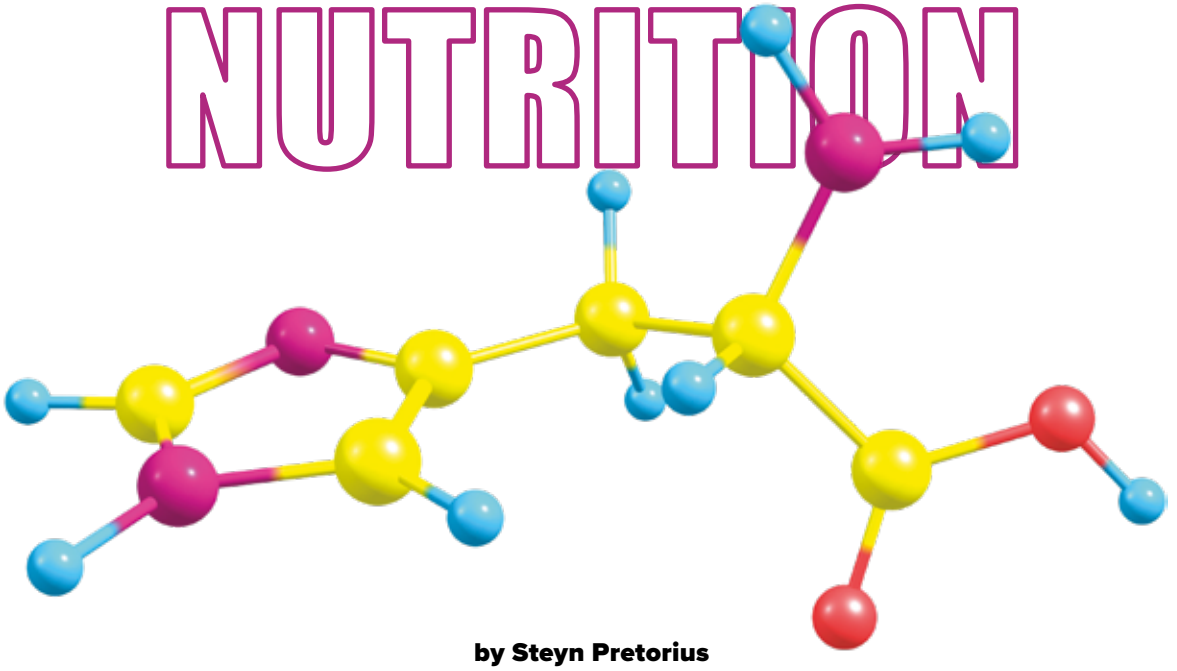
IMPROVING REPRODUCTIVE EFFICIENCY THROUGH NUTRITION



by Steyn Pretorius

Although milk production and health play a critical role in any dairy business, reproduction arguably plays the most important role in determining the future success of the farm and ensuring that new productive animals are constantly entering the herd to replace outgoing cows.

PROTEIN EFFICIENCY LEADS TO REPRODUCTIVE EFFICIENCY

To stimulate and support high milk production throughout the early phases of lactation, cows tend to be fed diets that are higher in dietary protein (> 17% crude protein), but this can result in decreased reproductive performance (Butler, 1998). In the rumen, breakdown of rumen-degradable protein, when an excess exists, results in increased blood nitrogen levels. This nitrogen, circulating as ammonia, has a toxic effect on mammalian cells and is, thus, converted into urea which can be excreted or cycled back into the rumen through secretions in saliva. This conversion to urea requires additional energy, which could be costly if excess dietary protein is fed.

Table 1 The negative association of PUN (plasma urea nitrogen), BUN (blood urea nitrogen), and MUN (milk urea nitrogen) concentrations and fertility in dairy cattle was summarised in a meta-analysis by Melendez *et al.* (2003)

Factor	Critical concentration (mg/dL)	Effect on fertility	Reference
BUN	20	BUN value ≤ 20 mg/dl resulted in a conception rate (CR) of 50%, and cows were 3 times as likely to conceive (P=0,01), whereas BUN value > 20 mg/dL resulted in CR of 23%.	Ferguson *et al.*, 1988
PUN	19,3 ± 0,3 and 12,3 ± 0,2	PUN value of 19,3 ± 0,03 mg/dL resulted in first service CR of 31%, which was significantly (P < 0,05) less than first service CR of 48% for PUN value of 12,3 ± 0,2 mg/dL.	Canfield *et al.*, 1990
PUN	17,5 ± 0,22 and 23,6 ± 0,23	PUN value of 23,6 ± 0,23 mg/dL resulted in first service CR of 61%, which was significantly (P < 0,05) less than first service CR of 82% for PUN value of 17,5 ± 0,22 mg/dL.	Elrod & Butler, 1993
PUN	> 20	CR decreases at PUN concentration of 20 mg/dL; CR decreases 0,8% units/% mg of increased serum urea nitrogen concentration.	Butler, 2000
PUN and MUN	> 19 for each	Associated with significant (P = 0,02) decrease in pregnancy rates (18% and 21% decrease in two experiments).	Butler *et al.*, 1996
BUN	16,4 ± 0,02 and 21,3 ± 0,5	BUN value of 21,3 ± 0,05 mg/dL resulted in CR of 41,3% at 120 days after parturition, whereas a BUN value of 16,4 ± 0,02 mg/dL resulted in a CR of 70,1% at 120 days after parturition.	Burke *et al.*, 1997
MUN	21,5 ± 0,7 and 23,3 ± 0,4	Cows with high MUN concentrations were more likely to return to oestrus 21 days after breeding.	Larson *et al.*, 1997
MUN	> 16	CR at first service was lower for cows with high MUN value; cows with a low MUN value bred in winter were 18 times more likely to conceive at first breeding than were cows with a high MUN bred during summer.	Melendez *et al.*, 2000
MUN	> 15,4	Cows with MUN values < 10 mg/dL were 2,4 times as likely and cows with MUN values between 10,0 and 12,7 mg/dL were 1.4 times as likely to be confirmed pregnant as were cows with MUN values > 15,4 mg/dL.	Rajala-Schultz *et al.*, 2001

High PUN concentrations have been shown to alter uterine pH (Rhoads *et al.*, 2004; Elrod & Butler, 1993; Elrod *et al.*, 1993) and concentrations of urea, magnesium, phosphorus, and zinc in uterine fluid (Jordan *et al.*, 1983). This has been shown to negatively affect embryo quality.

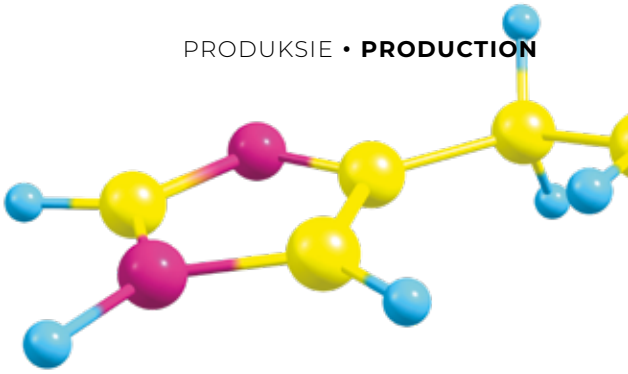
AMINO ACID PROFILING, RATIO AND FORMULATION ARE KEY

Focusing on formulating for the correct amino acid profile, where amino acids are fed at the required ratios, instead of the crude protein value, could reduce the overfeeding of certain amino acids and, thus, increase the nitrogen efficiency and lower the crude protein concentration without underfeeding metabolisable protein to the dairy cow, as stated in Table 2 by Wang *et al.*, 2010.

Correct supplementation of methionine and lysine, which are also known as the first two limiting amino acids for production, at the correct ratio, can have a significant impact on MUN and PUN concentrations as well as lowering the crude protein content of the ration without decreasing milk yield.

Table 2 Effects of dietary supplementation of lysine and methionine on milk production, nitrogen utilisation efficiency, and urea nitrogen (N) concentration serum, urine, and milk (as adapted from Wang *et al.*, 2010)

	Treatment		
	Control	**Met**	**Met + Lys**
Methionine (g/d)	38	48	48
Metabolisable Lysine (g/d)	122	122	144
Lys : Met	3,10 : 1	2,58 : 1	3,04 : 1
Milk yield (kg/d)	26,5	28,5	30,3
Fat-corrected milk (kg/d)	25,7	28,3	28,5
Protein production (kg/d)	0,87	0,92	0,98
Serum urea N (mg/dL)	14,8	13,6	13,0
Milk urea N (mg/dL)	14,4	13,4	12,8
N conversion	0,260	0,283	0,300



AMINO ACIDS AND THEIR ROLE IN REPRODUCTION

Although all amino acids play various important roles in reproductive efficiency, as shown by Wiltbank *et al.*, 2014, it is interesting to note that the three amino acids that were considered limiting amino acids for milk production, namely methionine, lysine, and histidine, showed the highest increase in concentration in the uterine lumen during embryo elongation. Undersupply of these three essential amino acids could stunt rapid embryonic development during the period 14 to 19 days after conception as well as subsequent development of foetal and placental tissues.

> “In the rumen, breakdown of rumen-degradable protein, when an excess exists, results in increased blood nitrogen levels. This nitrogen, circulating as ammonia, has a toxic effect on mammalian cells and is, thus, excreted in urine as urea.”

Placing greater emphasis on formulating for the correct amino acid profile and monitoring diets closely could improve reproductive efficiency and success. This is unequivocally important during early lactation as cows are preparing for a new reproductive cycle during this phase. Paying close attention and monitoring MUN levels is the easiest way of knowing whether you are on the right track. The MUN concentration within the range of 8–12 mg/dL shows that you are feeding the correct amount and quality of protein to the dairy cow. Amino acid supplementation can help improve the accuracy with which these requirements are met and could help reduce ration costs in the process.

STEYN PRETORIUS (Pr.Sci.Nat 118793) holds a bachelor’s degree in animal science and agronomy from Stellenbosch University. He is the technical services manager for ruminants at Kemin Industries, with nine years’ experience. Contact him at steyn.pretorius@kemin.com.