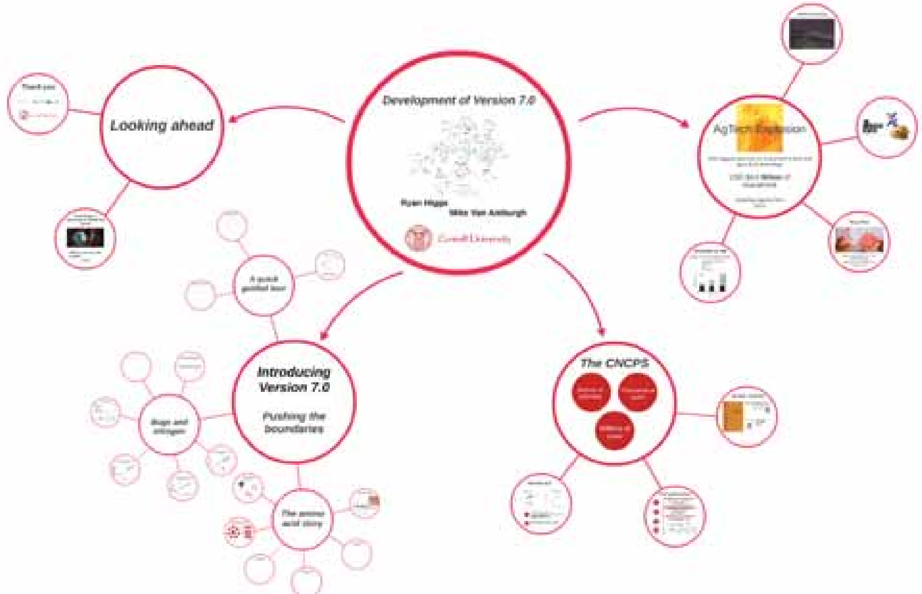
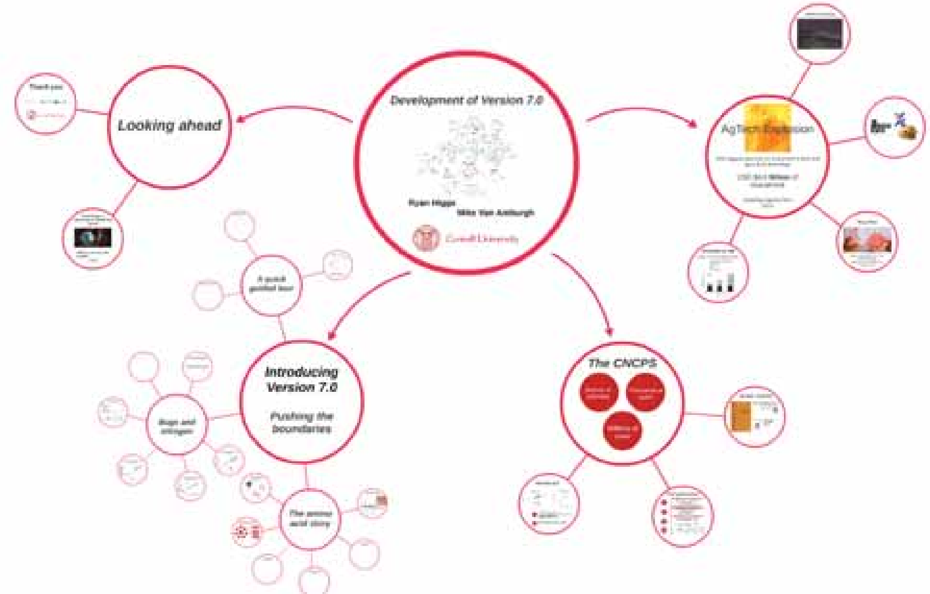
Evolution of the CNCPS



Evolution of the CNCPS



AgTech Explosion

2015 biggest year ever for investment in food and agriculture technology

USD $4.6 **Billion** of investment

Doubling figures from 2014

Vertical farming

THE IMPOSSIBLE BURGER

It's here. A delicious burger made entirely from plants for people who love meat. No more compromises. Ready for an introduction?

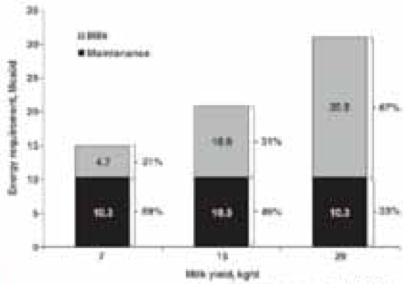
Mosa Meat

First burger $330,000 (2013)
Now $11/burger
Mainstream production 4-5 years away

Innovate or die

History of producing game changers

- Artificial insemination
- TMR diets
- bST
- Genomics



Source: Capper et al. 2009

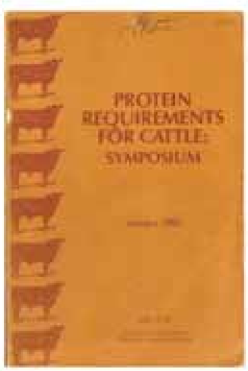
The CNCPS

Dozens of countries

Thousands of users

Millions of cows

30 year Journey



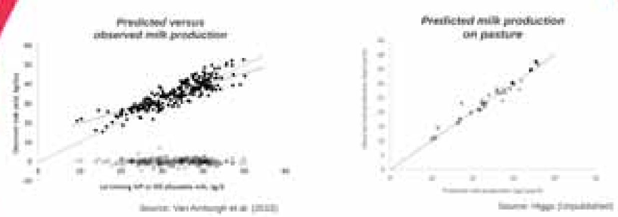
A Net Protein System for Cattle: The Rumen Submodel for Nitrogen

A Net Protein System for Cattle: Meeting Protein Requirements of Cattle

First publications

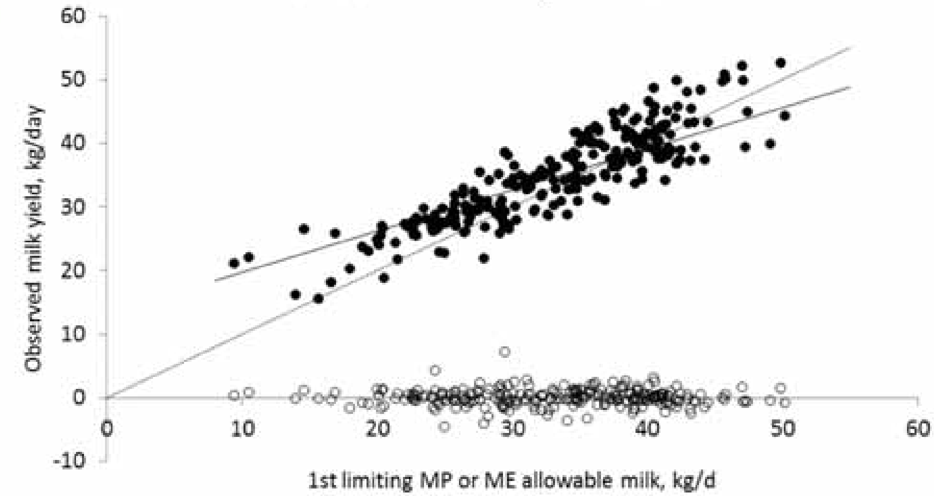
1. A Net Carbohydrate and Protein System for Evaluating Cattle Diets: I. Ruminal Fermentation
2. A Net Carbohydrate and Protein System for Evaluating Cattle Diets: II. Carbohydrate and Protein Availability
3. A Net Carbohydrate and Protein System for Evaluating Cattle Diets: III. Cattle Requirements and Diet Adequacy
4. A Net Carbohydrate and Protein System for Evaluating Cattle Diets: IV. Predicting Amino Acid Adequacy

Version 6.5



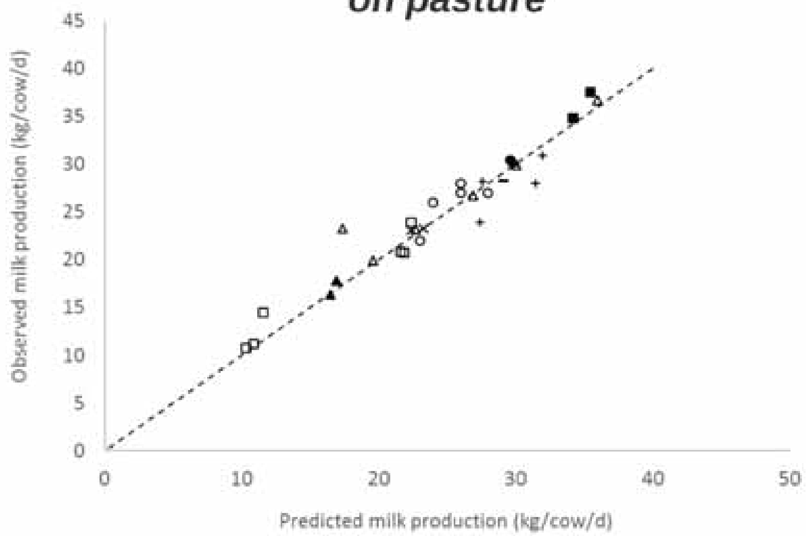
1. **The Cornell Net Carbohydrate and Protein System: Updates to the model and evaluation of version 6.5**
2. **Updating the Cornell Net Carbohydrate and Protein System feed library and analyzing model sensitivity to feed inputs**
   R. J. Higgs, L. E. Chase, D. A. Ross, and M. E. Van Amburgh

Predicted versus observed milk production



Source: Van Amburgh et al. (2015)

Predicted milk production on pasture



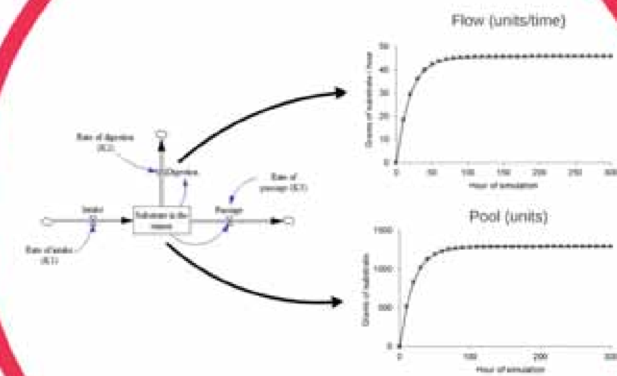
Source: Higgs (Unpublished)

Introducing Version 7.0

Pushing the boundaries

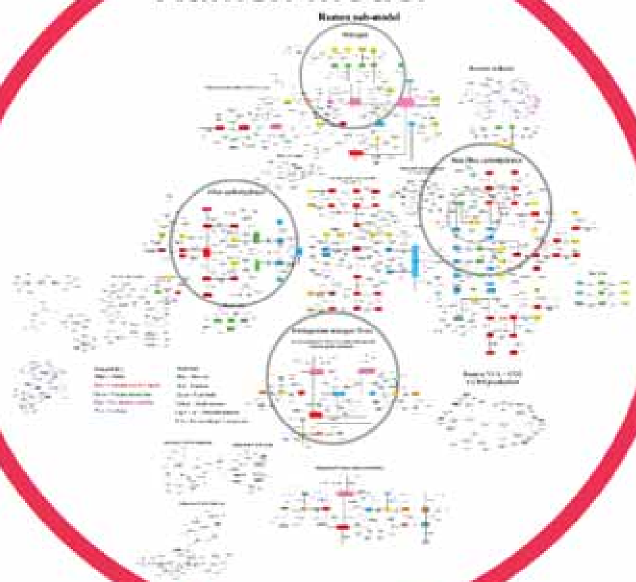
A quick guided tour

Model Structure

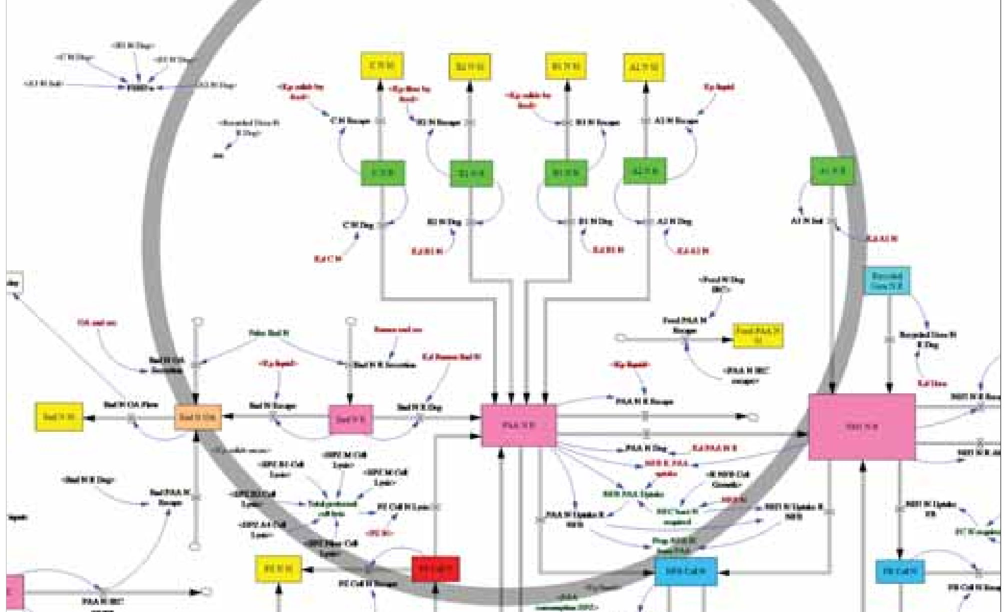


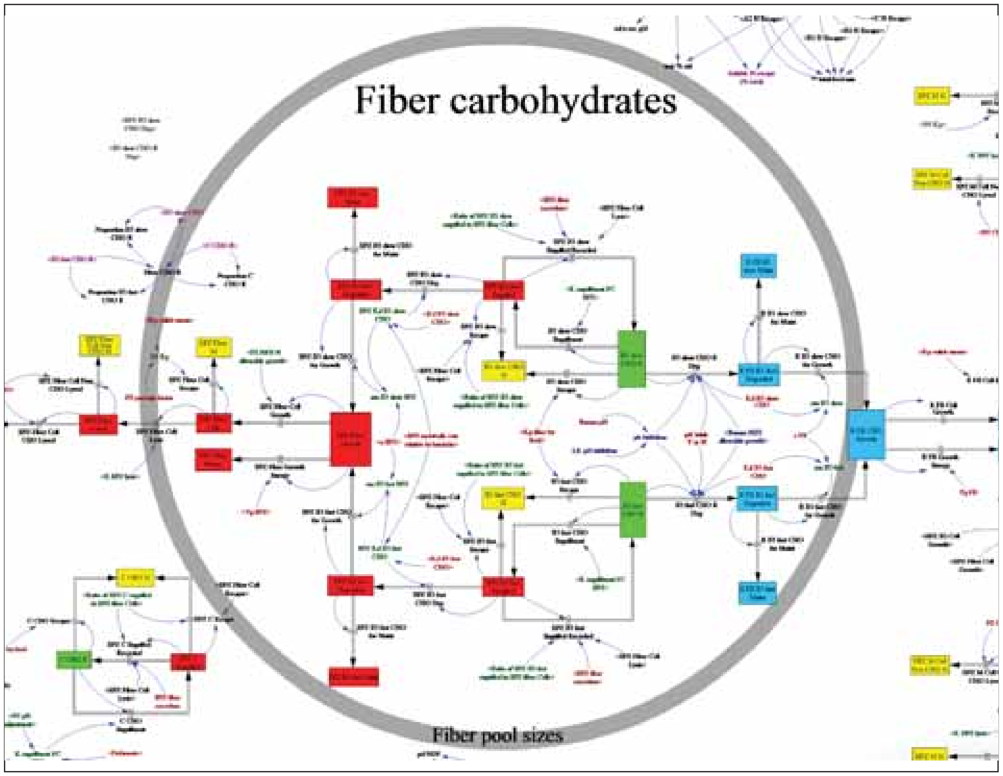
Steady state = when the flows in and out of a pool are equal

Rumen model

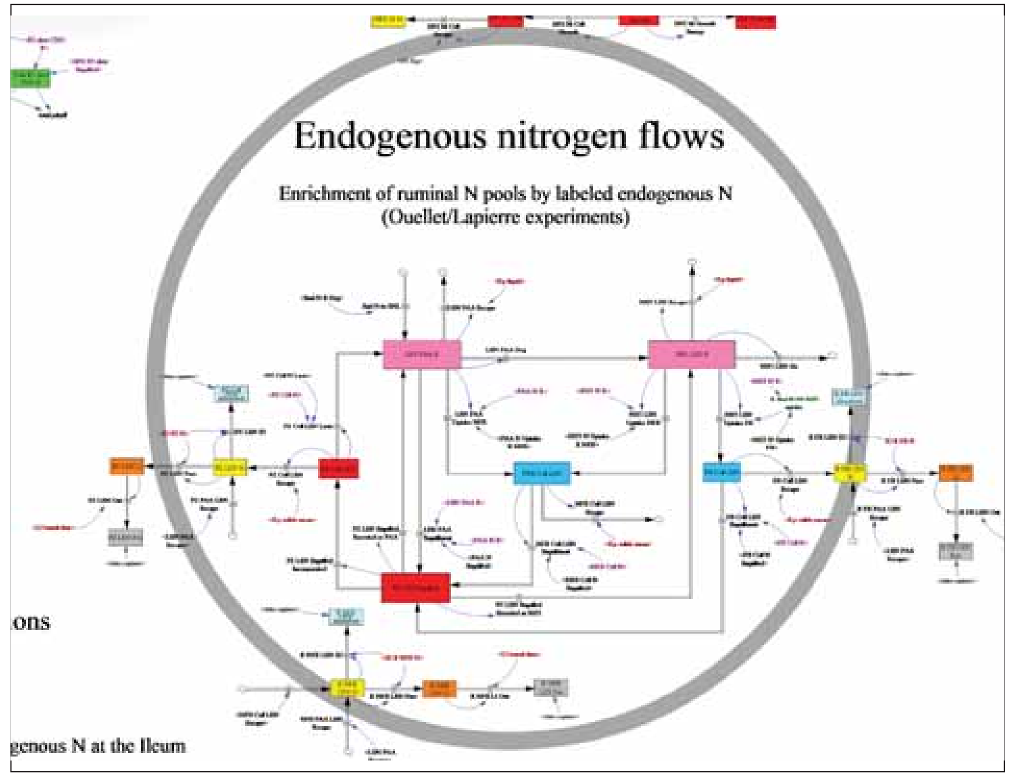


Nitrogen

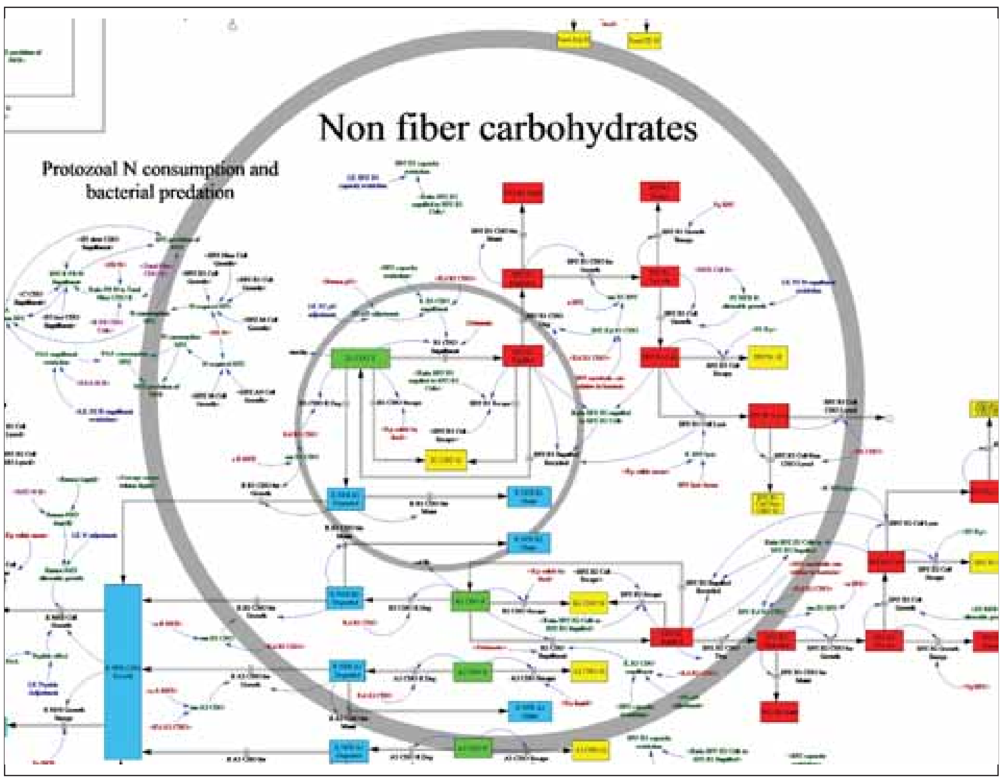




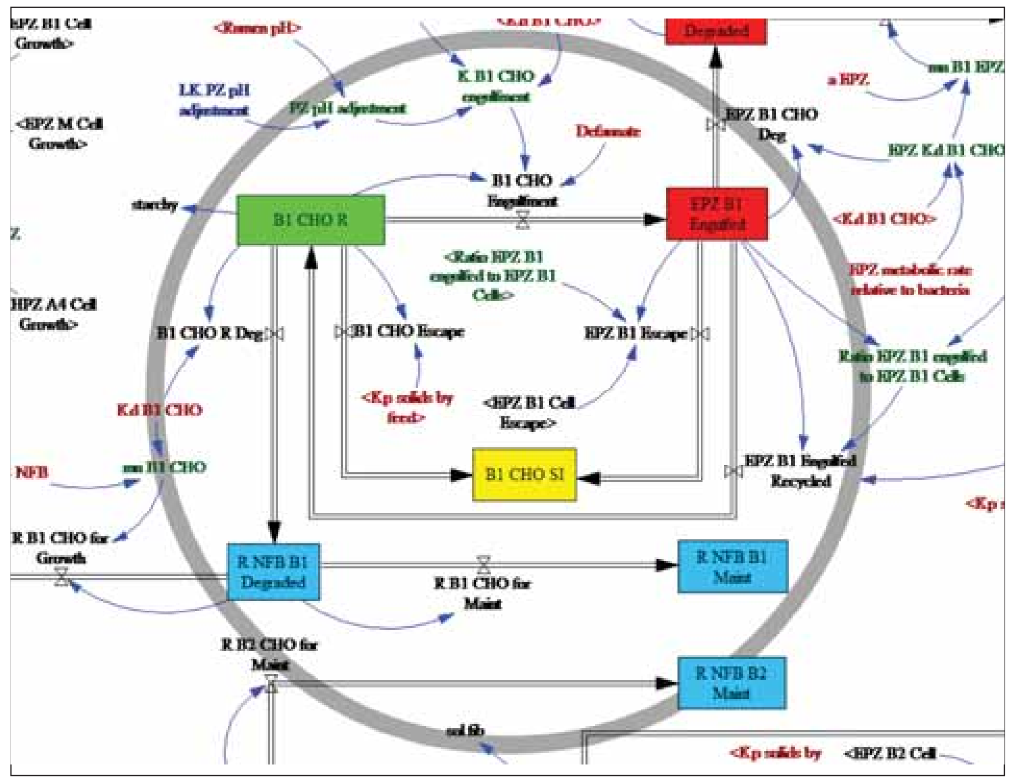
Fiber carbohydrates
Fiber pool sizes



Endogenous nitrogen flows
Enrichment of ruminal N pools by labeled endogenous N
(Ouellet/Lapierre experiments)
ons
genous N at the Ileum



Non fiber carbohydrates
Protozoal N consumption and
bacterial predation



<Rumen pH>
LK PZ pH
adjustment
PZ pH adjustment
K B1 CHO
engulfment
Degraded
a EPZ
mu B1 EPZ
<EPZ M Cell
Growth>
Defaunate
EPZ B1 CHO
Deg
EPZ Kd B1 CHO
starchy
B1 CHO R
B1 CHO
Engulfment
EPZ B1
Engulfed
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<Ratio EPZ B1
engulfed to EPZ B1
Cells>
EPZ metabolic rate
relative to bacteria
EPZ A4 Cell
Growth>
B1 CHO R Deg
B1 CHO Escape
EPZ B1 Escape
Ratio EPZ B1 engulfed
to EPZ B1 Cells
Kd B1 CHO
<Kp solids by
feed>
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Escape>
NFB
mu B1 CHO
B1 CHO SI
EPZ B1 Engulfed
Recycled
R B1 CHO for
Growth
R NFB B1
Degraded
R B1 CHO for
Maint
R NFB B1
Maint
R B2 CHO for
Maint
R NFB B2
Maint
sol fib
<Kp solids by
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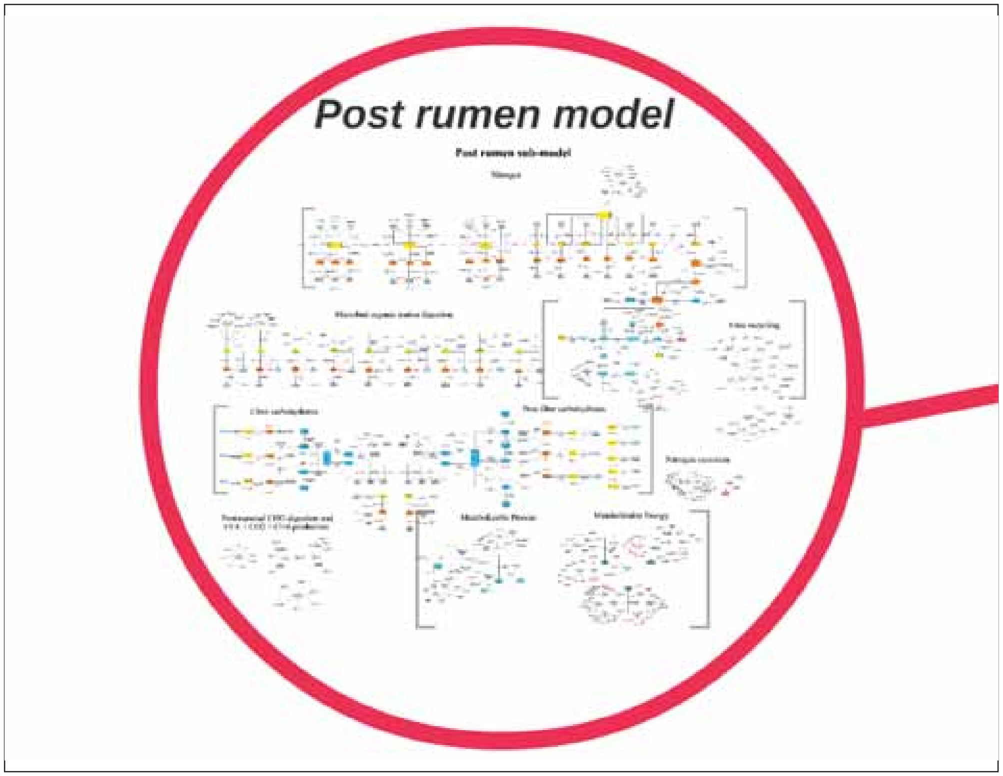
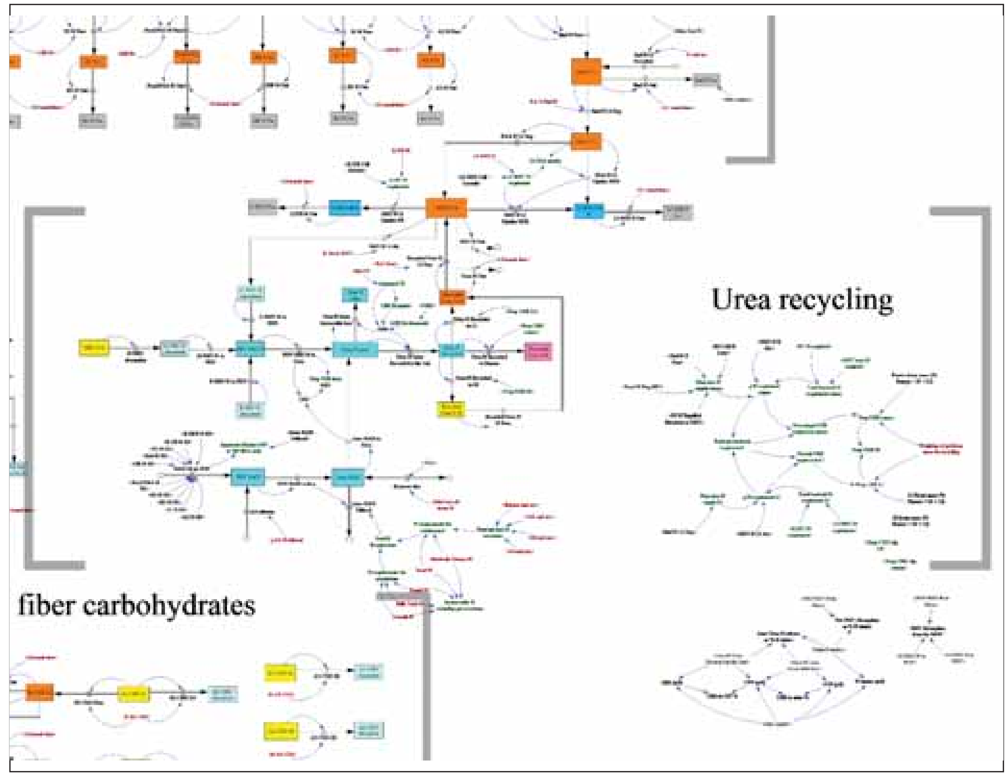
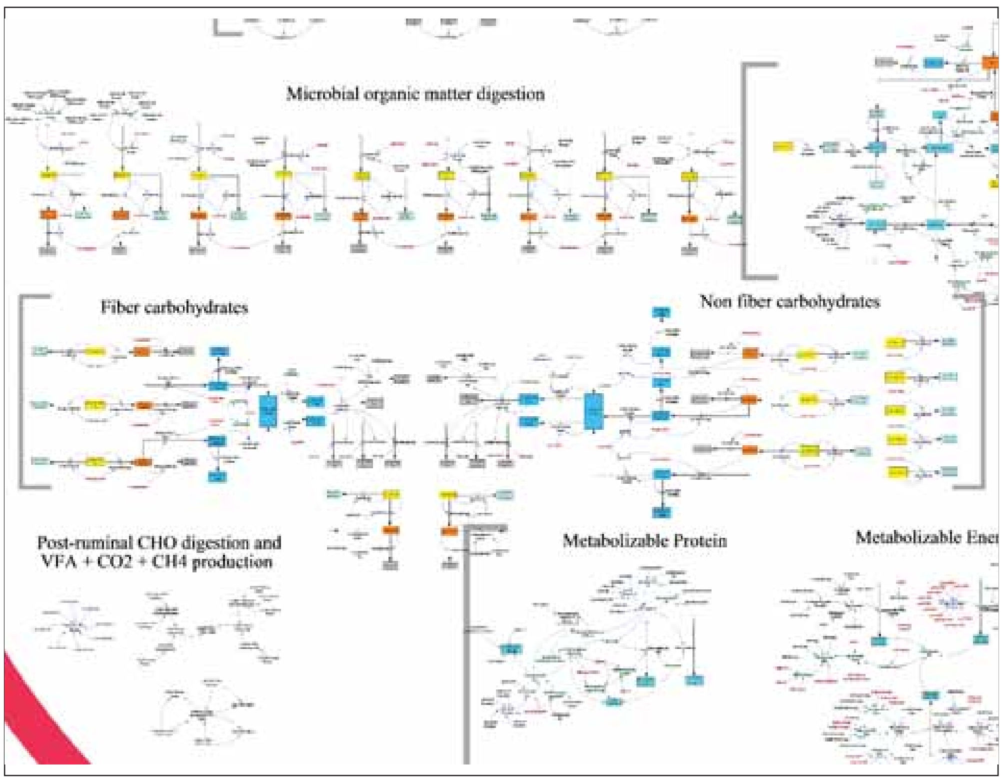
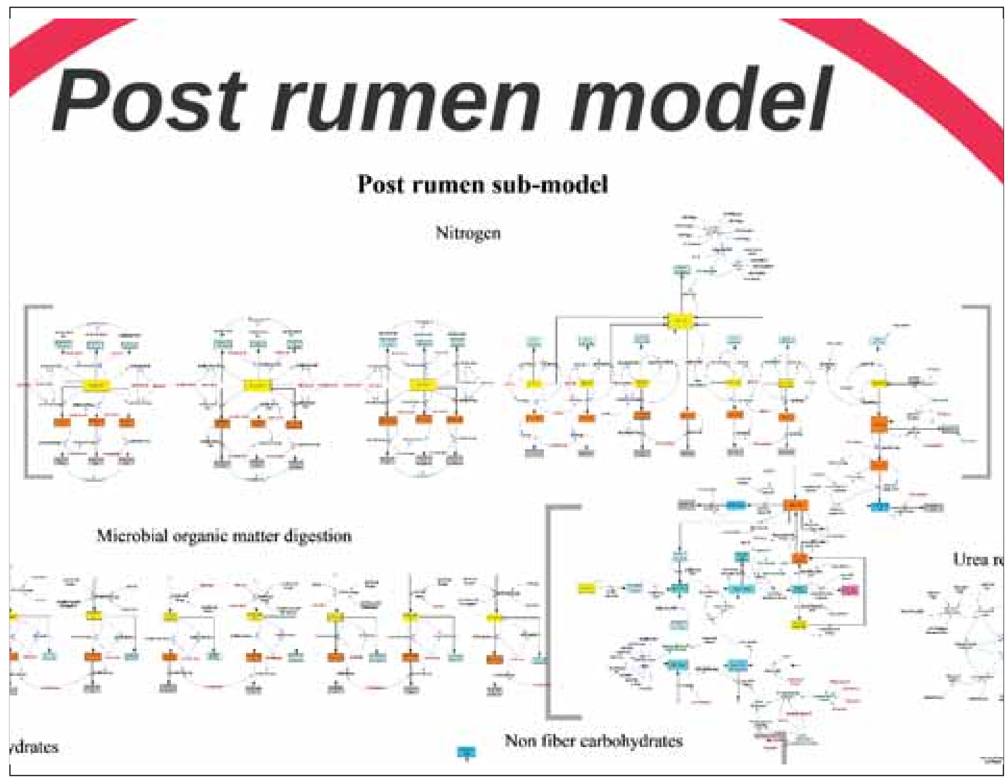
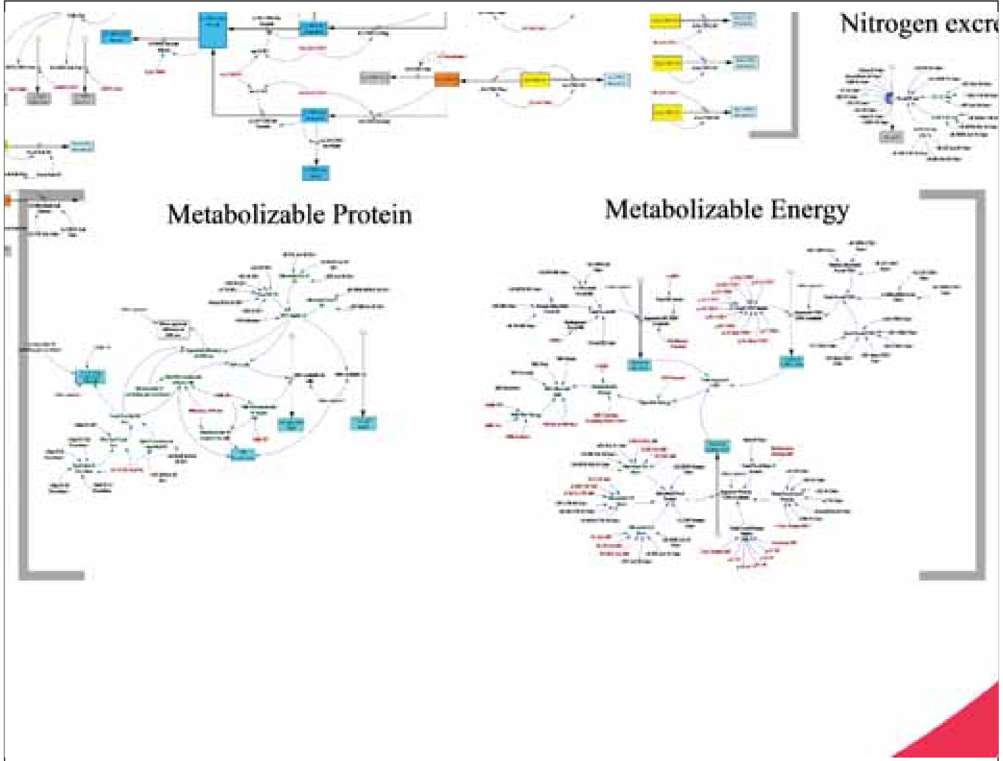

Post rumen model


Urea recycling
fiber carbohydrates

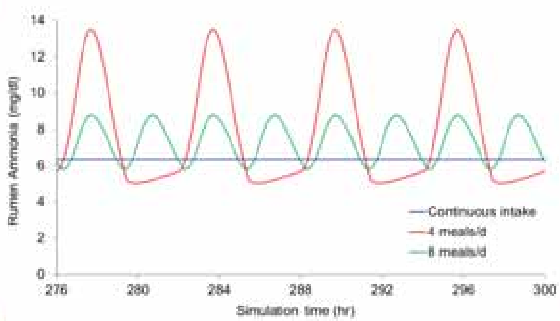

Microbial organic matter digestion
Fiber carbohydrates
Non fiber carbohydrates
Post-ruminal CHO digestion and
VFA + CO2 + CH4 production
Metabolizable Protein
Metabolizable Ener


Post rumen model
Post rumen sub-model
Nitrogen
Microbial organic matter digestion
Urea re
ydrates
Non fiber carbohydrates

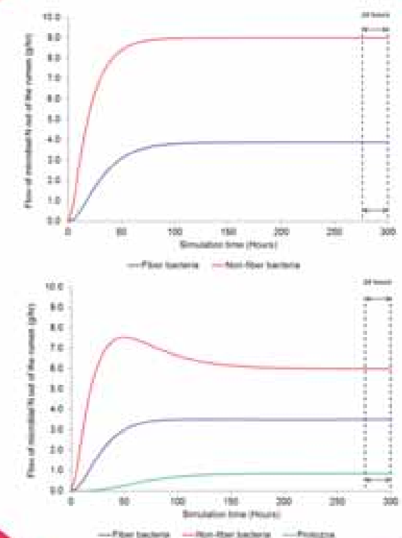


Bugs and nitrogen

The ups and downs of rumen ammonia - meals are important



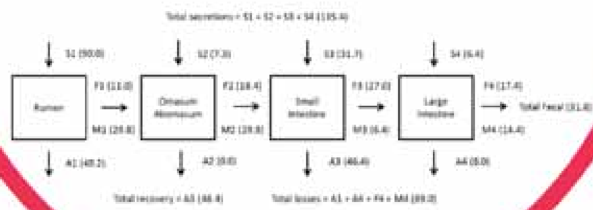
Adding Protozoa



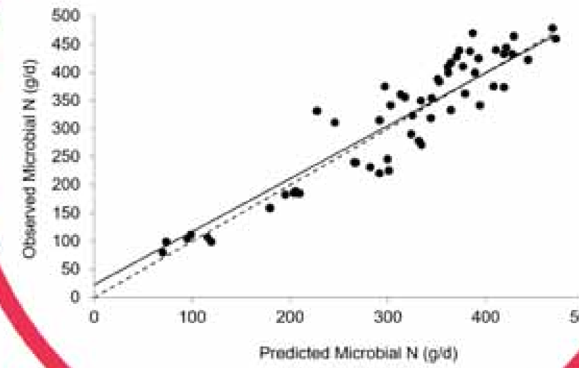
Endogenous N

Endogenous component	Secretion (g N/kg DMI)
Saliva	0.9
Rumen sloughed cells	4.3
Omasum/abomasum sloughed cells	0.3
Omasum/abomasum secretions	0.2
Pancreatic secretions	0.4
Bile	0.1
Small intestine sloughed cells[1]	0.7
Small intestine secretions[1]	0.7
Large intestine sloughed cells	0.3

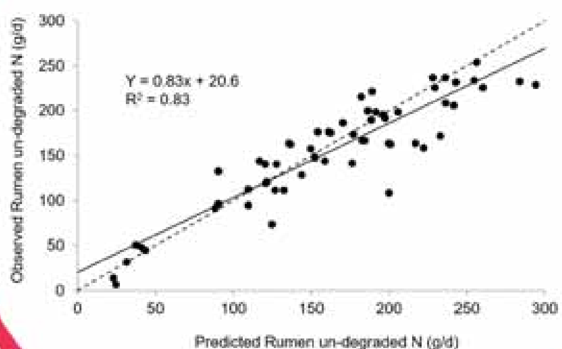
[1] Includes secretions past the pancreatic and bile duct and prior to the terminal ileum



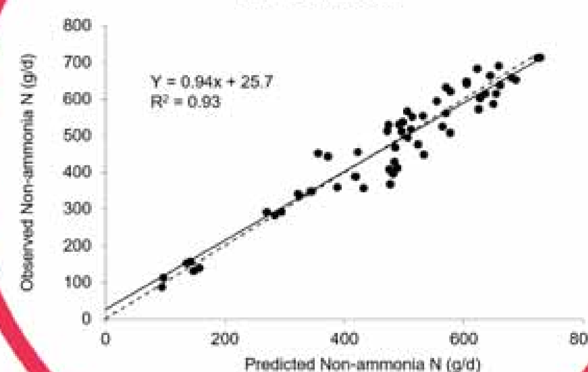
Predicting microbial N flows from the rumen



Predicting un-degraded N flows from the rumen



Predicting total N flows from the rumen



The amino acid story

What do they need?

Efficiency off AA use (additional requirement)

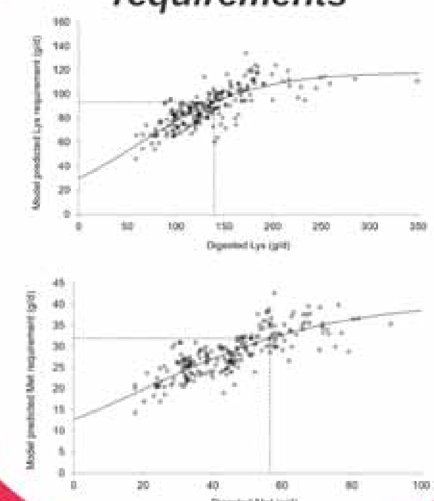
⇨ Oxidation

⇨ Anaplerosis

⇨ Synthesizing non-essential AA

⇨ Gluconeogenesis

Estimating requirements

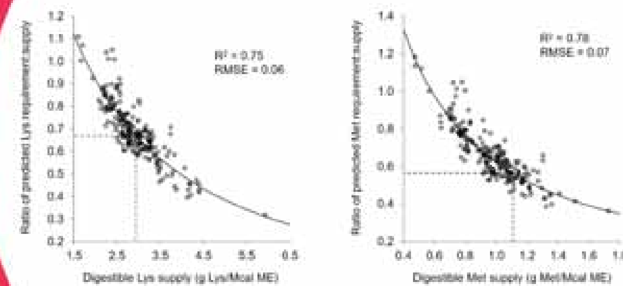


Optimum supply of EAA

AA	R^2	Optimum efficiency	Lapierre et al. (2007)	g AA/ Mcal ME	% EAA
Arg	0.81	0.61	0.58	2.04	10.2%
His	0.84	0.77	0.76	0.91	4.5%
Ile	0.74	0.67	0.67	2.16	10.8%
Leu	0.81	0.73	0.61	3.42	17.0%
Lys	0.75	0.67	0.69	3.03	15.1%
Met	0.79	0.57	0.66	1.14	5.7%
Phe	0.75	0.58	0.57	2.15	10.7%
Thr	0.75	0.59	0.66	2.14	10.7%
Trp	0.71	0.65	N/A	0.59	2.9%
Val	0.79	0.68	0.66	2.48	12.4%

Lys and Met requirements 14.9%, 5.1% - Schwab (1996)
Lys and Met requirements 14.7%, 5.3% - Rulquin et al. (1993)

Amino acids and energy



'Ideal' Protein

AA	g AA/ Mcal ME	Lys:AA Dairy	Lys:AA Sow
Arg	2.04	1.49	1.85
His	0.91	3.33	2.50
Ile	2.16	1.40	1.78
Leu	3.42	0.89	0.89
Lys	3.03	1.00	1.00
Met	1.14	2.66	3.71
Phe	2.15	1.40	1.82
Thr	2.14	1.41	1.49
Trp	0.59	5.16	5.33
Val	2.48	1.22	1.15

- The swine NRC (1998 and 2012) express the optimum supply of each EAA relative to Lys
- Should we do the same?

Looking ahead

Technology is advancing at breakneck speed

What is next for the model?

J.A.S

Thank you

Cornell University

Evolution of the CNCPS