**Appendix 1: Schematic of the AusBeef rumen model and microbial growth equations**

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**Fig. A1** A schematic representation of the AusBeef rumen model. See explanation of terms in table A1 (colour online).

Table A1. *Explanation of terms in schematic representation of the AusBeef rumen model*

|  |  |  |
| --- | --- | --- |
| Model Term | Description | Units |
| Q | Quantity | dimensionless |
| LP/MP/SP | Large/medium/small feed particles | grams/day |
| Stm/Lf/Gn | Stem/leaf/grain feed components | grams/day |
| Up/Dp/Sp | Undegradable/Degradable/Soluble protein | moles |
| Ufb/Dfb | Undegradable/Degradable fibre | moles  |
| Dst/Sst | Degradable/Soluble starch | moles |
| NSCSol | Soluble non-starch carbohydrates | moles |
| Li | Lipids | moles |
| Ba/Sba | Amylolytic bacteria/storage polysaccharide | moles/grams |
| Blc | Lactolytic bacteria | moles |
| Po/Spo | Protozoa/storage polysaccharide | moles/grams |
| VRu | Rumen volume | liters |
| QfTiRu | Time spent ruminating | minutes |
| Hxc/Hxh/Hxs | Hexose from cellulose/hemicellulose/starch | moles |
| Lac | Lactate | moles |
| Am | Ammonia | moles |
| Prp | Propionate | moles |
| Ac | Acetate | moles |
| Vl | Valerate | moles |
| Bu | Butyrate | moles |
| Sf/Uf | Saturated/Unsaturated lipid | moles |
| InsolAsh/SolAsh | Insoluble/Soluble Ash | grams |
| *F….Ab* | Absorption across the rumen wall | moles/day |
| FUeRu | Flow of urea into the rumen | moles/day |
| FSalNAm | Rate of salivary nitrogen conversion to ammonia | moles/day |
| FDMIStm/Lf/Gn | Dry matter intake of feed particles | grams/day |
| HungerCont/ CorrFacBdLi/ cMeBl1dRav | Energetic terms feeding into voluntary intake  | dimensionless; dimensionless; MJ/kg live weight |
| PCH4Ru | Production of CH4 in the rumen | moles/day |

*Microbial growth equations*

d*Q*Ba/d*t* = ( (*P*BaAm + *P*BaSp) - (*F*BaPo + *F*BaEx) ) [1]

d*Q*Sba/d*t* = ( (112.5 × *P*SbaHx) - (*F*SbaPo + *F*SbaEx) )[2]

d*Q*Bc/d*t* = ( (*P*BcAm + *P*BcSp) - (*F*BcPo + *F*BcEx) ) [3]

d*Q*Blc/d*t* = ( ((*Y*BaAm × *U*AmBlc) + (*Y*BaSp × *U*SpBlc) - (*F*BlcPo + *F*BlcEx) ) [4]

d*Q*Po/d*t* = ( (min( ((*F*ChoPo - *U*ChoMntPo) x *Y*PoCho), (*F*PrtPo/0.0067))) - (*F*PoDth + *F*PoEx + *F*PoPo)) [5]

d*Q*Spo/d*t* = ( ((112.5 x *U*HxsSpo) + (112.5 x *U*DstSpo)) - (*F*SpoPoDth + *F*SpoPo + *F*SpoEx) ) [6]

Table A2: *Description of variable names*

|  |  |  |
| --- | --- | --- |
| Variable Name | Meaning | Units |
| *F*BaEx | Rate of outflow of amylolytic bacteria from the rumen | grams/day |
| *F*BaPo | Flux of amylolytic bacteria engulfed by protozoa | grams/day |
| *F*BcEx | Rate of outflow of cellulolytic bacteria from the rumen | grams/day |
| *F*BcPo | Flux of cellulolytic bacteria engulfed by protozoa | grams/day |
| *F*BlcEx | Rate of outflow of lactolytic bacteria from the rumen | grams/day |
| *F*BlcPo | Flux of lactolytic bacteria engulfed by Po | grams/day |
| *F*PoDth | Rate of protozoal death | grams/day |
| *F*PoEx | Rate of outflow of protozoa from the rumen | grams/day |
| *F*PrtPo | Rate of protein engulfment by protozoa | moles/day |
| *F*SbaEx | Rate of outflow of amylolytic bacterial storage polysaccharide from the rumen | grams/day |
| *F*SbaPo | Engulfment rate of amylolytic bacterial storage polysaccharide by Po | grams/day |
| *F*SpoEx | Rate of outflow of protozoal storage polysaccharide from the rumen | grams/day |
| *F*SpoPo | Loss of protozoal storage polysaccharide via protozoal engulfment | grams/day |
| *F*SpoPoDth | Rate of loss of storage particles due to protozoal death | grams/day |
| *P*BaSp | Production of amylolytic bacteria from growth with soluble protein | grams/day |
| *P*BcAm | Production of cellulolytic bacteria from growth with ammonia | grams/day |
| *P*BcSp | Production of cellulolytic bacteria from growth with soluble protein | grams/day |
| *P*SbaHx | Production of amylolytic bacterial storage polysaccharide from absorbed hexose | grams/day |
| *Q*Ba | Amount of amylolytic bacteria in the rumen | grams |
| *Q*Bc | Amount of cellulolytic bacteria in the rumen | grams |
| *Q*Blc | Amount of lactolytic bacteria in the rumen | grams |
| *Q*Po | Amount of protozoa in the rumen | grams |
| *Q*Sba | Amount of amylolytic bacterial storage polysaccharide in the rumen | grams |
| *Q*Spo | Amount of protozoal storage polysaccharide in the rumen | grams |
| *U*AmBlc | Uptake of ammonia by lactolytic bacteria | moles/day |
| *U*ChoMntPo | Carbohydrate uptake needed for protozoal maintenance | grams/day |
| *U*DstSpo | Uptake of degradable starch into protozoal storage polysaccharide | grams/day |
| *U*HxsSpo | Uptake of hexose from starch into protozoal storage polysaccharide | moles/day |
| *U*SpBlc | Uptake rate of soluble protein by lactolytic bacteria | grams/day |
| *Y*PoCho | Yield of protozoa from carbohydrates | grams/day |

Table A3: *Description of constants*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable Name | Meaning | Units | Value | Source |
| *Y*BaAm | Yield of amylolytic bacterial biomass from growth with ammonia | grams/mole | 121 | Nagorcka (unpublished) |
| *Y*BaSp | Yield of amylolytic bacterial biomass from growth with Sp | grams/mole | 152 | Nagorcka (unpublished) |
| *Y*PoCho | Yield of protozoa from carbohydrates | grams/mole | 142 | Dijkstra (1994) |