# The Small Ruminant Nutrition System, a nutrition model to account for dietary supply and requirements of nutrients for sheep and goats


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## The Small Ruminant Nutrition System (SRNS)

The Small Ruminant Nutrition System (SRNS) is the result of a joint collaboration among Sassari University (Italy), Texas A&M University, and Cornell University. It predicts nutrient requirements of sheep and goats and feed biological values based on the structure of the Cornell Net Carbohydrate and Protein System (CNCPS) for Sheep (Cannas et al., 2004; 2006a, b).

The SRNS software is multi-language and can be downloaded from:
http://nutritionmodels.tamu.edu/srns.htm
Its registration and use is free for academic purposes

## SRNS prediction of nutrient supply

- Based on the supply submodel of the CNCPS for cattle
- It provides unique ME and MP feed values for each ration depending on CHO and N pool sizes and degradation and passage rates:
  - Modifications to the cattle CNCPS: new equations for forage, concentrate and liquid passage rates (Cannas and Van Soest, 2000)
- DMI prediction: specific equations for all sheep and goats categories

## SRNS prediction of energy and protein requirements

- ME maintenance requirements:
  - basal metabolic rate differs between species and genotypes
  - requirements affected by animal age, energy intake, movement, acclimatization, cold stress, cost of urea production and excretion
- MP maintenance requirements:
  - endogenous N excretion positively affected by wool/hair production, BW and dietary DMI
  - $k_{PM}$ (NP/MP for maintenance) = 0.67 for sheep and goats
- ME and MP milk production requirements:
  - based on NE and NP content of the milk
  - $k_L$ (NE/ME for milk) = 0.644 for sheep and goats
  - $k_{PL}$ (NP/MP for milk)= 0.58 for sheep, 0.64 for goats
- ME and MP pregnancy requirements: based on AFRC (1995)
- Growth model: variable NE for average daily gain (ADG) depending on relative body size, nutrition level and gender (Figures 1 and 2)
- Body reserve model: based on the BCS of the animals (Figure 1)

### Growth model (sheep and goats)

$$ADG = \frac{RE}{EVG \times 0.92}$$

RE = retained energy (Mcal/d)
EVG = energy value gain (Mcal/kg empty BW)

$$EVG = (6.7 + 2 \times (L - 1) + \frac{16.5 - 2 \times (L - 1)}{1 + e^{-6 \times (P - 0.4)}}) \times 0.239$$

$$L = \frac{MEI}{ME_m} - 1 \qquad P = \frac{SBW}{SRW}$$

SBW = shrunk BW, kg
SRW = mature weight at BCS 3.0, kg

### Body reserve model

Sheep and goats ⇒ Current BW = (0.594 + 0.163 BCS) × $BW_{BCS\ 2.5}$

Sheep ⇒ Fat (kg/kg empty body) = 0.0269 + 0.0869 BCS (Russel et al., 1969)
Goats ⇒ Fat (kg/kg empty body) = 0.0289 + 0.0708 BCS (Ngwa et al., 2007)

BCS = body condition score, scale 0-5 $BW_{BCS\ 2.5}$ = breed mature BW at BCS 2.5
Fat = body fat, kg/kg of empty body

Figure 1. Submodels used by the SRNS to predict body reserves changes in mature sheep and goats and ADG in lambs and kids.

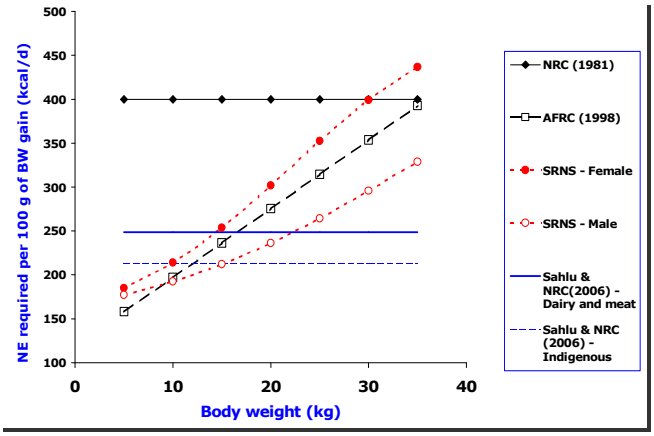


Figure 2. Simulation of the relationship between BW and NE requirements for 100 g/d of ADG of kids. For the SRNS a mature weight of 55 kg for females and 85 kg for males was considered.

## Model outputs

- Energy:
  - ME intake, requirements, and balance
  - Milk from mobilized energy, BCS, and BW variations,
  - cost of urea excretion
- Protein or N:
  - MP intake, requirements, and balance
  - rumen N and peptide balance, bacterial and dietary MP
- Others:
  - DMI prediction, required and supplied peNDF
  - rumen pH
  - rumen forage, concentrate and liquid passage rate
  - digestibility of all nutrients and feces composition

## Model Evaluation and Conclusions

The SRNS has been extensively evalauted by the authors and by independent research groups (Table 1).

Based on the evaluations, we believe that the SRNS can be reccomended for academic use and practical applications.

Table 1. Summary of the evaluations carried out on the SRNS.

| Stage | Variable, units | N | Obs (O) | Pred (P) | MB = O – P | RMS PE | $r^2$ | References |
|---|---|---|---|---|---|---|---|---|
| | | | | SHEEP | | | | |
| All [1] | OMd, g/100 g | 19 | 60.2 | 61.3 | -1.1 | 3.6 | 0.83 | Cannas et al. (2004) |
| All [2] | OMd, g/100 g | 12 | 56.6 | 53.3 | 3.3 | 6.5 | | Cannas et al. (2004) |
| Lact. [1] | SBW var., g/d | 15 | 22 | 28 | -5.8 | 30 | 0.73 | Cannas et al. (2004) |
| Lact. [2] | SBW var., g/d | 14 | -57 | 110 | 53.4 | 84.1 | 0.84 | Cannas et al. (2004) |
| Lact. | $NE_L$, Mcal/d | 19 | -- | -- | 0.174 | -- | 0.82 | NRC (2007) |
| Grow. [3] | ADG, g/d | 42 | 198 | 180 | 18 | 41 | 0.84 | Cannas et al. (2006a,b) |
| Grow. [3] | ADG, g/d | 156 | 189 | 179 | 10 | -- | 0.70 | NRC (2007) |
| Grow. [3] | ADG, g/d | 8 | 285 | 282 | 2.4 | 21.4 | 0.76 | Linsky (2008) |
| Grow. [3] | Fat, g/kg EBG | 8 | 275 | 295 | 19.8 | 59.2 | 0.30 | Linsky (2008) |
| Grow. [3] | Prot., g/kg EBG | 8 | 146 | 152 | 5.8 | 19.3 | 0.10 | Linsky (2008) |
| Grow. | MP for gain, g | 48 | -- | -- | 0.9 | -- | 0.88 | NRC (2007) |
| Grow. | DMI, kg/d | 8 | 1.33 | 1.29 | 0.04 | 0.05 | 0.95 | Linsky (2008) |
| | | | | GOATS | | | | |
| Lact. | MEI, Mcal/d | 21 | 4.04 | 4 | 0.04 | 0.23 | 0.99 | Cannas et al. (2007b) |
| Lact. | NE milk, Mcal/d | 21 | 1.664 | 1.746 | - | 0.10 | 0.99 | Cannas et al. (2007b) |
| Lact. [3] | NE bal., Mcal/d | 21 | 0.361 | 0.286 | 0.075 | 0.20 | 0.87 | Cannas et al. (2007b) |
| Grow. [3] | ADG, g/d | 31 | 136.1 | 142.5 | -6.4 | 32.5 | 0.85 | Cannas et al. (2007a) |

[1] positive rumen N balance; [2] negative rumen N balance; [3] *(0.09 x MEI)* correction factor of $ME_m$ not used

REFERENCES: reported in the back of the printout