NUTRIENT REQUIREMENTS AND WAYS TO FEED EWES BEING MACHINE MILKED

R.M. Jordan
Professor Emeritus
University of Minnesota

While millions of sheep have been milked in the Mediterranean basin for centuries there is very little hard data on the nutrition of dairy ewes (hand milked). Therefore we have to rely on data from ewes suckling lambs and on dairy cattle data. Unfortunately sheep are not simply small cows and ewes being milked rather than suckling their lambs bear little milk yield resemblance to one another.

Energy Requirements:

Cannas (1996) summed up the energy needs of 60 kg milked ewes vs 600 kg lactating cows as follows: a) Maintenance requirements are based upon metabolic weight (wt $kg^{.75}$). A 600 kg cow with a metabolic weight of 121.2 kg is only 5.6 times greater than the 60 kg ewe with a metabolic weight of 21.6, not 10 times greater. b) Cattle have more kg of GI tract available per unit of energy required for maintenance than sheep and can “store” more feed stuffs in the GI tract per unit of energy required than sheep. c) Cattle retain feedstuffs in the rumen longer than sheep therefore fibrous feeds are digested more highly by cattle. d) Feed passes through the sheep’s gut faster so sheep need to eat more as a percent of body weight. e) Sheep choose better feed, masticate it more thoroughly, thus, reducing particle size which affects passage rate. Sheep digest highly digestible diets better and low digestible diets less well than cattle. f) Major differences between the dairy ewe and the dairy cow is the sheep’s inconsistent response to changes in nutrient intake and their lack of yield persistence or, in short, less dairy temperament. As a hypothetical example a ewe being fed 4 units of feed and producing 4 units of milk will not necessarily increase milk production when fed 5 units or decrease yield appreciably when fed only 3 units of feed. This lack of response obviously makes determining nutrient requirements for dairy ewes frustrating to the researcher.

Suckled vs Milked Ewes:

a) As milk yield per ewe increases the percent of fat and protein decreases. b) Change from first four week suckling to milking is accompanied by a rapid reduction in milk yield of 30 to 40% (Treacher 1989). Thus, milk yield in the second month of milking is likely to be no more and probably less than a ewe suckling a single lamb. However, milk production during the first month strongly affects milk yield during mid and late lactation. Both lactation length and total production are positively influenced by high yield at the peak of lactation (Cannas 1996). In short, when ewes switch from suckling to milking a 40% milk yield reduction among ewes producing 6 lb. milk (6.0 - 2.4 lb = 3.6 lb) results in greater daily milk yield over a longer period of time than a 30% reduction in yield among ewes producing only 3 lb during early lactation. Some breeds of ewes machine milked have a disproportion decline in milk yield. Finn and Romanov suckled lambs grow at about the same rate, but when machine milked Finn ewes yielded twice as much milk (Boylan 1989).

Despite the problems cited as to specific nutrient requirements of dairy ewes Cannas (1996) provides daily metabolizable energy (ME data) from French, Australian, and British sources that are in good agreement with one another and are the best available. I’ve taken the liberty to calculate how much energy is required for each additional kg (qt) of milk produced (Table 1) along with the total amount.

Useful conversion values from feeds to metabolizable energy may be helpful in understanding the data in Table 1. Feedstuffs > gross energy (GE) > to digestible energy (DE) > metabolizable energy (ME) > net energy (NE). In the USA, we frequently use total digestible nutrients (TDN) interchangeably with DE with the value of 1 lb TDN being equal to 2 megacalories (Mcal) of DE. ME is equal to 82% of DE. One lb hay has about 50% TDN (.5 lb) or 1 Mcal DE. Corn has 80% TDN or about 60% more DE than hay.

The Australian data in Table 1 shows an increase for maintenance of .17 Mcal ME for each 1 kg increase in milk yield. Note also that for each increase of 1 kg of milk yield the amount of ME required is about 93 to 100% of the amount of ME required to maintain the ewe.

Lactation energy requirement suggested by NRC (1985) are not as specific as to milk yield and don't agree very closely with the English, French, and Australian data. However, they have been included as they are most available to US producers. NRC maintenance requirements for 60 and 70 kg ewes exceed 2.2 Mcal ME whereas other sources suggest less than 2.0 Mcal ME for maintenance. In order for NRC data to agree more closely with the French, English and Australian data, the NRC maintenance requirements would need to be reduced about 15% (from 2.2 to 1.87 and 2.4 to 2.04 Mcal ME for a 60 kg and 70 kg ewe, respectively). In estimating milk production of a suckling ewe that you intend to commence milking assume that a month old lamb requires about 5 units of milk for each unit of lamb gain. Thus, 2 kg milk (4.4 lb) should result in .88 lb lamb gain on a single lamb or .44 lb ADG on each twin lamb (Bocquier and Caja, 1992).

Protein Requirements:

Specific protein requirements for dairy ewes are very elusive and what values are available are largely from dry ewes, ewes nursing lambs, or from dairy cow data. The amount of protein required daily is influenced by the amount fermented in the rumen (degradable intake protein) and used by the rumen bacteria for growth and subsequently utilized by the ewe and undegradable intake protein is that digested in the intestines. The ability of bacteria to use protein is influenced by type and amount of feed eaten, frequency of feeding, and the amount of energy fermented in the rumen.

For dry ewes NRC (1985) suggests 104, 113, and 122 gms protein daily for 60, 70, and 80 kg ewes, respectively. Crude protein requirements for lactation are about 120 to 125 gms per kg of milk containing 4% CP. NRC (1985) suggests 13% CP for 90 kg ewes and 14.5% for 50 kg ewes producing 1.74 kg milk daily and 14% (90 kg ewe) and 16.2% (50 kg ewes) for ewes producing 2.6 kg milk daily. Ewes fed 18 to 18.5% CP have also increased milk yield, especially if the additional protein is of low rumen degradability (fishmeal, feathermeal, bloodmeal, etc). Microbial protein may not be able to completely meet the protein demands of high producing ewes. However, low rumen degradable protein seem less beneficial when fed in conjunction with corn than with barley (Hussein et al, 1991).

Practical Feeding:

The data in Tables 1 and 2 are rather removed from practical feeding of so many scoops of silage, flakes of hay or pounds of grain and supplements, but my following remarks will use them as the basis for constructing some farm rations for producers to use.

Preparing the Dairy Ewe:

Correct feeding of the dairy ewe should start at least 30 days prior to lambing at energy and protein intakes that a) enhances udder development; b) assure fat and protein reserves on the ewe and c) prepares or accustoms the ewe's digestive tract to the intake of 1.7 to 2.0 times more nutrients than were fed during late gestation. Furthermore, the increased nutrient intake will usually be provided by two to three times more grain than was fed during gestation which can easily cause acidosis (resulting in off-feed, scours and even entero-toxemia). A body condition score of 3.5 to 3.8 (one is thin, five is fat) should provide a body reserve during the first 2 to 3 weeks when energy and protein produced in the milk exceeds the amount contained in the feed eaten. Thus ewes are invariably in negative balance in the first two to three weeks of lactation. Ewes with low body fat reserves will produce about 50% less milk from fat reserves than ewes with adequate fat reserves (Robinson, 1987). Fat ewes (body condition scores of 4.5 to 5.0) normally eat less feed which adversely affects milk yield.

Grinding forage or feeding pelleted rations will increase dry matter intake appreciably, however, it increases ration costs 40 to 60% which no dairy sheep producer can stand. Some sheep producers believe high grain diets reduce milk yields and increase body fat deposition. Grain does increase propionate production in the rumen which tends to produce more body fat than acetic acid production which is more prevalent in high forage diets. However, practical data suggests that milk yield may actually be increased during early lactation and only during late lactation do ewes become fat when fed high grain rations. To minimize proprionic acid production in the rumen, feed very coarsely ground grains or whole corn (Barillet, 1995).

Lactating ewes respond to somatatropin (bST) treatment to about the same degree as dairy cattle (Jordan and Shaffhausen, 1954; Fernandez, 1995) and tends to cause partitioning of more nutrients for milk production than body fat deposits. This hormone treatment has increased milk yield 20 to 30% (Jordan and Shaffhausen, 1954; Fernandez, 1995) and may be a practical way to increase yield of a valuable product.

Assume that other than the ewes inherent capacity to produce milk, the amount produced is going to be influenced greatly by nutrient intake. Just how much and what kind of feed intake is equivalent to 5 to 7 Mcal ME intake (Table 1)? My experience with lactating ewes suggest that the ration should consist of a minimum of 30% and a maximum of 70% grain. The metabolizable energy and protein values in Tables 1 and 2 enables one to calculate compositions of the ration but not total intake. ME intake per day obviously is greatly affected by the amount fed daily. If your hay contains two Mcal ME per kg of DM or .9 Mcal ME per pound then a 30% corn and 70% hay ration would contain 2.345 Mcal ME per kg of ration (30 kg times 3.15 Mcal ME in corn = 94.15 Mcal ME and 70 kg times 2.0 Mcal ME in hay = 140 Mcal ME from the hay. Thus, 94.5 + 140 = 234.5 or 2.35 Mcal ME per kg of ration dry matter). For a 40:60; 50:50; and a 60:40 corn/hay ration the Mcal ME per kg of feed would be 2.46, 2.58, and 2.69 Mcal ME per kg dry matter, respectively. To convert ME per kg to ME per pound, divide each value by 2.2.

The amount of feed per ewe should be based on ewe weight. A 200 lb ewe needs more and will eat more than 140 lb ewe, but when feed is provided as a percent of ewes body weight nutrient intake per 100 lbs will be the same. We have fed ewes nursing twin lambs as little as 3% of their body weight of a 50:50 corn/hay ration and ewes nursing triples as much as 4.5 percent or their weight. A 50:50 corn/hay ration is and has been for some time less costly per pound than a 30:70 corn/hay ration and virtually eliminates feed refusal. When more than a 70:30 corn/hay ration is fed, you are more apt to encounter acidosis and you usually must add considerable protein supplements, thus adding to ration costs.

If you are milking 160 lb ewes and feeding 3.5 percent of their body weight of a 50:50 corn/hay ration you are giving them 5.6 lb dry matter x 1.17 Mcal ME per lb or 6.55 Mcal ME intake per day. Referring to Table 1, 70 kg ewes (154 lb) need about 5.53 Mcal ME to produce 4.4 lb milk or 7.37 Mcal ME to produce 6.6 lb milk. At this level of feed intake, would the protein intake be adequate?

A 50:50 corn/alfalfa hay ration would contain 13.5% protein. 5.6 lb of the corn/hay ration x 13.5% protein would provide .856 lb protein divided by 2.2 = .389 kg or 389 gms protein. Referring to Table 2, one notes 70 kg or 154 lb ewes require 113 gms protein for mere maintenance and an additional 123 gms for 1 kg of milk, and 246 for 2 kg of milk or a total of 236 or 359 gms protein daily for maintenance and either one or two kg milk, respectively. Based upon these calculations a 70 kg ewe producing 3 kg (6.6 lb) milk could be fed a 50:50 corn/hay ration containing at least 13-14% protein and at about 4% of body weight (4.0% x 70 kg = 2.8 kg corn/hay dry matter). Now 2.58 Mcal ME/kg, the energy in a 50:50 corn/hay ration, x 2.8 kg ration = 7.22 Mcal ME that the ewe would be consuming daily or enough nutrients for 3.0 kg (6.6 lb) of milk daily. Protein content 2.8 kg ration times 13.5% protein = 379 gms or .83 lb protein.

Feeding 154 lb ewes about 6.2 lb of 50:50 corn/hay diet to provide 7.22 Mcal ME or 8.8 Mcal DE or 4.4 lb TDN may seem like a great deal to many of you. Hogue (1994) fed ewes nursing triplet lambs about 7% of body weight of a pelleted ration containing 70-75% TDN with excellent lamb growth and about .5 lb ewe gain daily (too much). Benson (1998) fed 175 lb mature ewes nursing twin lambs and producing 8.5-9.5 lb milk daily (oxytocin induced) rations containing 70% TDN and 14% protein at levels to provide 8.5 lb dry matter, 1.22 lb protein and 5.95 lb TDN (9.76 Mcal ME). These data indicate that intake of sufficient feed to produce 6-8 lb milk is no problem. However, getting a machine milked ewe to yield that amount of milk is likely to remain unsurmountable. Feeding a ewe at a level to produce 6-8 lb milk and extracting only 2-3 lb milk daily will obviously make for obese ewes and extremely high milk production costs. Benson (1998) believes US ewes are producing more milk daily and are more efficient than we give them credit for. Hopefully, further research will focus on this point.

The problem of getting ewes to produce milk in accordance to their nutrient intake was addressed by Windels (1991) and is presented in Table 4 and 5. He used mature ¼ Finn, ½ Suffolk and ¼ Targhee ewes weighing 170-210 lb with sound and capacious udders. The ewes were individually fed for the first two (twins) to three weeks (triplets) and 2cc oxytocin was administered IM when ewes were hand milked. Other than when the ewes were hand milked the twin or triplet lambs had access to their mothers. A 50:50 corn-SBM and alfalfa haylage DM ration was fed once daily. The levels of ration fed daily were 90%, 100%, 110% and 120% of the daily amount of energy suggested by NRC (1985) for ewes suckling twins. Level of feed intake affected ewe weight change, condition score and time taken to consume their daily ration but had little affect on lamb weight gains or milk production. This study and several others conducted at Minnesota (Jordan, 1982; Jordan, 1985 and Jordan, 1986) point out the problems encountered in attempting to get non-dairy ewes to increase milk yield when stimulated with increases in nutrient intake. Hopefully dairy ewes will be more responsive than conventional mutton type sheep.

Pasture Feeding Dairy Ewes:

Your concern with pastured dairy ewes should be daily forage intake and forage quality. If the energy requirements of 70 kg ewes producing 2 kg milk are 5.9 Mcal ME or 7.2 Mcal DE that’s equivalent to 3.6 lb TDN or 7.2 lb of forage dry matter or 14.4 lb of pasture forage containing 50% dry matter or 20.5 lb if the forage contained only 35% dry matter, a more likely percentage. Daily intake of pasture forage is affected not only by the need of the ewe and availability but by pasture freshness. Daily forage intake is usually less the third or fourth day of grazing than it was the first day. Thus pasture rotation two or three times per week should encourage intake. During the first 10 weeks of lactation supplementing the pasture with 1.2 lb grain or about 25% of the 5.9 Mcal ME requirement or 1.48 Mcal ME or 1.8 Mcal DE should sustain yield. Thus if the ewe required a total of 5.9 Mcal ME or 7.2 Mcal DE she would acquire 5.4 Mcal DE from the pasture and 1.8 Mcal DE from the grain. Her pasture forage intake at 35% dry matter would be 15.4 lb. After 10 weeks lactation if the pasture is still of good quality the grain could be replaced with good quality hay so as to minimize propionic acid production that tends to over condition the ewe.

What kind (species) of pasture should you use? Initially use what you have, but fertilize it with 50 lb N in the spring and 50 lb N about July 15. If you intend to reestablish pastures Aug 10 seeding works best for us. Bromegrass, orchardgrass and low alkaloid canarygrass (palatin) are much more productive than timothy or bluegrass. Red clover can be frost-seeded at very low cost and will tolerate soils with pH of 5.5 to 6.0.

Summary of Factors Affecting Milk Yield

Pro

- Grinding and pelleting increases feed intake and possibly milk yield.
- High quality forage contributes more to total digested DM intake than pelleting.
- Adequate body fat at lambing.
- Adequate energy and protein intakes, health status and dairy temperment encompass 98% of factors influencing milk yield.
- Have silage finely ground to enhance feed intake.
- Quality pasture forage is crucial to nutrient and DM intake.
- Body condition, milk yield and feed intake are indicative of adequate nutrient intake.
- Cull about 25% of low milk producers the first 2-3 years.
- Repeatability of milk production is high. The top 20% of the producers in year one are apt to be in top 20% the 2^{nd} year.
- Breed or strain of ewe definitely affects oxytocin release, thus milk surge and udder evacuation.
- On average, ewes with 15 to 50% Friesland blood will prove more suitable than non-Friesland ewes for milking.

Con

- Grinding and or pelleting increases ration costs.
- Haphazard ration formulation and feeding levels has no place in a dairy sheep enterprise.
- Irrespective of breed some ewes are “Losers” for the same reason beef cows aren’t a part of productive dairy farms.
- High grain intakes during first 8 weeks of lactation are beneficial.
- Thereafter high grain rations increase body fat deposition and decrease milk yield.
- Grinding grain increases fermentation and increases propionic acid production and thus body fat deposits.
- Corn ferments slower than barley, oats or wheat and response from feeding low degradable protein will be less.
- If hay has a relative feed value below 100 expect 25-35% refusal.
- Liquid or loose feces suggest excess protein intake, too low fiber, excess starch and acidosis. Dry pellet like feces suggest inadequate degradable protein.
- Parlor grain feeding should not exceed .75 lb. at one time to mininize propionate surges. Fat in excess of 10% in concentrate is counter productive.
- Grazing increases maintenance requirements 20% on good quality flat pasture and 35-40% on extensive hilly pastures.

Table 1. Energy Requirements for Housed Lactating Ewes (Mcal. ME/day)

	60 Kg Ewe						70 Kg Ewe					
F.C.M.(6.5%)	British		French		Australia		British		French		Australia	
Kg/day	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg	Total	Per Kg
0	1.76		1.66		1.83		1.96		1.87		2.05	
1	3.51	1.75	3.40	1.74	3.71	1.71	3.73	1.74	3.60	1.73	3.94	1.71
2	5.31	1.58	5.13	1.74	5.60	1.71	5.63	1.77	5.34	1.74	5.82	1.71
3	7.18	1.61	6.87	1.74	7.45	1.71	7.37	1.79	7.07	1.73	7.70	1.71
4	9.10	1.63	8.61	1.74	9.30	1.71	9.27	1.82	8.81	1.73	6.59	1.71

USA (NRC)

	60 Kg Ewe			70 Kg Ewe		
F.C.M.(6.5%) Kg/day	Total Mcal	Per Kg Milk	15% Maintenance Reduction	Total Mcal	Per Kg Milk	15% Maintenance Reduction
0	2.20		1.87	2.40		2.04
1	6.40	2.20	3.69	6.00	3.66	3.86
2	5.40	1.50	1.78	5.50	1.75	1.93
3	6.10	1.90	2.32	6.60	2.16	1.53
4	6.10	1.30	1.41	6.60	1.40	1.19

Table 2. Crude Protein Requirements for Dairy Ewes

Body wt., Kg	60	70	80	90
Maintenance g/d	104	113	122	131
1 Kg Milk	125	123	121	120
2 Kg Milk	250	246	242	240
3 Kg Milk	375	369	363	360

Table 3. Energy and Protein Contents of Typical Sheep Feeds. (DM basis).

		Mcal./Kg DM		
	TDN %	DE	ME	Protein %
Alfalfa				
Midbloom	56	2.47	2.03	17.0
Early bloom	56	2.47	2.03	18.0
Bromegrass	55	2.43	1.99	9.7
Canarygrass	49	2.16	1.77	10.3
Red Clover	62	2.73	2.24	16.1
Orchardgrass	59	2.60	2.13	12.8
Corn silage	70	3.09	2.54	8.1
Barley	86	3.79	3.11	13.5
Beet pulp	77	3.48	2.78	10.1
Corn	87	3.84	3.15	10.1
Fishmeal	77	3.40	2.78	66.0
Oats	77	3.40	2.78	13.3
Soybean	94	4.14	3.40	42.8
Soybean meal	88	3.86	3.18	49.9
Wheat	87	3.84	3.15	16.0
Alfalfa, fresh	58	2.56	2.10	19.7
Bluegrass, early	69	3.04	2.50	18.6
Brome, vegatative	80	3.53	2.89	18.0
Rape, vegetative	75	3.31	2.71	23.5
Trefoil, fresh	63	2.78	2.28	21.0

Table 4. Energy Requirements of Ewes Nursing Twins or Triplets.

	Triplets				Twins			
	Energy as % NRC (Twins)				Energy as % NRC (Twins)			
	80	100	110	120	80	100	110	120
Ewe wt chg, lb	-13.20	-7.60	-10.50	-3.00	-15.10	-4.50	-7.20	-4.00
Daily intake, lb								
TDN/100 lb BW	2.24	2.53	2.67	3.09	2.20	2.39	2.45	2.35
DM/% BW	3.04	3.43	3.60	4.18	2.97	3.22	3.60	3.65
Protein/100 lb BW	.41	.42	.41	.47	.56	.59	.61	.62
No. Lambs	15	15	15	15	8	10	10	8
Birth wt, lb	10.10	11.45	9.90	10.1	11.60	11.70	13.00	12.90
ADG, 1st 8 wks, lb	.62	.52	.42	.63	.76	.63	.77	.70
# wt. sold/weaned, lb	104.20	109.70	104.50	100.80	85.50	97.00	85.80	80.80
Creep DM/hd, lb	.67	.70	.45	.55	.56	.83	.65	.66
Milk yield, lb (oxytocin)								
Week 1	7.46	8.09	8.02	7.99	8.50	9.70	8.50	8.56
Week 2	7.00	7.80	8.74	7.80	7.40	8.10	8.20	7.50
Week 3	6.52	8.30	6.84	6.90	–	–	–	–
Time to consume								
Once daily fed ration, hr	1.88	2.20	5.51	5.50	2.20	2.50	3.50	5.60

H. Windels, 1990

Table 5. Effects of Feeding Four Energy Intakes to Lactating Ewes Suckling Twin or Triplet Lambs.

	Energy Intake As % of NRC (Twins)				Type of Rearing	
	90	100	110	120	Triplets	Twins
No. Ewes	9	10	10	9	20	18
Initial wt, lb	185.8	185.6	188.5	185.0	183.4	189.1
Wt. chg, lb	-14.1	-6.1	-9.0	-3.5	-8.7	-7.7
Body cond. chg	-1.5	-0.4	-0.3	0.0	-0.6	-0.5
No. Lamb	22	25	25	23	60	36
Birth wt, lb	10.6	11.3	11.1	10.9	10.3	12.1
ADG, 1st 8 wks, lb	.67	.70	.68	.68	.62[b]	.70[c]
Lamb gain/ewe 1st 8 wks, lb	97.7	98.7	97.1	99.2	104.6[b]	87.5[c]
Creep DM/d, lb	.64	.75	.56	.83	.52	.88
Milk yield, with 2cc oxytocin/d, lb						
Week 1	7.0	7.4	7.7	7.3	8.0[b]	6.6[c]
Week 2	7.5	7.8	8.5	7.7	7.9	7.8
Week 3					6.7	
Feed consump. time, once daily feeding, hrs	2.0	2.3	3.7	5.8	3.5	3.5

H. Windels, 1990

Literature cited

1. Barillet, F. 1995. Sheep Dairying in France: production and objectives of research. Great Lakes Dairy Sheep Symposium. University of Wisconsin-Madison. p 44.
2. Benson, Margaret E. 1998. Feeding lactating ewes for lamb production. The Shepherd. 43:2 pp 16.
3. Bocquier F. and G. Caja. 1993. Recent advances on nutrition and feeding of dairy sheep. 5th International Symposium on Machine Milking of Small Ruminants. p 580.
4. Boylan, W.J. 1989. The genetic basis of milk production in sheep. North American Dairy Sheep Symposium. University of Minnesota, St. Paul. p 1.
5. Hogue, D.E. 1974. Further observations on feeding highly productive sheep. Proc. Cornell Nutrition Conf. Ithaca, NY:140-142.
6. Hussein, H.S., R.M. Jordan, and M.D. Stern. 1991. Ruminal protein metabolism and intestinal amino acid utilization as affected by dietary protein and carbohydrate sources in Sheep. J. Anim. Sci. 69:2134-2146.
7. Jordan, R.M. and Darold D. Shaffhausen. 1954. Effect of somatotropin on milk yield of ewes. J. Anim. Sci. 13:706-710.
8. Jordan, R.M. 1986. The effect of level of energy and protein intake of ewes nursing triplet lambs on lamb performance. Proceedings 58th Sheep and Lamb Feeders Day. University of Minnesota-Morris, p 2.
9. Jordan, R.M. 1982. The effect of type of ration on the cost and performance during gestation and lactation. Proceedings 54th Sheep and Lamb Feeders Day. University of Minnesota-Morris. p 2.
10. Jordan, R.M. and H.E. Hanke. 1983. The effect of protein intake by lactating ewes on subsequent performance. Proceedings 55th Sheep and Lamb Feeders Day. University of Minnesota-Morris. p 24.
11. Jordan, R.M. 1984. Effect of energy level and ratio of hay to corn on the performance of gestating and lactating ewes. Proceeding 56th Sheep and Lamb Feeders Day. University of Minnesota-Morris. p 33.
12. Jordan, R.M. 1985. Performance and production costs of triplet and twin lambs. Proceedings 57th Sheep and Lamb Feeders Day. University of Minnesota-Morris. p 17.
13. NRC. 1985. Nutritient Requirements of Sheep (6th Revised Ed.). National Academy Press, Washington, D.C.
14. Robinson, J.J. 1988. Energy and protein requirements of the ewe. In: Recent developments in ruminant nutrition. Eds., W. Haresign and D.J.S. cole. Buttersworth, London.
15. Treacher, T.T. 1989. Nutrition of the dairy ewe. In: Proceedings North American Dairy Sheep Symposium. Ed., W.J. Boylan. University of Minnesota, St. Paul.
16. Windels, Harvey. 1991. Energy requirements of ewes rearing triplets. Proceedings 63rd Sheep and Lamb Feeders Day, University of Minnesota, Morris. p 33.