Supplemental Table 1. Predicted AA supply for diets balancing methionine or all essential amino acids compared with the ideal supply, expressed as g AA digested per Mcal ME.

| | | Diet [1] | | | | |
|---|---|---|---|---|---|---|
| Essential AA | Ideal Ratio[2] | Base | Base + M | Base + MU | Positive | SEM |
| Arg | 2.04 | 1.85 | 1.86 | 1.96 | 2.15 | 0.006 |
| His | 0.91 | 1.01 | 1.01 | 1.05 | 1.19 | 0.003 |
| Ile | 2.16 | 1.83 | 1.83 | 1.94 | 2.00 | 0.005 |
| Leu | 3.42 | 3.64 | 3.65 | 3.81 | 4.15 | 0.012 |
| Lys | 3.03 | 2.83 | 2.82 | 2.98 | 3.09 | 0.007 |
| Met | 1.14 | 0.93 | 1.13 | 1.17 | 1.25 | 0.003 |
| Phe | 2.15 | 2.12 | 2.12 | 2.22 | 2.42 | 0.006 |
| Thr | 2.14 | 2.16 | 2.16 | 2.27 | 2.43 | 0.007 |
| Trp | 0.59 | 0.60 | 0.60 | 0.63 | 0.69 | 0.002 |
| Val | 2.48 | 2.33 | 2.33 | 2.45 | 2.62 | 0.007 |
| Lys:Met | 2.66 | 3.04 | 2.51 | 2.54 | 2.47 | 0.002 |

[1]Base = balanced for ME (assuming 45 kg ECM), but limited in MP, methionine and rumen N; Base + M = balanced for ME and methionine but limited in MP and rumen N; Base + MU = balanced for ME, methionine, with adequate rumen N, but limited in MP; Positive = balanced for ME, MP, all EAA and adequate rumen N.

[2] Justification for the ideal ratio can be found in Higgs and Van Amburgh (2016)

Supplemental Table 2. Selected outputs generated from the updated version of the Cornell Net Carbohydrate and Protein System on the diets balancing methionine or all essential amino acids.

| | Diet[1] | | | | |
|---|---|---|---|---|---|
| Parameter | Base | Base + M | Base + MU | Positive | SEM |
| DMI[2], kg/d | 23.9 | 24.8 | 24.7 | 24.4 | 0.1 |
| Actual milk[2], kg/d | 38.0 | 40.9 | 38.8 | 40.9 | 0.2 |
| ME supply, Mcals ME/d | 61.2 | 63.2 | 63.2 | 62.9 | 0.3 |
| ME required, Mcals ME/d | 56.3 | 57.4 | 57.6 | 59.6 | 0.2 |
| ME balance, Mcals ME/d | 4.9 | 5.8 | 5.6 | 3.3 | 0.3 |
| MP supply, g/d | 2323.0 | 2418.8 | 2527.9 | 2783.9 | 15.2 |
| MP required[3], g/d | 1864.4 | 1991.8 | 1948.7 | 2008.1 | 8.2 |
| MP required at 73% efficiency[4], g/d | 2554.0 | 2728.4 | 2669.5 | 2750.9 | 11.2 |
| Apparent efficiency[5], % | 80.3 | 82.1 | 77.1 | 72.0 | 0.3 |
| Productive N[6], g/d | 192[a] | 199[ab] | 199[ab] | 206[b] | 3.9 |
| Fecal N, g/d | 214[a] | 217[a] | 228[b] | 235[b] | 4.8 |
| Urinary N, g/d | 129[a] | 130[a] | 170[b] | 189[c] | 9.0 |
| Productive N:Urinary N | 1.65[a] | 1.70[a] | 1.29[b] | 1.13[c] | 0.11 |
| Productive N:Intake N | 0.37[a] | 0.38[a] | 0.35[b] | 0.34[b] | 0.01 |
| MP balance, g/d | -230.9 | -309.7 | -141.6 | 33.0 | 10.0 |
| MP RUP, g/d | 1118.5 | 1183.4 | 1180.0 | 1465.6 | 8.9 |
| MP microbial, g/d | 1204.5 | 1235.4 | 1347.9 | 1318.3 | 6.9 |
| MP microbial, % | 51.9 | 51.1 | 53.4 | 47.5 | 0.1 |
| ME allowable milk, kg/d | 42.1 | 46.1 | 43.6 | 44.7 | 0.3 |
| MP allowable milk, kg/d | 33.9 | 34.8 | 36.7 | 41.5 | 0.3 |
| ME/MP average, kg/d | 38.2 | 40.8 | 40.6 | 44.7 | 0.3 |
| ME/MP first limiting, kg/d | 34.3 | 35.4 | 37.6 | 42.5 | 0.3 |
| Met supply, g/d | 57.1 | 71.3 | 74.4 | 79.1 | 0.5 |
| Lys supply, g/d | 173.4 | 178.7 | 188.6 | 194.9 | 1.0 |
| Met balance, g/d | -15.6 | -6.9 | -1.8 | 0.0 | 0.3 |
| Lys balance, g/d | -18.3 | -27.0 | -12.5 | -13.3 | 0.7 |
| Rumen $NH_3$, mg/dL | 5.1 | 5.1 | 7.8 | 7.5 | 0.1 |
| Bacterial growth depression[7], % | 16.2 | 17.4 | 4.1 | 2.0 | 0.4 |

[a,b]Within a row, values with different superscripts statistically differ ($P < 0.05$).

[1] Base = balanced for ME (assuming 45 kg ECM), but limited in MP, methionine and rumen N; Base + M = balanced for ME and methionine but limited in MP and rumen N; Base + MU = balanced for ME, methionine, with adequate rumen N, but limited in MP; Positive = balanced for ME, MP, all EAA and adequate rumen N.

[2] Unadjusted means across the entire experiment

[3] MP required represents gross model predicted requirements for MP without accounting for its efficiency of use

[4] MP required assuming 73% efficiency of use, the weighted average efficiency for all essential AA in the updated CNCPS (Higgs et al., 2014, Higgs and Van Amburgh, 2016)

[5] Apparent efficiency of use is defined as the MP Required/MP supply

[6] Productive N = N used for milk, growth, pregnancy, and reserves (Fox et al., 2004)

[7] Bacterial growth depression is a calculation integrating feed nitrogen intake, endogenous nitrogen available to the bacteria, and recycled urea nitrogen to estimate rumen ammonia and peptide availability relative to the total fermentable carbohydrate pool to estimate ruminal nitrogen requirements given the number of bacteria that can be produced from the fermentable carbohydrate.