not have any negative effect.

Incorporating blood meal did show the trend of a positive effect on growth parameters. Had there been no fish meal in the control ration, the effect of incorporating blood meal might have been more evident. At the level of 30 per cent replacement of protein by blood meal there was no retardation in feed intake or growth in the experimental animals.

Summary

SUMMARY

Kerala farmer rear the young ones of his cows throughout the lactation period of dam and the male calves are later sold at nominal prices. The present study involved investigating the feasibility of resorting to liquid feeding and incorporation of blood meal in the ration in terms of growth rate in calves and also the cost involvement. The study also included the carcass characteristics of the calves in different treatment groups.

The study was carried out on twenty four crossbred calves (*B. taurus x B. indicus*) below one month of age at Cattle Breeding Farm, Thumburmuzhy; of the Kerala Agricultural University.

Types of feeding which included dry feeding and liquid feeding; and supplementation which included no addition of blood meal and addition of blood meal were the main treatments in a factorial design. Thus the treatment groups were:

T_1 - dry feeding, no supplementation of blood meal.,

T_2 - dry feeding, supplementation with blood meal.,

T_3 - liquid feeding, no supplementation with blood meal.,

T_4 - liquid feeding and supplementation with blood meal.

Twenty four selected calves were randomly allotted to the treatment groups so that each treatment group contained six calves.

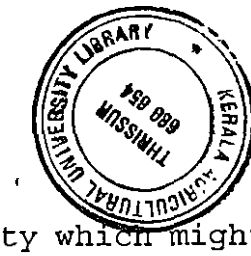
The starter rations were formulated satisfying specifications of Bureau of Indian standards. The blood meal for supplementation was prepared from the blood collected from meat technology unit of Kerala Agricultural University, and was initially heat treated to destroy pathogenic organisms and then got dried and used.

To dry feeding groups dry feed was offered in feeding baskets. For liquid feeding groups, the feed was made into a suspension in water using wet grinder and fed using aluminium buckets with calf feeding nipples.

The influence of environmental variables on growth; feed efficiency; disease incidence and carcass characteristics were studied.

The ambient temperature during the experimental period was neither too high nor too low; and the relative humidity was above 70 per cent, both parameters being typical of hot humid climate.

The THI values were above 75 per cent indicating that the environment was stressful because of the combined effect of



high temperature and high humidity which might have adversely affected the growth of calves in all the four treatment groups.

The water intake between treatment groups were not significantly different. The lowest water intake per kg metabolic body size was with control groups; the higher intake of water by the liquid feeding groups and similar to earlier reports.

Concentrate intake expressed per kg metabolic body size showed no significant difference between treatments. Roughage intake per kg metabolic body size was also not significantly different which indicates that the form of concentrate feeding with the incorporation of blood meal in the ration did not affect roughage intake in any significant manner.

From these, it can be inferred that the treatments did not significantly influence intakes of water, concentrate or roughage.

There was no significant difference between treatments in terms of live weight gain, but the general trend indicated that body weights were lower in T_3 and T_4 groups, where liquid feeding was resorted to. Multiple regression analysis revealed very high degree of relationship between weight gain and intakes of water, concentrate and roughages.

The maximum average weight gain occurred in T_2 group i.e., dry feeding with supplementation of blood meal. (266.29 g/day).

There was no significant difference between treatments in case of body length, height and chest girth. But in general the dry feeding groups had better gain in chest girth than the liquid feeding groups and this might have reflected in their live weight gain.

Haematocrit values of the four groups did not vary significantly (33.33 to 38.53) indicating that the form of feeding or incorporation of blood meal did not have any significant effect on haematocrit value.

Monthly values of haemoglobin (Hb) were also not significantly different between treatments but groups receiving blood meal showed slightly higher Hb (10.93) than calves not receiving blood meal (10.35).

There were no significant differences between treatments with regard to erythrocyte sedimentation rate serum glucose, serum cholesterol and plasma protein. But there was a trend showing higher plasma protein values in the groups receiving ration in dry form. This group had a higher daily weight gain also.

With regard to disease incidence group on liquid diet had more episodes of diarrhoea.

There were no significant differences between treatments with regard to any of the carcass characteristics; but the trend clearly indicated higher slaughter weight, carcass weight, weight of deboned meat, weight of bones and liver in the treatment groups where dry feeding was given.

One of the reasons why much beneficial effect due to the treatments could not be observed is that even the control ration contained fish meal - an ingredient which bypass rumen considerably. Low degree of beneficial effect of liquid feeding became evident only towards the end of the experiment, during 5th and 6th months where the calves had a fully developed rumen.

At the level of 30 per cent replacement of protein by blood meal, there was no retardation in feed intake or growth in the experimental animals, nor was there any increase in feed intake or acceleration in growth.

References

REFERENCES

*Abe, M., Iriki, T., Kimoto, T., and Tokuma, M. (1985). Significance of rumen-bypass protein: growth of calves in three to six months of age. *Jap J. Zootech. Sci.* **56**(2): 103-107.

Abe, M., Iriki, T., Kondoh, K. and Shibui, H. (1979a). Effects of nipple or bucket feeding of milk substitute on rumen by-pass and on rate of passage in calves. *Br. J. Nutr.* **11**(1): 175-181.

*Abe, M., Iriki, T., Shibui, H. and Kondoh, K. (1979b). Comparative nutritions of calves receiving a concentrate diet via rumen or via oesophageal groove. *Jap. J. Zootech. Sci.* **49**(12): 889-897.

Abe, M., Shibui, H., Iriki, T., Kondoh, K. and Kawai, T. (1978). Effects of liquid feeding of concentrate from a pail on growth and on the digestibility of the diet in young calves. *Br. J. Nutr.* **39**(3): 469-482.

AOAC (1990). Official methods of analysis of the Association of Official Analytical Chemists. Vol.1. Edited by Kenneth Helrich. AOAC, Inc. Virginia. 15th Ed. pp. 17-18.

Ayangbile, O.A., Thallam, S.K. and Surtan, M.S. (1993). Processing of slaughter house blood and poultry litter; and the effects on nutrient digestibility by steers. *Anim.Feed Sci. Technol.* **40** (2-3) : 153-164.

*Bani, P., Soressi, A. and Casati, M. (1993). Effect of protein sources with different rumen degradability. (Soyabean meal or blood meal) on beef cattle performance. In proceedings of 10th National congress, Scientific Association of Animal Production, Bologna, Italy, (edited by Monetti, P.G. and Cavani, C) Bologna, Italy.

Beede, D.K. and Collier, R.J. (1986). Potential nutritional strategies for intensively managed cattle during thermal stress. *J. Anim. Sci.* 62 (2): 543.

*Ben Asher, A., Nitsan, Z and Nir, I. (1981). Comparison of ruminal and post ruminal digestion of a concentrate fed in the young calf. *Reprod. Nutr. Dev.* 21(6A): 999-1007.

Benjamin, M.M. (1985). Outline of Veteirnary Clinical Pathology. The Iowa State University Press, Iowa, 2nd Ed. pp. 233-254.

Bethard, G.L., James, R.E. and Mcgilliard, M.L. (1997). Effect of rumen-undergradable protein and energy on growth and feed efficiency of growing Holestein heifers. *J. Dairy Sci.* 80(9): 2149-2155.

*Bianca, W. (1965). Reviews of the progress of dairy science. Section A. Physiology. Cattle in Hot environment. *J. Dairy Res.* 32: 291.

Blasi, D.A., Klopfenstein, T. J., Drouillard, J.S. and Sindt, M.H. (1991). Hydrolysis time, as a factor affecting the nutritive value of feather meal and feather meal-blood meal combinations for growing calves. *J. Anim. Sci.* 69(3): 1272-1278.

*Drevjany,L.A., Mc Knight, D.R., Gowenlock, D and Veira, D.M. (1989). Holsteins can produce more than milk: beefing qualities of male calves. *Highlights-of-Agricultural- Research-in-Ontario* 12(1) : 6-10.

*El-Sayed. A.B., Shalash, M.R., Nawito, M.F. and El.Nasr, E.S. (1991). Growth rate and behavioural patterns of buffalo calves under natural and artifical suckling conditions. *Egyptian J. Vet. Sci.* 28: 65-74.

Finch, V.A. (1986). Body temperature in beef cattle: Its control and relevance to production in the tropics. *J Anim. Sci.* 62(2): 531-542.

Fuquay, J.W. (1981). Heat stress as it affects animal production. *J. Anim. Sci.* 52(1) : 164.

*Gallasz, E., Jans, F. and Schneeberger, H. (1973) Feeding technique in the use of automatic drinkers in fattening and rearing calves. *Mitteilungen-fur-die-Schweizerische- Landwirtschaft.* 21(7): 139-148.

Getty, R. (1975). In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 201.

Grossman, J.D. (1949). In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 201.

Hahn, L.G. (1981). Housing and management to reduce climatic impacts on livestock. *J. Anim. Sci.* 52(1) :175.

Hanekamp, W.J.A., Smits, A.C. and Weirenga, H.K. (1994). Open versus closed barn and individual versus group housing for bull calves destined for beef production. *Livest. Prod. Sci.* 37(3): 261-270.

Harvey, R.W., and Spears, J.W. (1989). Effect of blood meal processing method on performance and nitrogen utilization by growing cattle. *Anim. Feed. Sci. Technol.* 24(3-4): 337-343.

Hedde, R.D., Knox, K.L., Johnson, D.E. and Ward, G.M. (1974). Energy and protein utilization in calves fed via rumen by-pass. *J. Anim. Sci.* 39(1): 108-114.

Hill, K.J., Noakes, D.E. and Lowe, R.A. (1970). In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 203.

Hinks, C.E. and Whittemore, C.T. (1976). A note on the utilization by calves of maize and potato diets in liquid suspension or in dry form. *Anim. Prod.* 22(3): 415-418.

Huber, J.T., Standaert, J.E. and Emery, R.S. (1982). Rumen bypass of protein through suckling of liquids by lactating heifers. *J. Dairy Sci.* 65(7): 1163-1169.

Indian Standard Specification (1970). Indian Standard Specification for compounded seeds for young stock. Indian Standards Institution. New Delhi, Pages 3,5, 11-13.

*Iriki, T., Adachi, K. and Abe, M. (1992). Necessity of ruminally undegraded dietary protein in 4-5 months old calves under the condition of low-protein intake. *Anim. Sci. Technol.* 63(4): 414-419.

*Iwuanyanwa, I.E. J., Umunna, N.N., Dim, N.I. and Ohajuruka, O.A. (1990). Performance of beef heifers fed low quality hay and supplemented with urea, blood meal and or bone meal. *Bulletin of Animal Health and Production in Africa* 38 (3) 207-212.

Jenny, B.F., Mills, S.E., Johnston, W.E. and O'Dell, G.D. (1978). Effect of fluid intake and dry matter concentration on scours and water intake in calves fed once daily. *J. Dairy Sci.* 61(6): 765-770.

Kibler, H.H., Johnson, H.D. and Berry, I.L. (1966). Energetic efficiency of lactating cows: effect of controlled and ad libitum feeding at 18°C and 31°C temperatures. *Miss. Exp. Sta. Res. Bul.* 913

Kilshaw, P.J. and Sissons, J.W. (1979). Gastrointestinal allergy to soyabean protein in pre ruminant calves. Allergenic constitutents of soybean products. *Research-in-Veterinary- Science* 27(3): 366-371.

*King'ori, A.M., Tuitock, J.K. and Muiruri, H.K. (1998). Comparison of fermented dried blood meal and cooked dried blood meal as protein supplements for growing pigs. *Trop Anim. Health Prod.* 30 (3): 191-196.

Klopfenstein, T. (1981). Animal proteins fed as rumen bypass proteins. *Feed Stuffs* 53 (29): 23-24.

*Kobayashi, T., Itabashi, H., Shishido, H. and Omori, S. (1984). Effects of giving liquids by nipple-feeder or bucket on concentrations of glucose and insulin in the blood plasma of calves. *Bulletin- of National-Institute-of-Animal- Industry.* 42: 7-14.

Kopp. M.B. Friend, T.H. and Dellmier, G.R. (1986). Effect of feeding method on nonnutritive oral activities in Holstein calves. *J. Dairy Sci.* 69(12): 3094-3099.

Knaus, W.F., Beermann, D.H., Robinson, T.F., Fox, D.G. and Finnerty, K.D. (1998). Effects of a dietary mixture of meat and bonemeal, feathermeal, blood meal and fish meal on nitrogen utilisation in finishing Holstein steers. *J. Anim. Sci.* 76 (5): 1481-1487.

*Knaus, W.F., Zollitsch, W., Lettner, F., Schlerka, G. and Pangerl, R. (1997). Effect of iron supplementation on the performance, blood haemoglobin, iron concentration and carcass color of veal calves. Bodenkultur 48(1) :43-51.

Lalles, J.P. and Poncet, C. (1990). Changes in ruminal and intesinal digestion during and after weaning in dairy calves fed concentrate diets containing pea, soyabean meal. 1. Digestion of organic matter and nitrogen. *Livest. Prod. Sci.* **24**(2): 129-142.

*Lee, D.H.K. (1953). Manual of field studies on the heat tolerance of domestic animals. F.A.O. agric. Dev. Paper. No.38. FAO, Rome, Italy.

*Lindt, F and Blum, J.W. (1994). Growth performance, haematological traits, meat variables, and effects of tread mill and transport stress in veal calves supplied different amounts of iron. Zentralbl Veterinarmed (A) 41(5): 333-342.

Loerch, S.C., Berger, L.L., Plegge, S.D. and Fahey, G.C. Jr. (1983). Digestibility and rumen escape of soybean meal, blood meal, meat and bone meal and dehydrated alfalfa nitrogen. *J.Anim. Sci.* **57**(4) :1037-1047.

*Macolm-Callis, K.J., Galyean, M.L. and Duff, G.C. (1994). Effects of dietary supplemental protein source and a *Pastuerella haemolytica* toxoid on performance and health of newly received calves. *Agri-Practice* **15**(4): 22-28.

McDowell, R.E., McDaniel, B.T., Barrada, M.S. and Lee, D.H.K. (1961). Rate of surface evaporation from the normal body surface and with sweat glands inactivated under hot conditons. *J. Anim. Sci.* **20**(2): 380.

*Mees, A.M.F., Metz, J.H.M. and Kzeeb. (ed). (1984). The sucking behaviour of calves and its satisfaction by various feeding systems. *Aktuelle-Arbeiten-zur-artgemassen- Tierhaltung* 92-93.

*Morel, I. (1996). Iron supply in veal calves. *Agrarforschung* 3(2):53-56.

Morrill, J.L. and Dayton, A.D. (1981). Method of feeding milk and access to fiber source for young calves. *J. Dairy Sci.* 64(1) : 146-148.

Mortenson, F.N., Espe, D.L. and Cannon, C.Y. (1935). In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 203.

Mylrea, P.J. (1966). In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 203

Nair, S.P. (1997) Report on fifteenth quinquennial livesock census - 1996. The Director of Animal Husbandry, Kerala,Thriuvanathapuram. pp.20, 115.

Nauheimer-Thoneick., Von, H., Thomas, C.K. and Weniger, J.H. (1988). *Untersuchungen zum Engergieumsatz von laktierenden Kuhen unter Warmebelastung Zuchtungskunde* 60(5), S. 388-397.

*Nuwagaba, H.M., and Koyongo -Male- H (1983). Comparison of performance between bucket-fed and nipple-fed dairy calves on different levels of milk intake. *Trop. Anim. Prod.* 8(3) : 206-214.

Ørskov, E.R. (1994). Recent advances in understanding of microbial transformation in ruminants. *Livest. Prod Sci.* 39(1), 53-60

Perry, W. (1988). Role of bypass protein in liquid supplements examined. *Feed Stuffs* 60 (39): 17-18.

Pryor, W.J. and Ternouth, J.H. (1972). A comparison of feeding reconstiuted and dried milk upon the growth and carcass composition of calves. *Br. J. Nutr.* 27(3): 517-525.

*Podkowka.W., Podkowka, Z., Dorszewski, P and Cermak, B. (1994). The use of machinekombi; produced by Alfa-Laval for suckling calves. *Zootechnicka Rada* 11(1): 41-50.

Quigley, J.D. 3rd., Bernard, J.K., Tyberendt, T.L. and Martin, K.R. (1994). Intake, growth, and selected blood parameters in calves fed calf starter via bucket or bottle. *J. DairySci.* 77(1) : 354-357.

Rajala, P. and Castren, H. (1995). Serum immunoglobulin concentrations and health of dairy calves in two management systems from birth to 12 weeks of age. *J. Dairy Sci.* 78(12): 2737-2744.

Rangngang, M.B., Nelson, M.L. and Parish, S.M. (1997). Ruminal undegradability of blood meal and effects of blood meal on ruminal and postruminal digestion in steers consuming vegetative orchardgrass hay. *J Anim. Sci.* 75(10) 2788-2795.

*Robinson, P.H., Mowat, D.N., Chapman, H.W. and Parkins, J.J. (1977). Nipple feeding of supplemental protein to calves. *Can J. Anim. Sci.* 57(1): 181-186.

*Sambraus, H.H. (1984). Mutual sucking in artificially reared calves. *Berliner-und-Munchener-Tierarztliche-Wochenschrift*97(4): 119-123.

Saseendranath, M.R., Thomas, C.K. and Geevarghese, P.I. (1983). Effect of two types of housing and two concentrate feeds on growth of crossbred calves . *Indian. J Anim. Sci.* 53 (6):591-595.

Shaji, A. (1994). Factors influencing calf growth and mortality in field and organised farms. M.V.Sc. Thesis. Kerala Agricultural University, Thrissur. pp. 68-70.

Specht, S.M. Faustman, C., Bendel, R.B., Malkus, L.A. Kinsman, D.M and Sison, C. (1994). Carcass composition of "Bob" and "Special-Fed" veal and its prediction. *J. Anim. Sci.* 72 (10) :2635-2641.

*Stewart, J.A. (1976). Effect of feeding calves by artificial teats at two drinking rates or by bucket. Proceedings of the Australian Society of Animal Production 11: 265-267.

Swartz, L.A. Heinrichs, A.J. Varga, G.A. and Muller, L.D. (1991). Effects of varying dietary undegradable protein on dry matter intake, growth and carcass composition of Holstein calves. *J. Dairy Sci.* 74 (11): 3884-3890.

*Szucs, E., Molnar, I., Weber-Forgony, A., Szollosi, I. and Kishonti, L. (1983). Effects of feeding milk from nipple-pails or buckets in calf rearing. *Acta-Agronomica-Academiae-Scientiarium-Hungaricae*.32 (3-4): 273-284.

Ternouth, J.H., Roy, J.H.B. and Siddons, R.C. In. The Calf. By Roy, J.H.B. (1980). Butterworths, London. 4th Ed. pp. 203.

Tripathi, V.N., Thomas, C.K., Sastry, N.S.R. and Guptha, L.R. (1972). Effect of shelter and water sprinkling on buffaloes - Growth rate. *Indian J. Anim. Sci.* 42(9): 745-749.

*VanStraalen, W.M. and Tamminga, S. (1990). Protein degradation of ruminant diets. In. Feed Stuff Evaluation. Edited by Julian-Wiseman and Cole, D.J.A. (1990) Butterworths, London. pp. 55-72.

*Vardevanyan, L. (1977). Rearing calves with starting concentrate mixtures. *Molochnoe-i-Myasnoe-Skotovodstvo*3: 40-41.

*Warner, R.G. (1984). The impact of protein solubility in dairy calf starters. Proceedings of the Cornell Nutrition-Conference. 42-45.

*Wee-E-ter., Wierenga, H.K., Jorna, I.P. and Smits, A.C. (1989). Feeding milk replacer with a floating rubber teat and supplying water via a nipple to group housed veal calves. Consequences for behaviour and production. *Rapport-Instituut-voor-Veeteeltkundig-Onderzoek-'Schoonoord'*B-329:49.

Wells, G.A.H., Scott, A.C., Johnson, C.J., Gunning, R.F., Hancock, R.D., Jeffrey, M., Dawson, M. and Bradley, R. (1987). A novel progressive spongiform encephalopathy in cattle. *Vet. Rec.* **121**: 419-420.

Young, B.A. (1981). Cold stress as it affects animal production. *J. Anim. Sci.* 52 (1): 154-163.

*Zaremba, W. (1983). Feeding technique and its importance for the health of newborn calves with reference to diarrhoea. *Praktische-Tierarzt.* 64(11): 977-992.

Zinn, R.A and Owens, F.N. (1993). Ruminal escape protein for light weight feed lot calves. *J. Anim. Sci.* 71(7): 1677-1687.

* Originals not consulted

FEEDING TECHNIQUES TO ENHANCE THE GROWTH IN CALVES

By
RENY K. OOMMEN

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Livestock Production Management
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR
KERALA, INDIA

1999

ABSTRACT

With the objective of investigating the feasibility of the technique of liquid feeding of concentrates to calves through nipple buckets with and with out incorporation of blood meal in the ration, 24 calves below one month of age at Cattle Breeding Farm Thumburmuzhy, Kerala Agricultural University were randomly allotted to four treatment groups. The four treatment groups were

T_1 - dry feeding and no supplementation of blood meal.

T_2 - dry feeding and supplementation with blood meal

T_3 - liquid feeding and no supplementation with blood meal.

T_4 - liquid feeding and supplementation with blood meal.

The dry feeding groups were offered feed in feeding baskets and the same feed suspended in water was fed to liquid feeding groups through feeding nipples fixed on aluminium buckets.

The experiment was conducted during the months of April to September, 1997 where the temperature Humidity Index values were above 75 per cent indicating a stressful environment due to the combined effect of high temperature and high humidity

which adversely affected the growth of calves in all four treatment groups.

Intakes of water, concentrate and roughage were not significantly different between treatment groups but liquid feeding group showed a slightly higher trend on water intake.

There was no significant difference between treatment groups in terms of live weight gain, body length, height and chest girth. But the general trend varied for live weight and chest girth. Body weights were lower in T_3 and T_4 groups where liquid feeding was resorted to. The dry feeding group had better chest girth than liquid feeding group which reflected in their live weight gain also.

Monthly values of haematocrit, haemoglobin, erythrocyte sedimentation rate, serum glucose, serum cholesterol and plasma protein were not significantly different between treatment groups. But treatment groups receiving blood meal showed slightly higher haemoglobin per cent. The plasma protein values were slightly higher in groups receiving ration in dry form which had a higher daily weight gain.

Treatment groups on liquid diet had more episodes of diarrhea than those on dry diet.

Treatment groups showed no significant difference with regard to carcass characteristics but the trend indicated higher meat yield from groups receiving dry feed.

Only during the last two months, i.e., in the fifth and sixth months when the rumen is somewhat fully developed, some beneficial effect of liquid mode of feeding was evident.

Liquid feeding through nipple is known to bypass rumen and in animals with ill developed rumen, liquid feeding should show beneficial effects on growth. In the present study such a difference could not be observed possibly due to the fact that all the rations contained fish meal which has high content of protein escaping rumen degradation.

The level of 30 per cent replacement of protein by blood meal showed no retardation in feed intake or growth in the experimental animals.