NUTRITION & HUSBANDRY

TRADITIONAL VERSUS HIGH INPUT FEEDING SYSTEM: IMPACT ON NUTRIENTS INTAKE, BLOOD DYNAMICS, HORMONAL PROFILE, WEIGHT GAIN AND ECONOMICS IN GROWING LAMBS

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ABSTRACT

The study was planned to compare the influence of high and low input feeding systems on nutrients ingestion, digestibilities, nitrogen retention (NR), blood urea nitrogen (BUN), metabolic hormones, liver enzymes and economics of weight gain in growing male *lohi* lambs. Eighty lambs, 3 months of age, were randomly divided into ten groups with eight animals in each. Ten diets were formulated. The diet F only contained barseem fodder (hay) while nine isocaloric diets with three levels of crude protein (CP) i.e. low protein (LP, 18%CP), medium protein (MP, 22%CP) and high protein (HP, 26%CP) with ionophores (LPI, MPI and HPI) and probiotics (LPP, MPP and HPP) were formulated. Inclusion rate of ionophores and probiotics in diets was 20ppm and 0.1% of ration, respectively. The LP, MP and HP diets were grouped as concentrate (C) diets. These CP diets when supplemented with ionophores and probiotics were grouped as CI and CP diets. Lambs fed C, CI, CP diets consumed higher feed than those fed F diet. A linear and quadric increase ($p<0.05$) in nutrients intake was observed in lambs fed C, CI and CP diets with increasing dietary CP level. Similar trend was noticed for neutral detergent fiber (NDF) and acid detergent fiber (ADF) intakes ($p<0.05$). However, ionophores and probiotics supplementation did not affect feed consumption in lambs fed C, CI and CP diets. Dry matter digestibility and nitrogen retention was higher ($p<0.05$) in lambs fed C, CI and CP diets than those fed F diet. The blood urea nitrogen (BUN) increased linearly with increasing dietary CP in the concentrate diets. However, ionophores and probiotics supplementation did not affect BUN ($p<0.05$). Serum creatinine was not affected by ionophores or probiotics, however, increased linearly with increasing dietary CP in the concentrate diets. Cholesterol, triglyceride, LDL and HDL were higher ($p<0.05$) in lambs fed concentrates than those fed fodder only. Serum calcium, P and Cl were higher ($p<0.05$) and blood pH was lower ($p>0.05$) in lambs fed concentrate diets than those fed fodder only. A gradual increase in dietary crude protein concentration of C, CI and CP diets increased triiodothrionine (T_3), thyroxin (T_4) and testosterone in lambs compared to those fed on fodder. Alanine aminotransferase (ALT) were higher ($P<0.05$) in lambs fed concentrates than those fed fodder only. A linear increase was observed in blood ALT with increasing CP levels in concentrate diets. Economic appraisal indicated that feed to gain ratio was lower in lambs fed concentrate diets than those fed diets containing fodder only. Total feed cost of lambs fed concentrate diets was higher ($p<0.05$) than those fed fodder only. However, cost to produce one kg live weight of lambs fed concentrates were lower ($p>0.05$) than those fed diets containing fodder only reflecting that high concentrate portion in feed reduced the cost of production in growing lambs.

Key words: *High input feeding system, weight gain, economics, lambs*

INTRODUCTION

Sheep is an important segment of mutton production in Pakistan. *Lohi* sheep is main breed with about 4% share in total sheep population **(Pakistan Livestock Census, 2006)** in Pakistan. This breed has an adult weight of 65 kg **(Shah, 1994)** with 55% dressing percentage **(Mustafa, 2006)**. Male lambs are preferred for mutton production because of higher weight gain than ewes. Male lambs consume more dry matter; have better growth rate, slaughter and carcass weights than ewes **(Macit *et al*., 2002).**

Balanced and cost-effective system **(Kemp *et al*., 1981)** to produce lean and slaughter lambs **(Borton *et al*., 2005)** is of paramount importance **(Belloff, 2003)**. Imbalance and poor nutrition is the main cause of poor growth rate and meat quality. In traditional feeding system, sheep are predominantly raised for meat production on grazing or on seasonal fodder where growth is compromised due to poor quality pasture or forage characterized by high fiber and low protein contents **(Sarwar *et al*., 2005)**. Moreover, pasture based feeding system increases maintenance energy requirements of grazing animals **(Diaz *et al*., 2002)**.

Intense urbanization and industrialization is decreasing availability of both grazing and fodder production land. In addition, there is an increasing trend in the farming community to adopt backyard sheep rearing as commercial enterprise which further underlines the need of rapid economical weight gain in lambs. Under these circumstances, stall feeding lambs with nutrient rich (high energy and protein) diets seems an option for increased mutton production. Nutrient rich feeding system ensures sufficient nutrients supply which increases weight gain in growing lambs and also improves meat quality **(Bennett *et al*., 1995; Ryan *et al*., 2007)**. The information regarding raising small ruminants on high input system versus fodder system is limited under tropical and subtropical conditions, particularly with local sheep breeds. The present study, therefore, was planned to examine the economic feasibility of Lohi sheep raised on traditional (fodder) versus high input feeding (concentrates) systems and to evaluate ionophores or probiotics supplementation with concentrates diets effects on nutrients intake, digestibilities, nitrogen balance, blood dynamics, growth performance and economics in *Lohi* male lambs.

MATERIALS AND METHODS

Eighty male lambs (3 months of age) were randomly divided in ten groups with eight animals in each. Nine isocaloric diets with three levels of crude protein (18, 22 and 26%) with or without ionophores (@ 20ppm) and probiotics (0.1% of ration) were formulated (Table 1). These diets were fed to nine groups of lambs while tenth group was offered fodder (berseem hay) only. The lambs were fed *ad libitum* and were weighed weekly. The study lasted for 90 days; first month was adaptation period while every alternate week thereafter served as collection period. During each collection week, feed intake was recorded daily. Total collection method was used to determine the nutrient digestibilities. Feces were collected daily, dried at 55°C, bulked and mixed at the end of each collection period. Urine samples were acidified with 50% H_2SO_4 and stored at -20°C for laboratory analysis. Feed and fecal samples were analyzed for neutral detergent fiber (NDF) and acid detergent fiber (ADF), by the method described by **Van Soest *et al*. (1991)** and crude protein (CP) by **AOAC (2003)**. Nitrogen (N) balance was calculated using equation described by **NRC (2001)**. Blood samples were collected by puncturing jugular vein from each animal into vacutainer tubes containing EDTA solution and serum were harvested for further analysis. Glucose was analyzed by method described by **Davies *et al*. (2007)**, serum minerals by **AOAC (1990)**, whereas, triiodothyroxin (T_3) and thyroxin (T_4) concentrations by the methods of **Todini *et al*. (2007)**. Lipid profile and creatinine were analyzed according to methods described by **Meyer (1996)**.

The experiment was executed under completely randomized design and the data collected were analyzed using Analysis of Variance technique. The results found significantly different were treated by Duncan multiple range test to explore the treatment differences **(Steel and Torrie 1980)**.

RESULTS & DISCUSSION

Nutrients intake

Dry matter intake (DMI) by lambs fed on C, CI and CP diets was higher than those fed on fodder (Table 2). A linear and quadratic increase ($p<0.05$) in nutrients intake was observed in lambs with increasing dietary CP level in C, CI and CP diets. Similar trend was noticed for NDF and ADF intakes ($p<0.0$). However, ionophores and probiotics supplementation did not affect feed consumption in lambs fed C, CI and CP diets. Higher nutrients intake by lambs fed C, CI and CP diets compared to those fed on fodder was due to lower dietary NDF content of these diets as shown in table (1). Higher dietary NDF content might have reduced nutrients intake by imparting rumen fill effect **(Sarwar *et al*., 1991)**. Furthemore, it is hypothesized that better rumen microbial proliferation and efficiency, due to sufficient supply of nitrogen and carbon units at ruminal level, in lambs fed C, CI and CP diets have increased DM degradation and thereby increased nutrients intake in these animals. Increased feed consumption due to increasing protein level in the concentrate diets in the present study is in agreement with **Haddad *et al*. (2001)** who reported that feed intake was higher in Awassi lambs fed diets containing 16 and 18% CP than those fed 12 and 14% dietary CP. Similarly, **Atti *et al*. (2004)** reported that nutrients intake was higher in kids fed concentrates than those fed fodder only. **Ponnampalam *et al* (2005)** noticed improved feed intake in lambs fed concentrate than those fed hay only. Enhanced nutrients intake by supplementation of concentrate is also documented by **Atti *et al*. (2004).**

Nutrients digestibilities and nitrogen balance

Dry matter digestibility was higher ($p<0.05$) in lambs fed C, CI and CP diets than those fed fodder only (Table 2) and a similar trend was noticed for CP, NDF and ADF digestibilities. The DM digestibility by lambs fed CI and CP diets was higher than those fed C diet. Ionophore and probiotics increased DM and NDF digestibilities. Synchronized availability of sufficient carbon and nitrogen units at rumen level might have enhanced rumen microbial enzyme production and thereby increased nutrient digestibility. Similar findings have been reported by **Dabiri and Thonney (2004)**. They reported that nutrient digestibility was higher in lambs fed diets containing 17% CP than those fed diets containing 13 and 15% CP. A positive relationship among nutrients intake, digestibility and concentrate supplementation is also documented **(Atti *et al*., 2004)**. Increased nutrients digestibilities by lambs fed CI diet than those fed C diet might be attributed to modifying the movement of ions across cell wall of rumen microbes **(Potter *et al*., 1976; Raun *et al*., 1976)**. Efficient utilization of nutrients by lambs supplemented with probiotics has been attributed to their favorable effects on rumen microbes and ecology **(Schelling, 1984)**. Higher N retention in lambs fed C, CI and CP diets was due to their higher N intake than those fed on Fodder (Table 3).

Blood Urea Nitrogen, Glucose, Creatinine and Lipid profile

The blood urea nitrogen (BUN) and blood glucose were higher ($p<0.05$) in lambs fed C, CI and CP than those fed fodder only. However, blood glucose in lambs fed concentrate with or without probiotics or ionophore remained unaffected ($p>0.05$).The BUN increased linearly with increasing dietary CP in concentrates (Table 4). However, ionophores and probiotics supplementation did not affect BUN ($p<0.05$). Serum creatinine was not affected by ionophores or probiotics, however, increased linearly with increasing dietary CP in concentrate diets. Cholesterol, triglyceride, LDL and HDL were higher ($p<0.05$) in lambs fed concentrates than those fed fodder only.

There was a linear and quadratic increase in cholesterol and LDL concentration with increasing dietary CP in concentrate diets. The LDL was higher ($p<0.05$) in lambs fed probiotics and ionophore diets than those fed diets without probiotics and ionophores. The LDL was also higher ($p<0.05$) in lambs fed diets containing probiotics than diets fed containing ionophores (Table 4).

Blood urea nitrogen (BUN) is an indicator of normal functionality of renal tubular. Its concentration was higher in lambs fed diets containing high CP than those fed low protein diets. These results supported the findings of **Ponnampalam *et al*. (2005)** who observed increased BUN in lambs fed high CP diets. Other researchers **(Hristoe *et al*. 2004; Castillo *et al*., 2001; Armentano *et al*., 1993; Jia *et al*., 1995)** also reported increased blood urea N concentration with increasing dietary CP content. Similarly, **Sahlu *et al*. (1993)** observed that increasing dietary CP in concentrate from 8.5 to 13.9% and 20.3% in Alpine, Bubian and Angora breeds of goats increased plasma urea N from 8.3 to 22 and 33.3 mg/L, respectively. Increased BUN is directly related with urine urea N concentration. Increasing CP level in diet increased BUN which resultantly excreted more N in urine **(Dabiri and Thonney, 2004)**. The probable reason for increased BUN in lambs fed high crude protein diets might be attributed to increased absorption of ammonia across the ruminal wall **(Williams *et al*., 1991)**. Increased blood glucose levels with concentrate diets were consistent with **Anthony *et al*. (1986)**. They reported that serum glucose concentration was lower in heifers fed low protein diets. Similarly, **Sertich *et al*. (1979)** observed lower blood glucose in ewes fed low concentrate diets. **Prior and Laster (1979)** observed that pregnant heifers fed less concentrate diets had lower glucose levels than those fed high concentrate diets. The findings of the current study are consistent with those reported by **Grundy and Denke (1990)** who reported that concentration of plasma cholesterol is affected by the dietary nutrient composition especially that of protein. Soy protein in animals reduced the cholesterol concentration **(Barth *et al*., 1990; Forsythe1995)**. Present findings are in concordance with previous researchers **(Rauprich *et al*., 2000; Hammon and Blum, 1998)**. Also, **Muri *et al*. (2005)** reported higher triglycerides concentration in calves fed high concentrate diets.

Hormonal profile [Testosterones, T_3 andT_4] and Liver Enzymes [ALT and ALP]

Triiodothyronine (T_3) increased linearly ($p<0.05$) in lambs with increasing dietary CP. The T_3 was higher ($p<0.05$) in lambs fed concentrate than those fed fodder only. Higher T_3 ($p<0.05$) concentration was also noticed in lambs fed diets containing probiotics than those fed ionophore (Table 5). Thyroxin (T_4), testosterone and blood glucose were higher ($p<0.05$) in lambs fed concentrate than those fed fodder only. Lambs fed diets with probiotics or ionophores had higher ($p<0.05$) T_4 than those fed diets without additives. Testosterone was higher ($p<0.05$) in lambs fed C, CI and CP than fodder only. The ALT was higher ($p<0.05$) in lambs fed diets containing concentrate than those fed fodder only. The ALP was higher ($p<0.05$) in lambs fed concentrate diets with ionophore and probiotics than those without . The ALP increased linearly ($p<0.05$) as dietary CP increased in concentrate diets (Table 5).

Higher concentrations of T_3 and T_4 hormones are related with nutritional status and metabolic rates as recorded by **Todini *et al*. (2007)** who observed that high energy diets had higher concentrations of plasma T_4 concentration when compared with low energy diets. The T_3 and T_4 act on different target tissues, stimulating oxygen utilization and heat production in almost every cell of the body. As a result of increased basal metabolism due to these hormones, more glucose becomes available to cells which stimulates protein synthesis, increases lipid metabolism and stimulates cardiac and neural functions **(Capen and Martin, 1989)**. Our results support the work of **Oboh and Olumese (2008)** who reported that ALT concentration in rabbit was significantly higher and ALP was significantly lower in high protein and low carbohydrates diets.

Serum minerals

Serum calcium, P and Cl were higher ($p<0.05$) and blood pH was lower ($p>0.05$) in lambs fed concentrate diets than those fed fodder only (Table 6). The Ca, P and blood pH decreased linearly ($p<0.05$) as dietary CP increased in the concentrate diets. Sodium concentration was higher in diets containing ionophore than those containing probiotics and it was also higher ($p<0.05$) in diets without ionophores and probiotics than those with ionophores and probiotics (Table 6). Higher serum mineral concentration in lambs fed concentrate diets might be attributed to better dietary composition of these minerals and their availability. The Ca and P concentrations in our study are supported the previous findings of **Hayashida *et al*. (2004)** who observed higher plasma P levels in goats supplemented with concentrate than goats fed roughage alone. The effect of concentrate on serum Na, K and Mg was similar to the previous results reported by **Davies *et al*. (2007)** that serum Na and K remained unaffected by diet. It was not in agreement with **Heijnen *et al*. (1993)** who reported that decreased pH increased the solubility of intestinal Mg which increased Mg absorption and plasma Mg level.

Growth performance and economic appraisal

A significant increase ($p<0.05$) in daily weight and total weight gain were observed in lambs fed concentrates than those fed fodder only (Table 7). Daily gain, total gain, economic and total cost of feed for lambs remained unaffected due to ionophores or probiotics supplementation. In the present study, increased weight gain in lambs fed C, CI and CP diets might be increasing supply of nutrients to these animals. Furthermore, lambs fed on concentrate diets had sufficient quantity of protein as bypass protein which has increased postruminal availability of amino acid supply which has significant impact on muscle accretion phenomena. Similar findings have been reported by **Murphy *et al*. (1994)** who reported increased average daily weight gain in lambs fed concentrate diet than those lambs grazing ryegrass during the growing period.

Craddock *et al*. (1974) observed that average daily gain was significantly higher in lambs fed diet having 13.5% protein than those lambs fed diets having 10.5% protein. The feed cost to produce one kg live weight was lower in lambs fed concentrate than those fed fodder only (Table 7). The findings of present study indicate that increasing weight by feeding concentrate is a profitable activity. Similar observations have been found by **Merchen *et al*. (1987)** who reported increased feed to gain ratio in steers fed low concentrate diets compared to those fed high concentrate diets.

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Table-1 : **Ingredients and chemical composition of diets fed to growing lambs**

Ingredients		Experimental diets[1]								
		C			CI			CP		
	F	LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP
Corn grains		31.05	30.61	28.22	31.05	30.61	28.22	31.05	30.61	28.22
Soybean Meal		5.82	5.84	9.00	5.82	5.84	9.00	5.82	5.84	9.00
Wheat Bran		7.67	7.12	5.20	7.67	7.12	5.20	7.67	7.12	5.20
Cotton Seed Meal		6.13	6.05	8.24	6.13	6.05	8.24	6.13	6.05	8.24
Canola Meal		6.37	6.23	8.15	6.37	6.23	8.15	6.37	6.23	8.15
Rice Polishing		7.05	6.64	4.64	7.05	6.64	4.64	7.05	6.64	4.64
Wheat straw		10.00	10.00	9.02	10.00	10.00	9.02	10.00	10.00	9.02
Sunflower Meal		6.04	6.02	9.56	6.04	6.02	9.56	6.04	6.02	9.56
Corn gluten 30%		5.97	5.89	6.92	5.97	5.89	6.92	5.97	5.89	6.92
Molasses		8.32	7.57	3.70	8.32	7.57	3.70	8.32	7.57	3.70
Urea		0.49	2.00	2.00	0.49	2.00	2.00	0.49	2.00	2.00
Vegetable Oil		1.08	2.04	2.00	1.08	2.04	2.00	1.08	2.04	2.00
DCP		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
NaCl		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$NaHCO_3$		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Probiotic (%) (Sacromyces cerevece)		-	-	-	-	-	-	0.1	0.1	0.1
Ionophores (ppm) (Salinomycine)		-	-	-	20	20	20	-	-	-
Berseem Hay	100	-	-	-	-	-	-	-	-	-
Chemical composition (%)										
Dry Matter	88.89	89.54	89.86	90.56	89.54	89.86	90.56	89.54	89.86	90.56
Crude Protein	18.9	18	22	26	18	22	26	18	22	26
Total Digestible Nutrients	60.6	70	70	70	70	70	70	70	70	70
Acid Detergent Fiber	41.97	12.48	12.27	13.15	12.48	12.27	13.15	12.48	12.27	13.15
Neutral Detergent Fiber	51.37	21.90	21.43	22.2	21.90	21.43	22.2	21.90	21.43	22.2

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively. Diet F presents fodder (barseem hay).

Table-2 Nutrients intake and digestibilities in lambs as influenced by traditional and high input feeding systems

Items	Experimental diets[1]										SE	Main Contrasts[2]				PROTEIN	
	F	C			CI			CP									
		LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP		F vs. C	CI vs. CP	C vs. CI	C vs. CP	L	Q
Nutrients intake , g/d																	
Dry matter	420	702	775	824	735	815	810	764	794	710	258	*	NS	NS	NS	*	*
Crude protein	79.4	126.4	170.5	214.2	132.3	179.3	210.6	137.5	174.6	184.6	5.5	*	NS	NS	NS	*	NS
Neutral detergent fiber	215.7	153.7	166.0	182.9	161.0	174.6	179.8	167.3	170.1	157.6	6.0	*	NS	NS	NS	*	NS
Acid detergent fiber	176.3	101.6	95.1	108.4	91.7	100.0	106.5	95.3	97.42	93.4	3.8	*	NS	NS	NS	*	NS

Table-2 (Follow) Nutrients intake and digestibilities in lambs as influenced by traditional and high input feeding systems

Items	Experimental diets[1]										SE	Main Contrasts[2]				PROTEIN	
		C			CI			CP									
	F	**LP**	**MP**	**HP**	**LPI**	**MPI**	**HPI**	**LPP**	**MPP**	**HPP**		**F vs. C**	**CI vs. CP**	**C vs. CI**	**C vs. CP**	**L**	**Q**
Nutrients digestibilities, %																	
Dry matter	57.6	66.3	69.4	65.6	68.3	71.8	67.8	68.7	71.5	67.9	1.2	*	NS	*	*	NS	*
Crude protein	71.3	73.8	71.8	72.1	72	71.3	72.4	74.5	71.2	71.3	1.1	*	NS	NS	NS	NS	NS
Neutral detergent fiber	44.8	51.5	58.3	53.9	55.9	60.4	59	56	62.4	58.3	1.5	*	NS	*	*	*	8
Acid detergent fiber	38.4	45.3	46.6	41.1	49	47.1	45.8	48.5	49.8	46.6	1.2	*	NS	*	*	*	*

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * (P<0.05), NS=Non significant

Table- 3 Nitrogen balance in lambs as influenced by traditional and high in put feeding systems.

Item	Experimental diets[1]										SE	Main contrasts[2]				PROTEIN	
		C			CI			CP									
	FOD	LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP		F vs. C	CI vs. CP	C vs. CI	C vs. CP	L	Q
N Intake (g/d)	12.7	20.22	27.23	34.28	21.17	28.69	33.7	22.0	27.95	29.54	0.87	*	NS	NS	NS	*	NS
Faecel N (g/d)	3.61	6.12	7.89	9.35	5.88	8.12	9.65	6.23	8.0	8.31	0.51	*	NS	NS	NS	*	NS
Faecel N (% of Intake)	28.43	30.27	28.98	27.28	27.78	28.30	28.64	28.32	28.62	28.13	1.4	*	NS	NS	NS	*	NS
Apparent N digestion (g/ d)	9.09	14.89	19.34	24.93	15.29	20.75	24.05	15.77	19.95	21.23	0.64	*	NS	NS	NS	*	NS
Urinary N (g/day)	0.15	0.19	0.21	0.24	0.18	0.21	0.25	0.29	0.30	0.31	0.03	*	NS	NS	NS	*	NS
N balance (g/day)	8.94	14.7	19.13	24.69	15.11	20.36	23.8	15.48	19.65	20.92	0.64	*	NS	NS	NS	*	NS

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of “I” and “P” in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * ($P<0.05$), NS=Non significant

Table-4 Blood dynamics in lambs as influenced by traditional and high input feeding systems

Items	Diets[1]											Main Contrasts[2]				PROTEIN	
	F	C			CI			CP			SE						
		LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP		F VS C	CI VS CP	C VS CI	C VS CP	L	Q
Blood Urea Nitrogen, (mg/dl)	12.1	20.1	23.4	26.0	20.2	23.6	26.1	21.4	24.1	25.4	1.2	*	NS	NS	NS	*	NS
Blood glucose, (mg/dl)	49.3	66.8	70.8	78.7	69.5	74.1	69.8	77.6	68.7	72.8	2.0	*	NS	NS	NS	NS	NS
Creatinine (mg/dl)	0.80	0.75	0.79	0.95	0.76	0.76	0.98	0.78	0.82	0.95	0.05	NS	NS	NS	NS	*	NS
Lipid Profile																	
Cholesterol, (mg/dl)	53.4	70.6	81.0	82.7	71.8	87.8	84.7	70.9	83.5	80.9	4.4	*	NS	NS	NS	*	*
Triglyceride, (mg/dl)	28.7	37.0	34.6	48.9	31.6	42.4	56.2	38.3	44.8	54.8	4.2	*	NS	NS	NS	*	NS
LDL, (mg/dl)	24.9	32.6	36.9	29.0	34.0	38.5	28.6	47.0	40.3	30.7	2.6	*	*	*	*	*	*
HDL, (mg/dl)	34.1	31.9	33.8	34.3	37.1	35.5	35.3	34.6	35.9	38.3	3.4	*	NS	NS	NS	NS	NS

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * (P<0.05), NS=Non significant

Table-.5 Hormones and liver enzymes in lambs as influenced by traditional and high input feeding systems

Items	Diets										SE	Main Contrasts				PROTEIN	
	Fodder	C			CI			CP				F vs. C	CI vs. CP	C vs. CI	C vs. CP	L	Q
		LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP							
Hormones																	
T_3 (n mol/L)	1.1	1.4	1.6	2.2	1.6	1.4	1.5	1.7	1.8	2.5	0.12	*	*	*	*	*	*
T_4 (n mol/L)	67.6	87.9	93.8	98.4	91.6	93.1	97.1	106	103	92.4	5.5	*	NS	NS	NS	NS	NS
Testosterone (ng/ml)	1.1	2.7	2.9	2.7	2.8	2.6	2.8	2.8	2.8	2.9	0.31	*	NS	NS	NS	NS	NS
Liver Enzymes																	
ALT (u/l)	49.9	69.9	74.2	77.1	75.3	83.3	79.8	83.4	76.3	80.5	3.2	*	NS	*	*	NS	NS
ALP (u/l)	186	195	195	237	164	251	329	235	214	245	20.7	NS	NS	*	NS	*	NS

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * (P<0.05), NS=Non significant

Table-.6 Serum minerals and blood pH in lambs as influenced by traditional and high input feeding systems

Item	Diets[1]										SE	Main Contrasts[2]				PROTEIN	
		C			CI			CP									
	Fodder	LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP		F vs. C	CI vs. CP	C vs. CI	C vs. CP	L	Q
Ca (mg/dL)	6.7	9.7	9.0	8.7	9.4	8.8	8.0	9.3	8.5	8.2	0.46	*	NS	NS	NS	*	NS
P (mg/dL)	5.4	6.9	6.7	5.9	6.5	6.9	6.3	6.6	6.3	7.0	0.39	*	NS	NS	NS	NS	NS
Na (mEq/dL)	146	146	147	148	138	144	137	135	133	134	3.3	NS	*	*	*	NS	NS
Cl (mEq/dL)	103	109	107	105	105	106	105	107	107	105	1.1	*	NS	NS	NS	*	NS
K (mEq/ dL)	4.1	4.4	4.2	4.1	4.4	4.5	4.9	4.6	4.8	4.5	0.32	NS	NS	NS	NS	NS	NS
Mg (mEq/dL)	2.2	2.0	2.0	2.1	2.1	2.1	2.1	2.2	2.2	2.1	0.12	NS	NS	NS	NS	NS	NS
Blood pH	7.3	7.3	7.0	6.4	7.1	6.9	6.7	7.0	6.9	6.6	0.13	*	NS	NS	NS	*	NS

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * (P<0.05), NS=Non significant

Table.7 **Growth economics in lambs as influenced by traditional and high input feeding systems**

Item	Diets[1]										SE	Main Contrasts[2]				PROTEIN	
	Fodder	C			CI			CP									
		LP	MP	HP	LPI	MPI	HPI	LPP	MPP	HPP		F vs. C	CI vs. CP	C vs. CI	C vs. CP	L	Q
Daily gain (g/day)	54	139	195	172	148	176	165	149	185	162	5.1	*	NS	NS	NS	*	*
Cost of feed to produce one kg live weight (Rs)	132	82	92	108	86	96	111	89	98	113	7.5	*	NS	NS	NS	NS	*
Feed:gain	7.77	5.05	3.97	4.79	4.97	4.63	4.91	5.13	4.29	4.38	0.4	*	NS	NS	NS	NS	*

[1]C, CI and CP stands for Concentrate, concentrate with ionophores and concentrate with probiotics, respectively. While LP, MP and HP represent low (18%), medium (22%) and high (26%) dietary crude protein (DCP) concentrations, respectively. Affixes of "I" and "P" in remaining diets indicate supplementation of ionophores and Probiotic with similar low, medium and high DCP contents, respectively.

[2] F vs. C = Fodder versus Concentrate, CI vs. CP = concentrate ionophores versus Concentrate Probiotic, C vs. CI = Concentrate verses concentrate ionophores, C vs. CP = Concentrate verses concentrate Probiotic, L=linear, Q=Quadratic, * ($P<0.05$), NS=Non significant