Using the NASEM 2021 Dairy Requirements Program

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NASEM Nutrient Requirements Background

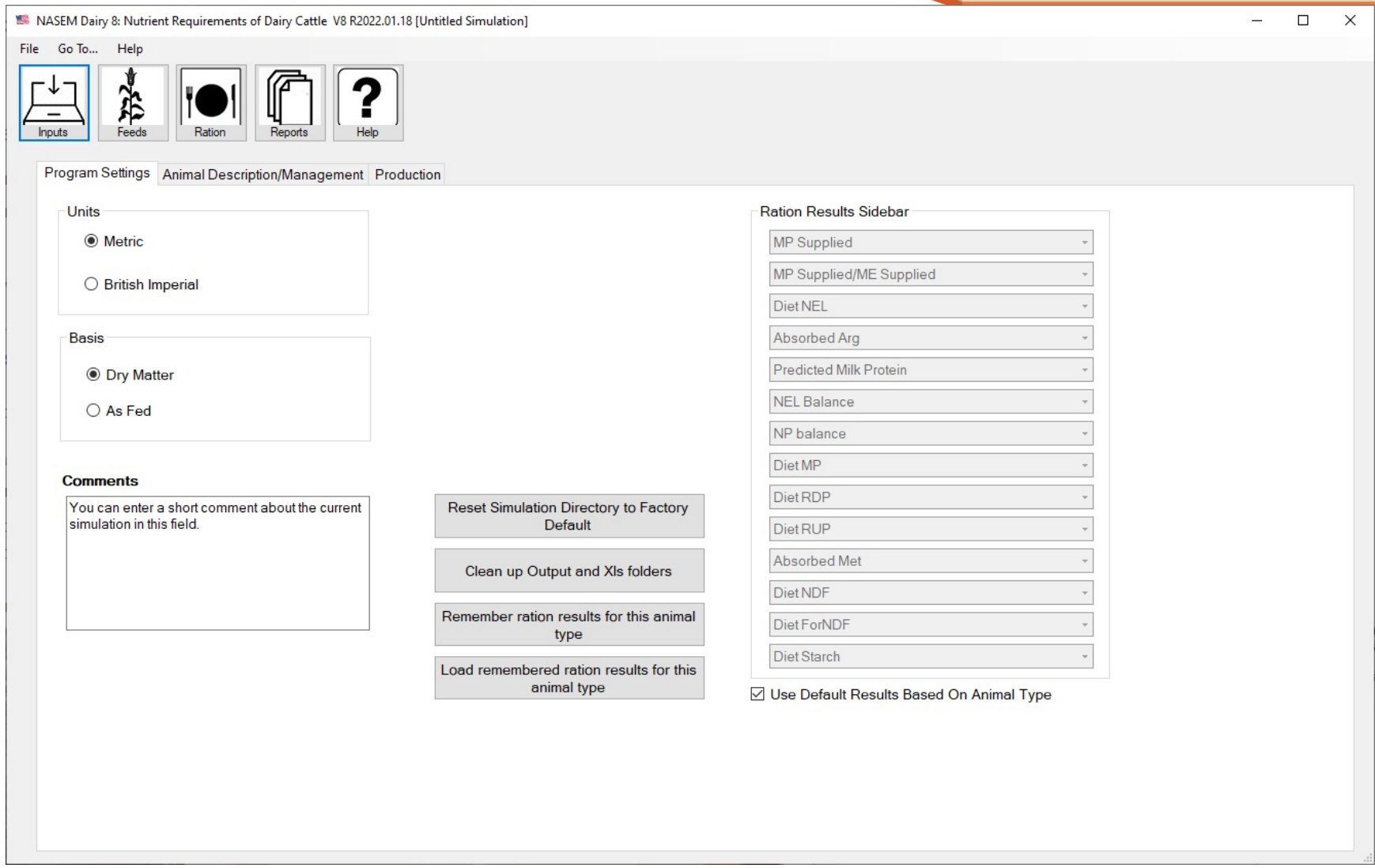
- The National Academy of Sciences, Engineering, and Medicine (NASEM)
  - Independent scientific body established to provide unbiased scientific input to the government
  - Animal industry commissions them to produce the updates for the Nutrient Requirement Series for all Ag species
  - No more than ½ the funding can come from industry
- Committee of experts is convened
  - Richard A. Erdman - (Co-Chair), University of Maryland, College Park
  - William P. Weiss - (Co-Chair), The Ohio State University
  - Michael Allen, Michigan State University
  - Louis Armentano, University of Wisconsin-Madison
  - James Drackley, University of Illinois at Urbana-Champaign
  - Jeffrey Firkins, The Ohio State University
  - Mary Beth Hall, USDA US Dairy Forage Research Center
  - Mark Hanigan, Virginia Polytechnic Institute and State
  - Ermias Kebreab, University of California, Davis
  - Paul Kononoff, University of Nebraska-Lincoln
  - Hélène Lapierre, Agriculture & Agri-Food Canada
  - Michael VandeHaar, Michigan State University
- Charged to update the report and requirement system
  - Based on scientific findings
  - Represents the best knowledge at that time
  - Report is published as a book by National Academies Press (NAP)
  - Software is available to the public through NAP
  - https://www.nap.edu/catalog/25806/nutrient-requirements-of-dairy-cattle-eighth-revised-edition

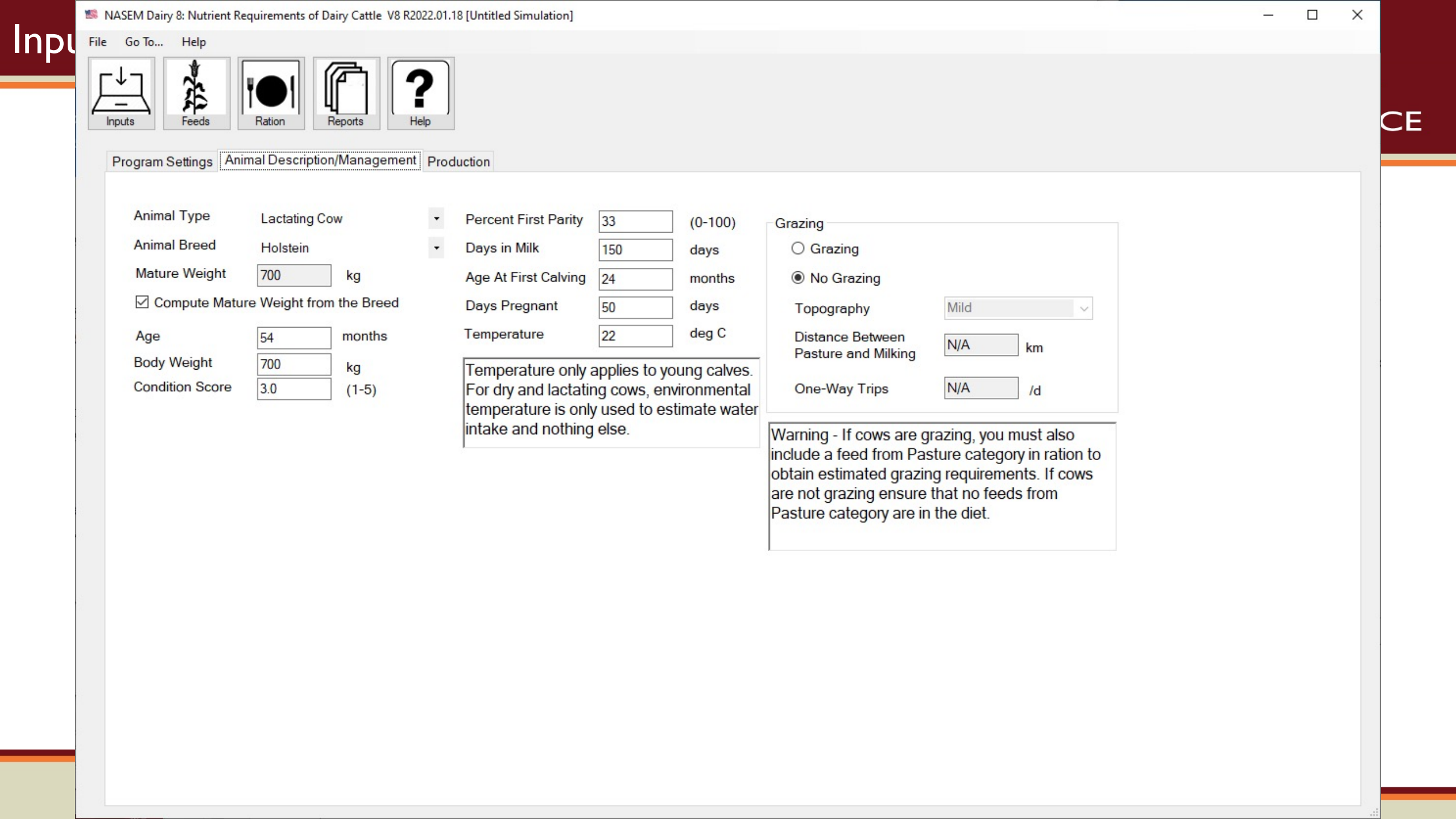
Program Code

- Dr. Abbas Ahmadi was the programmer, Davis, CA
- rewrote old software in C#
- Very similar look and feel
- Enhanced Function and Reporting

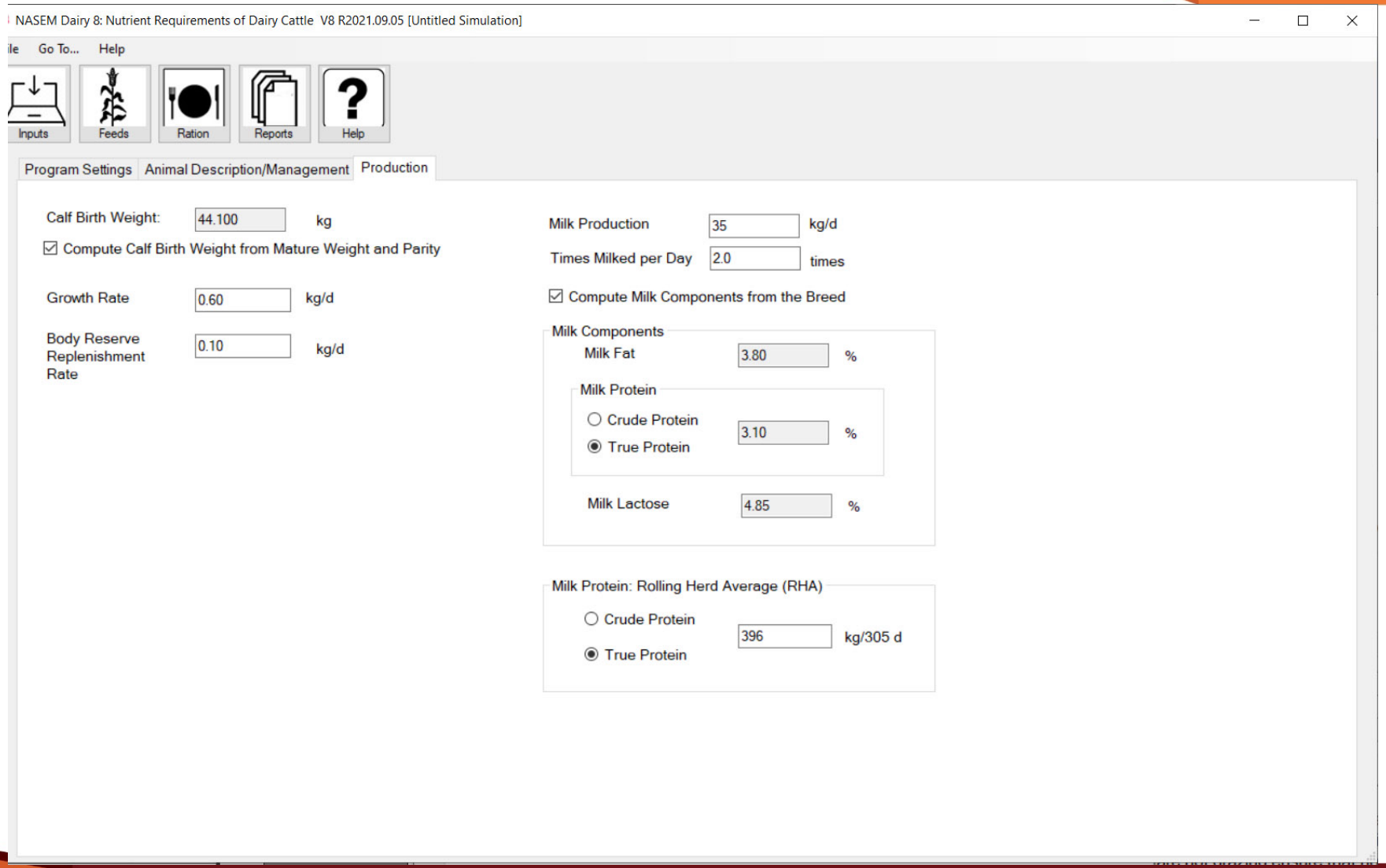
Program Settings

- 5 Program Sections
  - Inputs
  - Feeds
  - Ration
  - Reports
  - Help
- Inputs Subsections
  - Program Settings
    - Units, Feed Basis, Results to show on Ration Page
  - Animal Description/Management
  - Production

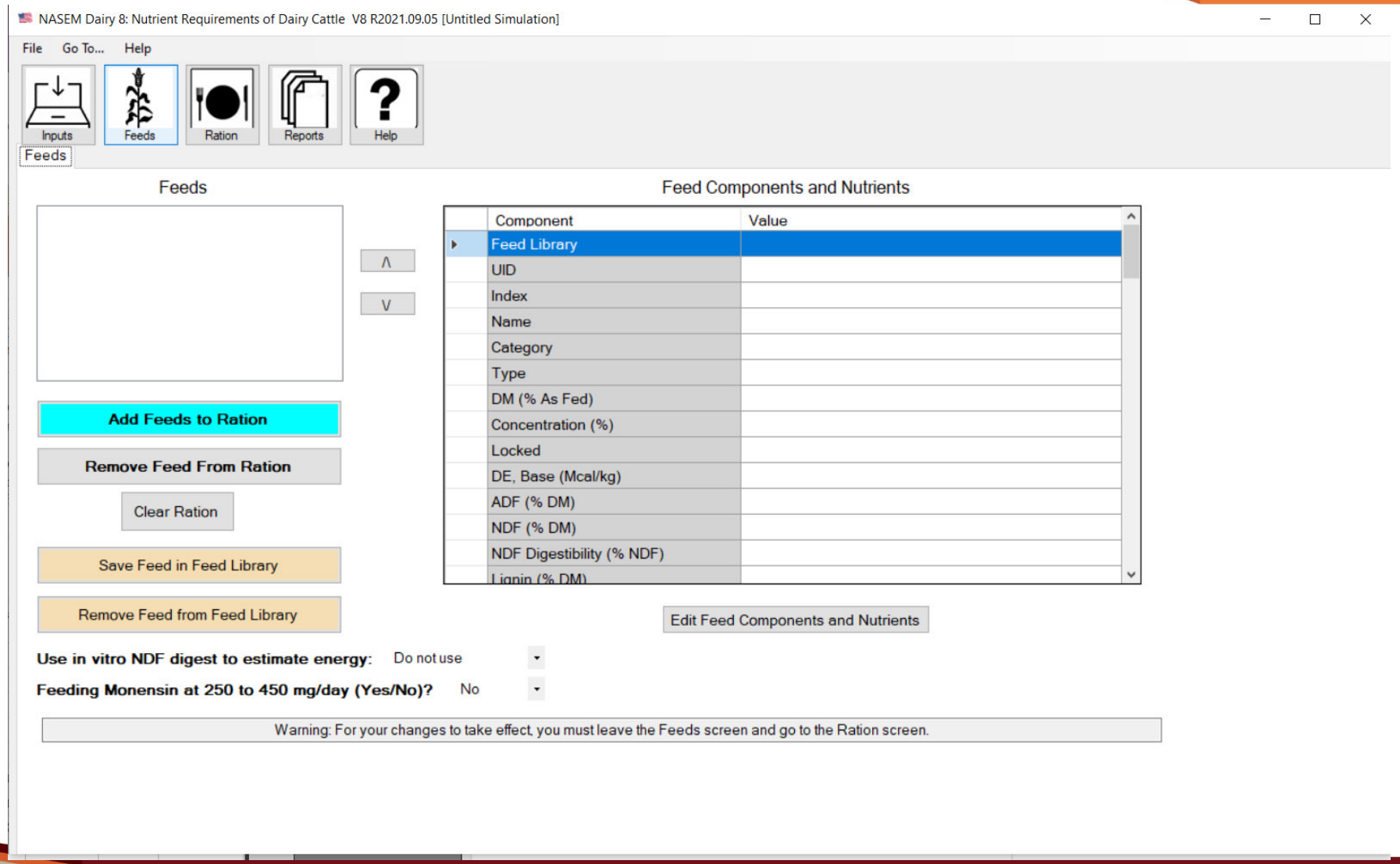



NASEM Dairy 8: Nutrient Requirements of Dairy Cattle V8 R2022.01.18 [Untitled Simulation]
File
Go To...
Help
Inputs
Feeds
Ration
Reports
Help
Program Settings
Animal Description/Management
Production
Animal Type
Lactating Cow
Animal Breed
Holstein
Mature Weight
700
kg
Compute Mature Weight from the Breed
Age
54
months
Body Weight
700
kg
Condition Score
3.0
(1-5)
Percent First Parity
33
(0-100)
Days in Milk
150
days
Age At First Calving
24
months
Days Pregnant
50
days
Temperature
22
deg C
Temperature only applies to young calves. For dry and lactating cows, environmental temperature is only used to estimate water intake and nothing else.
Grazing
Grazing
No Grazing
Topography
Mild
Distance Between Pasture and Milking
N/A
km
One-Way Trips
N/A
/d
Warning - If cows are grazing, you must also include a feed from Pasture category in ration to obtain estimated grazing requirements. If cows are not grazing ensure that no feeds from Pasture category are in the diet.

Inputs Screen: Production

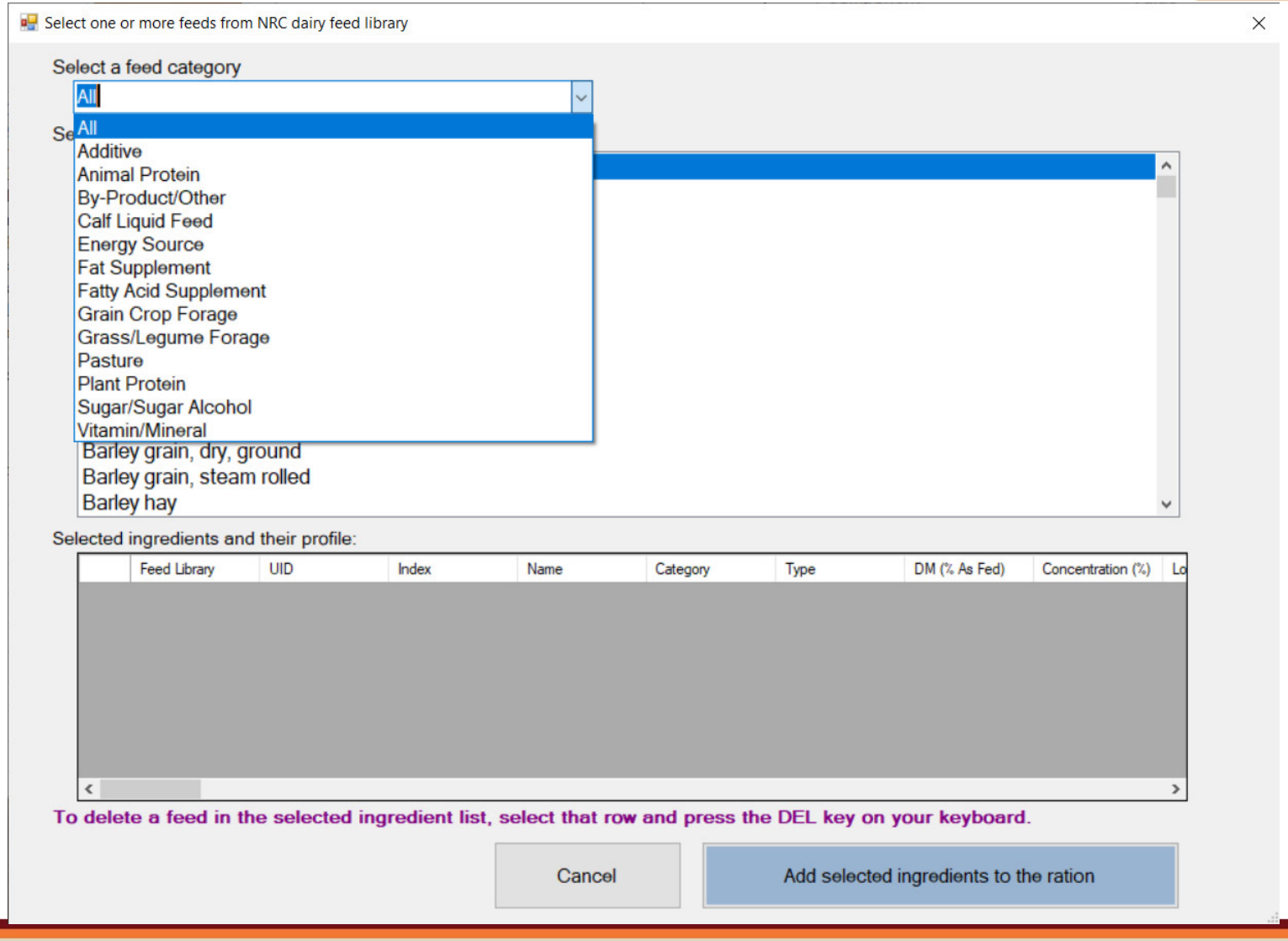


Feeds Screen: Adding Feeds to the Diet

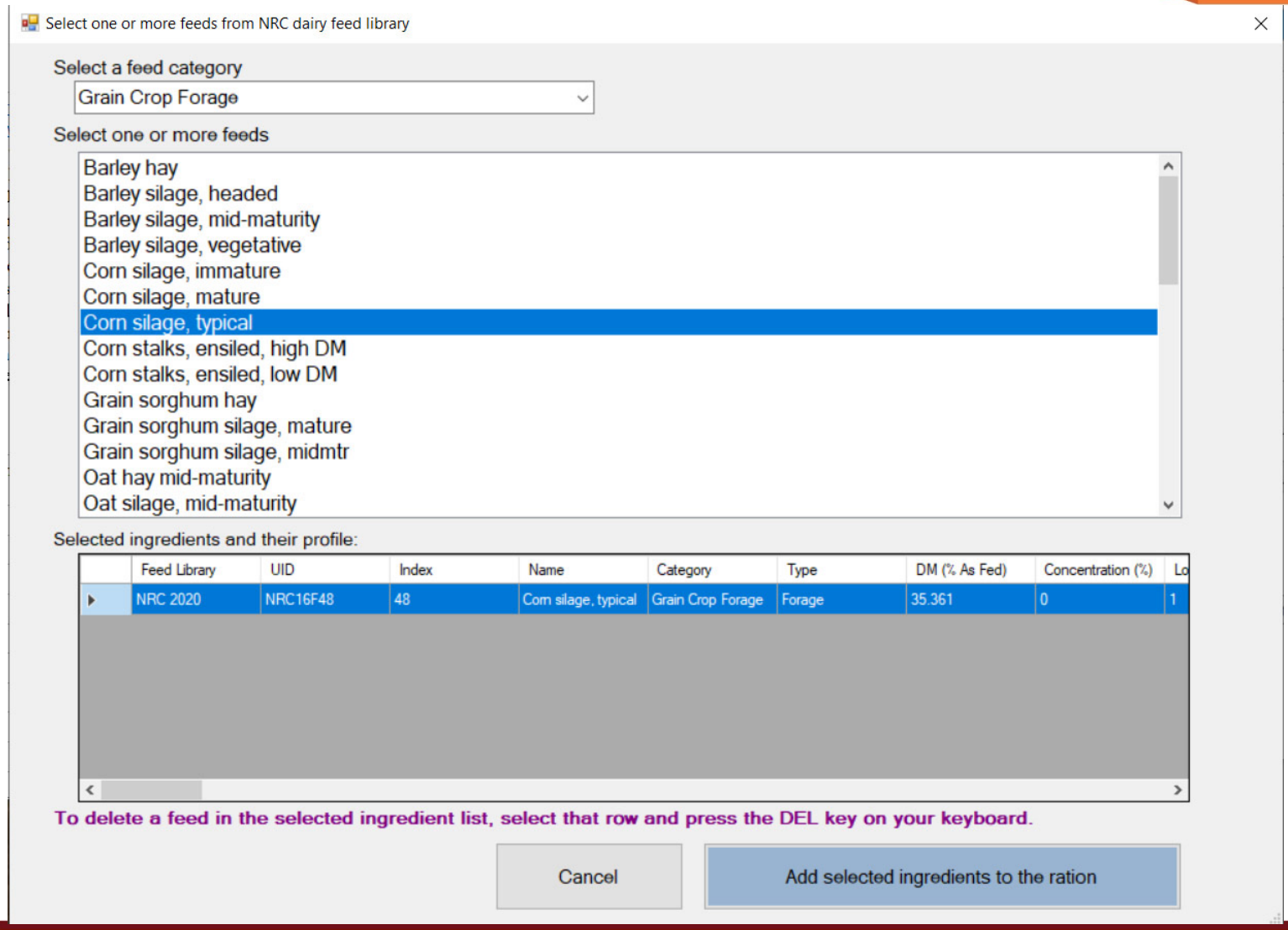


Feed Add Screen: Selecting a Feed Category

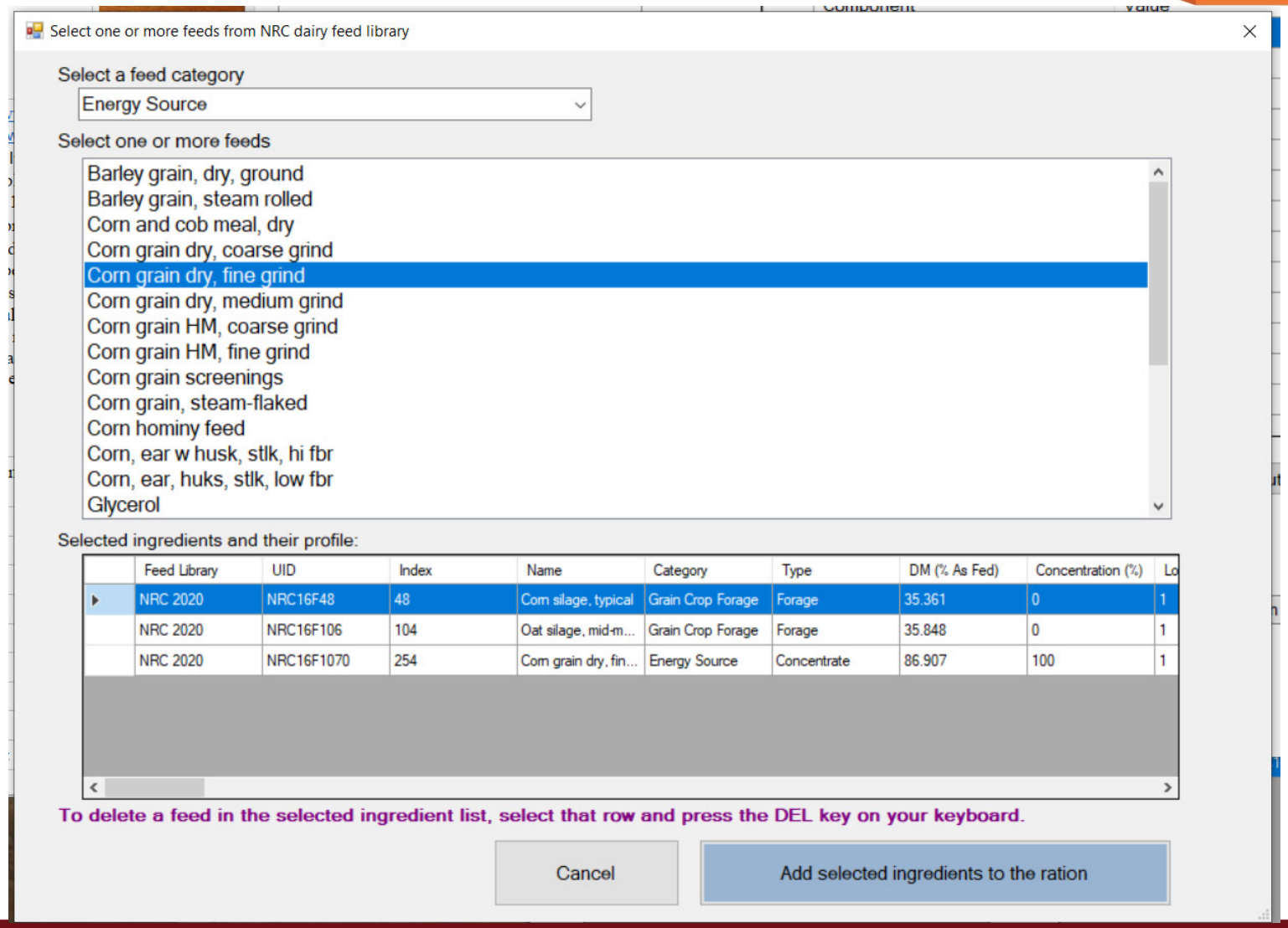
After selecting "Add Feeds to Ration" use the drop down category list to filter feeds.



Feed Add Screen: Selecting an Ingredient

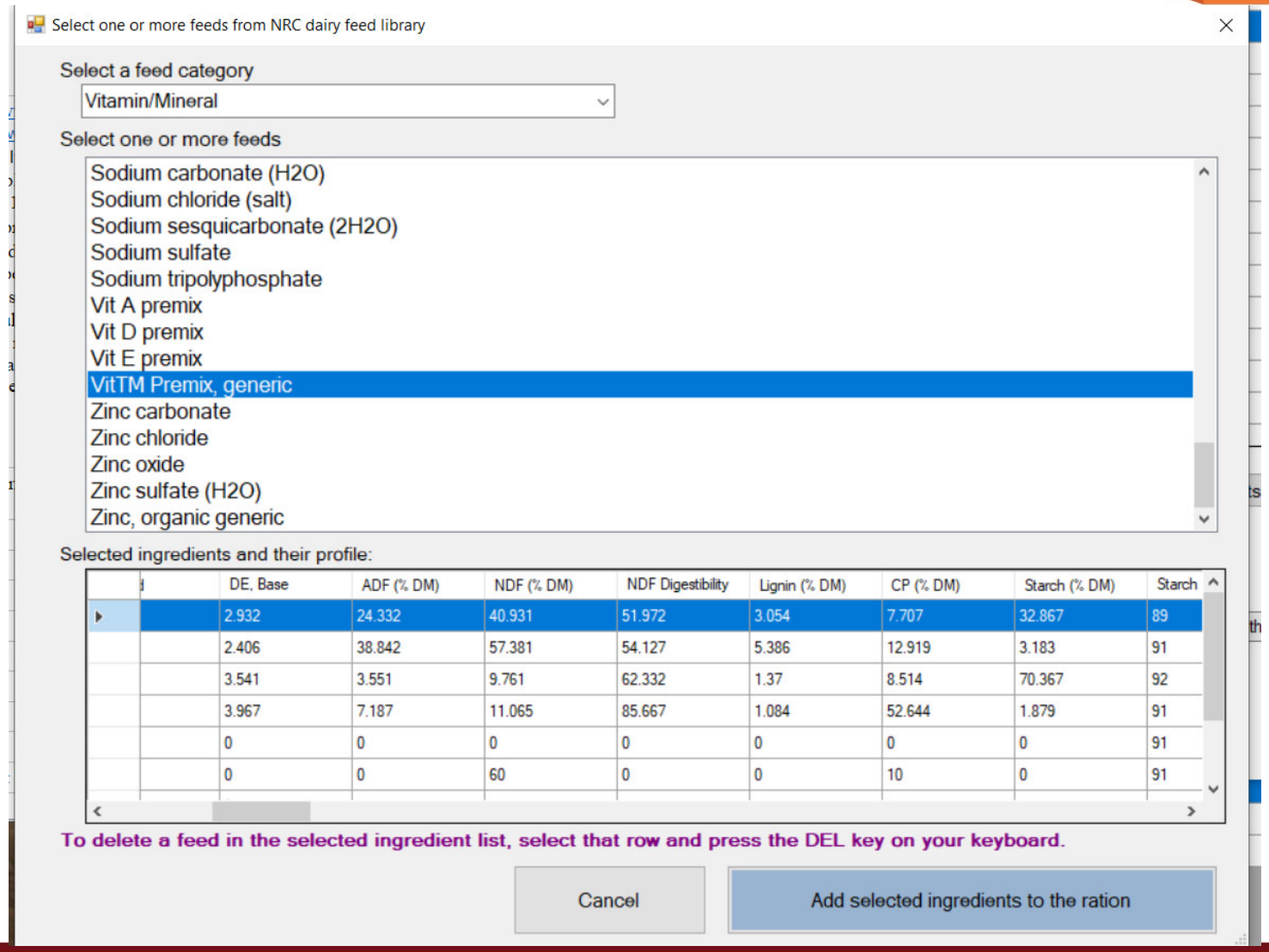


Feed Add Screen: Selecting Additional Ingredients



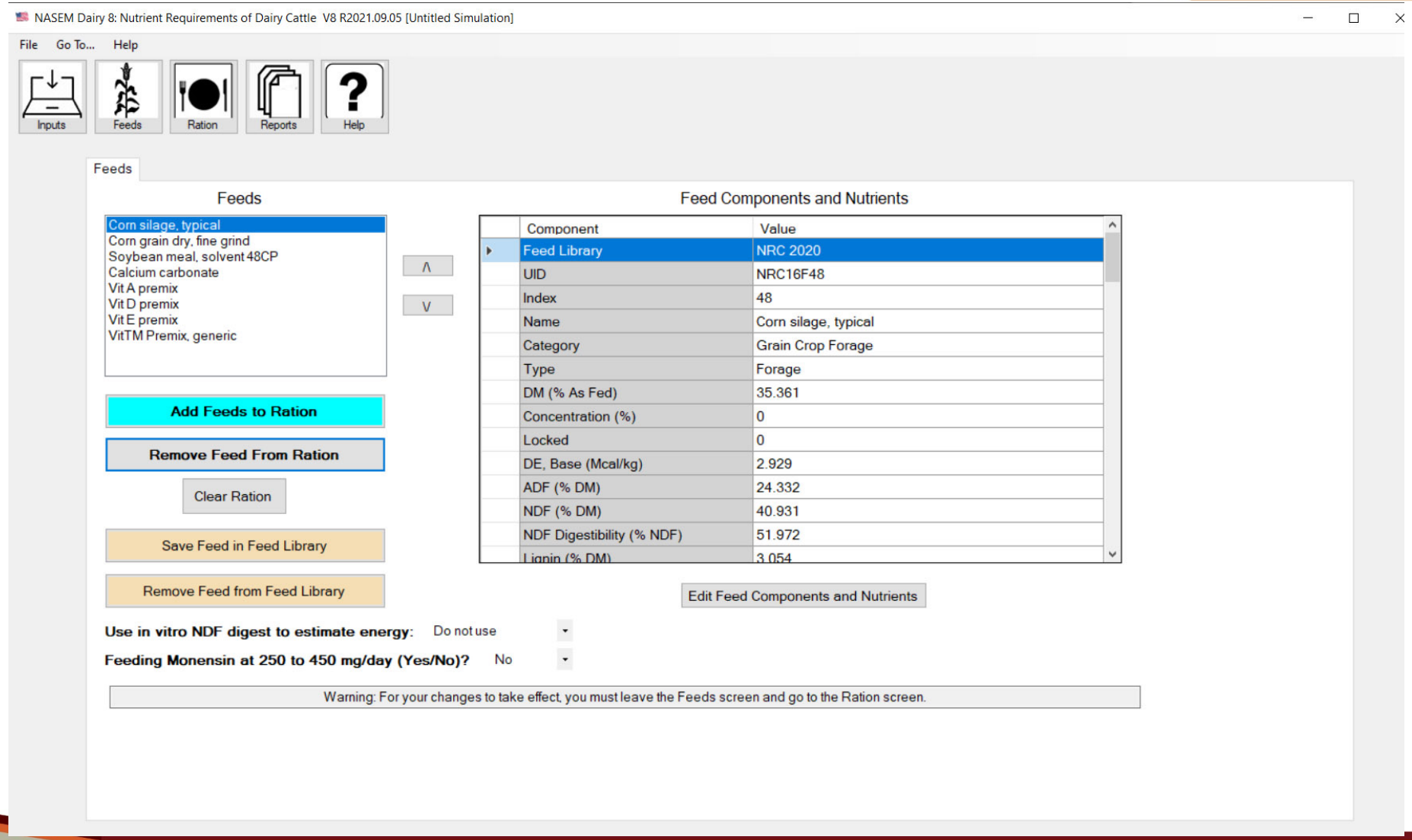
Feed Add Screen: Adding Selection to the Ration

When the desired feeds have been selected, click "Add selected ingredients to the ration".



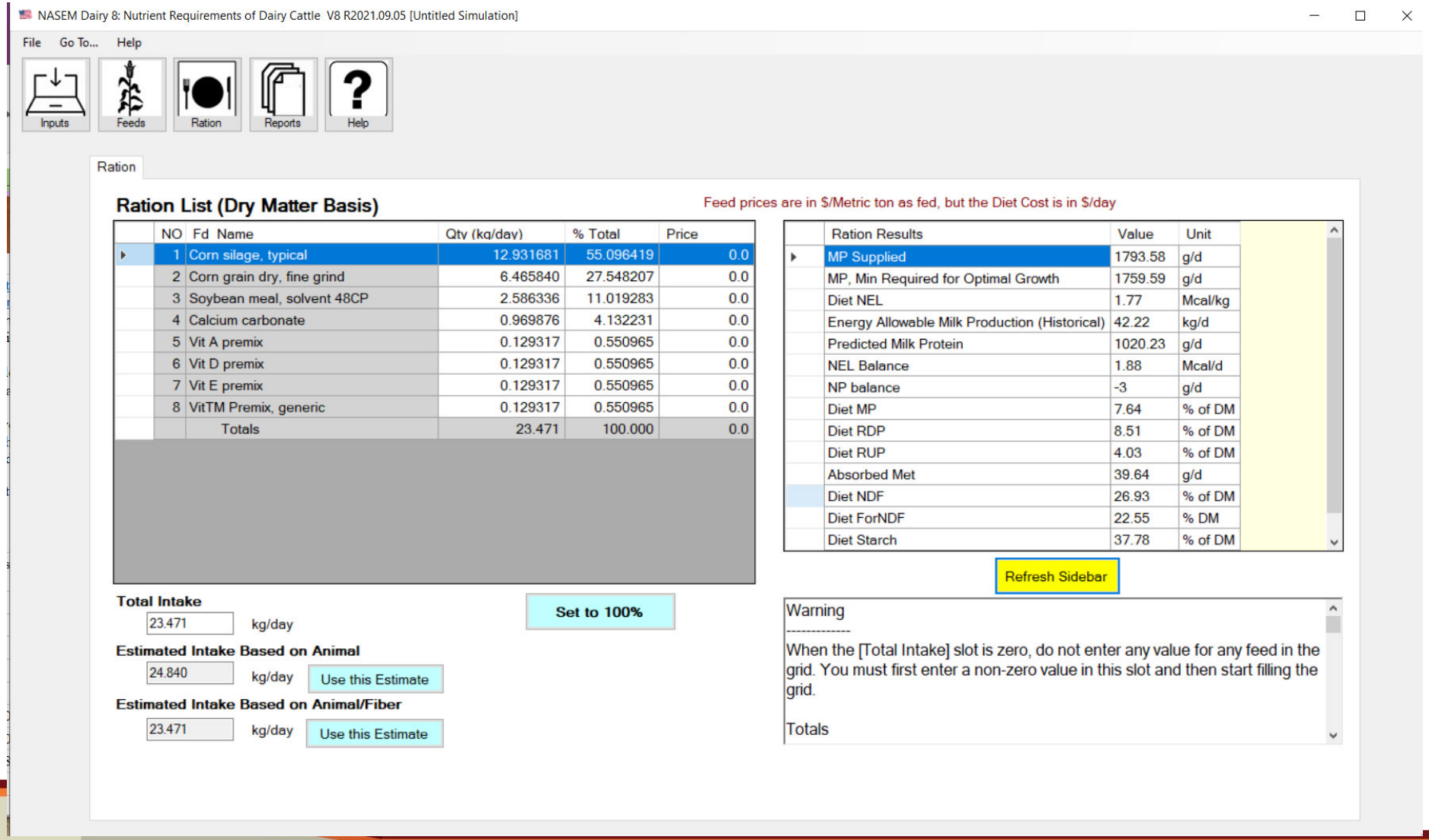
Feeds Screen: Editing Feed Nutrients

Edits to the feed are applied only to the copy in the current Ration. To use the edited copy in other diets, change the feed name, and click "Save Feed in Feed Library". User added feeds are denoted with "*".



Ration Screen: Diet Composition

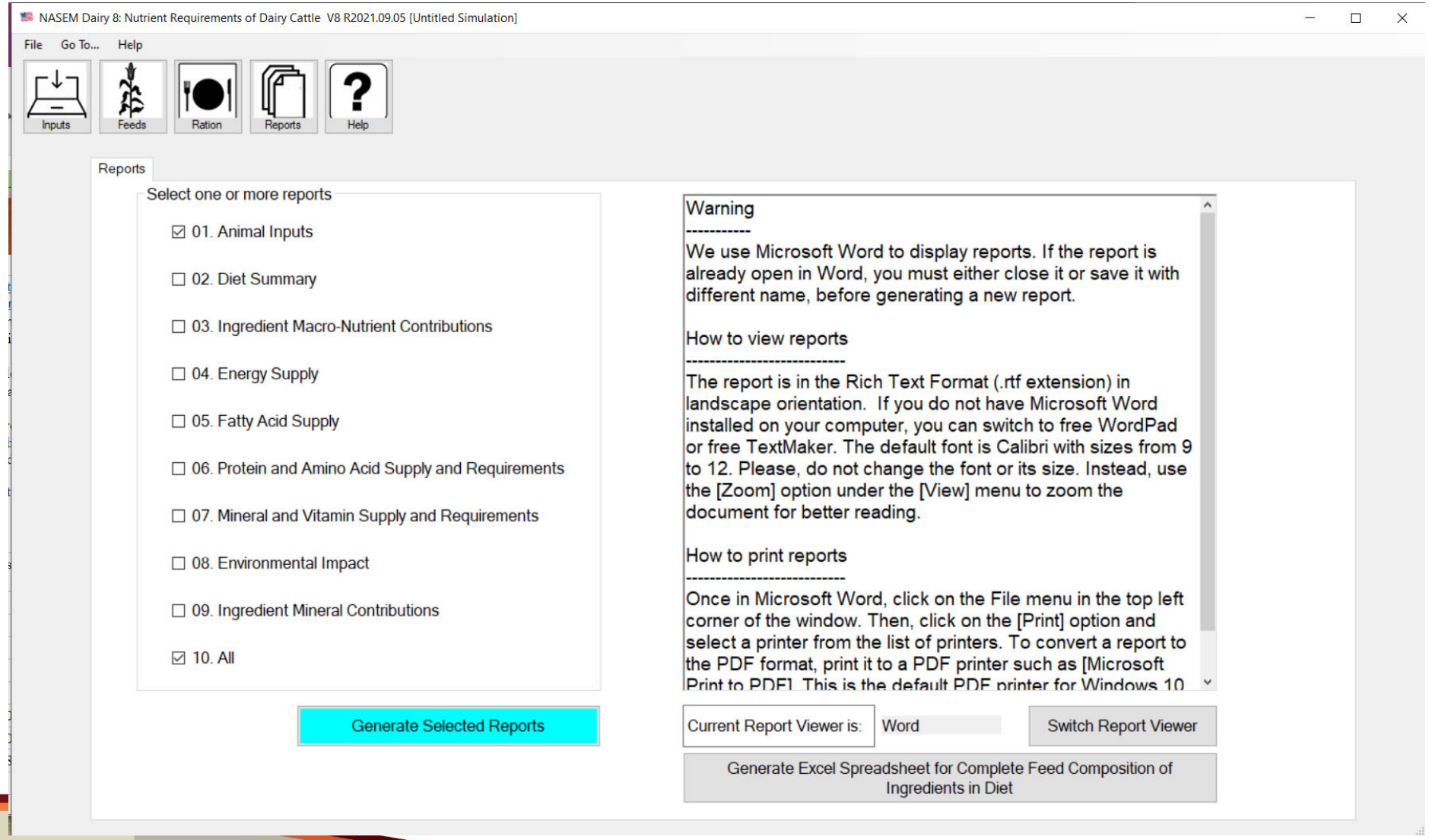
Ingredient feeding rates can be entered as mass/d or as a % of the total diet. Enter the desired intake and click "Set to 100%" to scale all entries to the desired intake, or click on "Use this Estimate" to rescale to a predicted intake.



Variables listed in the Sidebar are those selected on the Program Inputs Tab. Click the "Refresh Sidebar" button to populate the grid with the results from the diet as entered. Refresh each time you make a change in the diet to see the effects.

Reports Screen: Select Reports

Select the desired reports to be generated, or add a check mark to box 10 if you desire all reports.



The default report viewer is Word, but an open source viewer is also provided.

Click "Generate Excel …" to transfer the diet and ingredient composition to an excel file.

Report 1. Animal Inputs

1.1 Physiological State/Management

Item	Value	Unit
Animal Type	Lactating Cow	
Breed	Holstein	
Body Weight	700	kg
Mature Weight	700	kg
Age	54.0	months
Condition Score	3.00	(1-5)
Percent First Parity	33	(0-100)
Days in Milk	150	days
Age At First Calving	24	months
Days Pregnant	50	days
Temperature	N/A	deg C
In vitro NDF digest	Do not use	
Feeding Monensin	No	
Grazing	No	
Topography	Mild	Topography
Distance (Pasture to Parlor)	0.000	km
One-Way Trips	N/A	times/day

Report 1: Performance

1.2 Entered Performance

Item	Value	Unit
Milk Production	35.0	kg/d
Milk Fat	3.80	%
Milk True Protein	3.10	%
Milk Lactose	4.85	%
Milk Fat	1.33	kg/d
Milk True Protein	1.09	kg/d
Milk Lactose	1.70	kg/d
Milk True Protein RHA	396	kg/305 d
Energy Corrected Milk	37.0	kg/d
DMI	23.47	kg/d
DMI	3.35	% BW
ECM/DMI	1.58	kg/kg
Growth Rate	0.60	kg/d
Change in Body Reserves	0.10	kg/d

1.3 Predicted Production Variables

Item	Value	Unit
Milk, NEL Allowable	37.59	kg/d
Milk, MP Allowable	29.82	kg/d
Milk Production, Nutrient Predicted	32.1	kg/d
Milk True Protein, Nutrient Predicted	1.02	kg/day
Milk Fat, Nutrient Predicted	1.08	kg/day

- NEL and MP Allowable are classical, 1st limiting predictions
  - biased and imprecise before
  - more precise, but still biased!
- Nutrient Predicted Milk True Protein
  - the new EAA and DEI based prediction equation
  - unbiased and much greater precision
- Nutrient Predicted Milk Fat
  - based on FF DMI, C16:0, C18:3, Abs Ile, Abs Met, and DIM
  - unbiased and fairly precise, but very empirical
- Nutrient Predict Milk
  - based on milk protein, milk fat, and DIM

Report 2. Diet Summary (DM Basis)

2.1 Macronutrients

Nutrient	Content
Dry Matter, %	54.4
Forage, % DM	49.7
CP, % DM	17.2
ME, Mcal/kg	2.74
MP, % DM	9.73
NEL, Mcal/kg	1.81
RUP, Base, % DM	5.7
RDP, % DM	11.5
Dig. RUP, % DM	4.6
ADF, % DM	19.5
NDF, % DM	30.2
ADF/NDF, Ratio	0.65
Forage NDF, % DM	20.1
Starch, % DM	27.7
WSC, % DM	4.7
Ash, % DM	6.4
Total FA, % DM	5.28
Ca, % DM	0.70
P, % DM	0.39
Mg, % DM	0.25
K, % DM	1.34
Na, % DM	0.25
Cl, % DM	0.57
S, % DM	0.20
DCAD, mEq/kg	166
Cost, $/ton As Fed	82.53
Cost, $/day	8.25

2.2 Diet Ingredients

Ingredient	As Fed kg/d	% As Fed	DM kg/d	% of DM
01 Corn silage, typical	36.570462	75.549272	12.931681	55.096419
02 Corn grain dry, fine grind	7.439953	15.369864	6.465840	27.548207
03 Soybean meal, solvent 48CP	2.897304	5.985409	2.586336	11.019283
04 Calcium carbonate	0.969876	2.003623	0.969876	4.132231
05 Vit A premix	0.129317	0.267150	0.129317	0.550965
06 Vit D premix	0.129317	0.267150	0.129317	0.550965
07 Vit E premix	0.129317	0.267150	0.129317	0.550965
08 VitTM Premix, generic	0.140562	0.290381	0.129317	0.550965
Totals	48.406	100.00	23.471	100.00

No ingredient values entered

Report 3. Ingredient Macro-Nutrient Contributions (DM Basis)

Ingredient	Cost $/d	% of DM	BASE DE Mcal/d	CP kg/d	RDP g/d	RUP g/d	dRUP g/d	NDF kg/d	Starch kg/d	Total FA g/d
Corn silage, typical	1.25	31.00	25.89	0.68	473	206	145	3.61	2.90	207
Legume silage, immature	0.65	14.70	11.32	0.92	754	169	118	1.62	0.08	83
Grass lg mixt, leg., hay, immtr	0.13	4.00	3.01	0.23	187	45	33	0.50	0.02	20
Corn grain dry, fine grind	1.92	23.42	23.61	0.57	336	231	169	0.65	4.69	256
Cottonseed, whole	0.70	9.00	8.06	0.60	478	119	88	1.29	0.02	467
DDGS, low fat	0.28	5.00	4.85	0.44	245	196	147	0.44	0.09	112
Soybean meal, solvent 48CP	0.72	5.00	5.65	0.75	523	226	206	0.16	0.03	15
Soybean meal, expellers	0.74	5.00	5.53	0.68	267	410	382	0.28	0.03	87
Fat, lard	0.16	1.00	1.71	0.00	0	0	0	0.00	0.00	250
Calcium carbonate	0.05	0.80	0.00	0.00	0	0	0	0.00	0.00	0
Magnesium oxide	0.00	0.04	0.00	0.00	0	0	0	0.00	0.00	0
Sodium chloride (salt)	0.01	0.50	0.00	0.00	0	0	0	0.00	0.00	0
Zinc sulfate (H2O)	0.01	0.00	0.00	0.00	0	0	0	0.00	0.00	0
Vit A premix	0.10	0.04	0.00	0.00	1	0	0	0.01	0.00	0
VitTM Premix, generic	1.55	0.50	0.00	0.02	14	9	8	0.04	0.02	3
Totals	8.25	100.00	89.64	4.89	3277	1611	1294	8.59	7.87	1502

Report 4. Energy Supply and Requirements

4.1 Energy Supply

Energy	Mcal/d	Mcal/kg	% of GE	% of DE	% of ME
DE	71.21	3.03	72.5	100.0	
Urinary E	1.79	0.08	1.8	2.5	
Gaseous E	6.58	0.28	6.7	9.2	
ME	62.84	2.68	64.0	88.2	100.0
NEL	41.48	1.77	42.2	58.2	66.0

4.2 NEL and ME Requirements

Requirement	ME Mcal/d	NEL Mcal/d	NE:DEIn Fraction	NE:ME Efficiency
Maintenance	20.62	13.61	0.19	0.66
Milk Production*	38.50	25.41	0.36	0.66
Pregnancy*	0.06	0.04	0.00	0.14
Grazing Activity	0.00	0.00	0.00	0.66
Thermal Stress	0.00	0.00	0.00	0.66
Frame Gain*	0.82	0.54	0.00	0.40
Reserves Gain*	0.00	0.00	0.00	0.89
Total Required, Target*	59.99	39.60		
Balance (Intake - Required), Target	2.85	1.88		

*Based on User Entered Target Production

Report 4. Energy from Individual Nutrients

4.3 Nutrient Contributions to DE

Nutrient	Intake kg/d	Base Digest %	Intake Adjusted Digest %	Truly Digested kg/d	Endog. Fecal kg/d	Apparently Digested kg/d	Apparently Digested %	Heat of combust Mcal/kg	DE Mcal/d
NDF	6.32	56.08	49.29	3.12	0.00	3.12	49.29	4.20	13.09
Starch	8.87	90.55	90.70	8.04	0.00	8.04	90.70	4.23	34.02
FA	0.58	73.00	73.00	0.43	0.00	0.43	73.00	9.40	4.00
rOM	3.01	96.10	96.10	2.89	0.81	2.09	69.34	4.00	8.34
CP	2.94	93.57	93.57	2.75	0.67	2.08	70.74	5.65	11.76
OM	21.69	81.35	79.43	17.23	1.48	15.75	72.62	4.52	71.21

Report 5. Fatty Acid Supply

Fatty Acid	Profile % of Total FA	Concentration % of DM	Intake g/d
C12:0	0.16	0.00	0.9
C14:0	1.27	0.03	7.4
C16:0	15.76	0.39	91.8
C16:1	0.24	0.01	1.4
C18:0	2.32	0.06	13.5
C18:1 trans	0.02	0.00	0.1
C18:1 cis	20.93	0.52	122.0
C18:2	51.23	1.27	298.6
C18:3	5.40	0.13	31.5
Others	2.23	0.06	13.0
Total Fatty Acids	100.00	2.48	583.0
Total Saturated Fatty Acids	21.74	0.54	126.7
Total Mono-Unsaturated Fatty Acids	21.19	0.53	123.6
Total Poly-Unsaturated Fatty Acids	56.62	1.41	330.1

Report 6. Protein Supply and Requirements

6.1 Animal Inputs

Item	Value	Unit
DE from Non-Protein Components	68.45	Mcal/d
Ruminal Digestion and Outflow		
Rumen Digested Starch	4.13	kg/d
Rumen Digested NDF	4.04	kg/d
Microbial Protein (MiCP)	2.23	kg/d
RDP - MiCP Balance	1043	g/d
Rumen Undegraded Protein	1.61	kg/d
Metabolizable Protein Supply	2.77	kg/d
MP from Microbial CP	1.47	kg/d
MP from RUP	1.29	kg/d
MP from Body Reserve	0.01	kg/d

Item	NP	MP
Scurf, g/d	9	13
Endogenous Urinary, g/d	232	232
Metabolic Fecal, g/d	324	470
Frame Growth, g/d	7	13
Body Reserves, g/d	0	0
Pregnancy, g/d	1	2
Lactation, Target, g/d	1540	2232
Lactation, Nutrient Allow, g/d	1318	2014
Total Required, Nutrient Allow, g/d	1891	2744
Total Required, g/d	2113	2962
Dietary Supply, g/d	N/A	2767
Balance (intake - required) at Target Production, g/d	N/A	-195
Target MP to Export NP Efficiency	N/A	0.69
Predicted MP to Export NP Eff at Target (3)	N/A	0.74
Predicted MP to Export NP Eff at Nut Allow	N/A	0.56
MP Supply / ME Supply, g/Mcal	N/A	35.50
MP Req / ME Req, g/Mcal	N/A	41.67

Footnote1: MP efficiency for endogenous urinary and pregnancy are 1 and 0.33, respectively.
Footnote2: Efficiency calculated using the user entered Target milk protein or that predicted based on absorbed (allowable) nutrients.
Footnote3: Adjust DE or Abs EAA supplies to match Predicted MP efficiency to the Target or Nutrient Allowable efficiency.

Report 6. Target Amino Acid Supply and Efficiency

6.3 Predicted and Target Supply of Metabolizable Protein and Amino Acids

Item	Target Milk Protein g/d	Target Metab AA Efficiency	Target Supply g/d	Predicted Supply Mcal or g/d	Predicted Metab AA Efficiency	Milk Protein Regr Coeff	Predicted Milk Protein g/d
Intercept + BW effects + dNDF							-122
DE Non-Protein				68		10.79	739
Arg	58			159	0.45	0.00	0
His	45	0.75	78	67	0.77	1.64	110
Ile	95	0.71	161	161	0.63	0.87	140
Leu	163	0.73	269	253	0.68	0.46	116
Lys	136	0.72	228	203	0.71	1.13	230
Met	47	0.73	73	60	0.78	1.81	108
Phe	81	0.60	167	158	0.56	0.00	0
Thr	71	0.64	152	143	0.61	0.00	0
Trp	25	0.86	37	35	0.79	0.00	0
Val	106	0.74	178	168	0.69	0.00	0
EAA	827		1343	1407	0.64	0.00	-190
Other AA				2439		0.08	189
Nutrient Allowable (1)	1540				0.65	N/A	1318
Pred Milk NP / 305d Max (2)	N/A	N/A	N/A	N/A	N/A	N/A	0.57

(1) Manipulate digested NDF, absorbed DE, and absorbed EAA (His, Ile, Leu, Lys, and Met) to match Target and Predicted efficiencies and NP production.

(2) Pred Milk NP / 305d Max reflects the ratio of the Nutrient Allowable Milk NP to the user entered 305d herd production. This ratio should not be greater than 0.80 under normal feeding conditions.

Report 6. EAA Partitioning

6.4 EAA Partitioning using Predicted Milk NP, g/d

Item	Diet	Dig. RUP	Dig. Microbes	Urin. End.	Fecal Metab.	Scurf	Milk	Preg.	Body Gain	Total Use	Pred Export Eff	Trg Export Eff
Arg	272.5	78.1	80.5	3.6	19.1	0.8	49.3	0.1	0.6	73.5	0.45	N/A
His	124.2	34.3	32.5	1.7	11.5	0.2	38.5	0.0	0.2	52.1	0.77	0.75
Ile	211.8	57.8	102.9	1.6	17.5	0.3	81.5	0.0	0.2	101.1	0.63	0.71
Leu	424.4	116.8	135.9	3.6	29.8	0.6	139.2	0.1	0.6	173.9	0.68	0.73
Lys	229.7	64.1	139.0	3.5	24.7	0.5	116.3	0.1	0.5	145.5	0.71	0.72
Met	78.6	20.9	38.7	1.0	5.6	0.1	39.9	0.0	0.2	46.9	0.78	0.73
Phe	242.7	65.6	92.8	1.9	17.1	0.3	69.3	0.0	0.3	89.0	0.56	0.60
Thr	192.1	51.5	91.7	2.1	23.9	0.4	60.9	0.0	0.3	87.6	0.61	0.64
Trp	56.6	15.2	20.2	0.5	5.8	0.1	21.8	0.0	0.1	28.2	0.79	0.86
Val	253.6	67.0	101.3	2.3	22.7	0.4	91.0	0.0	0.3	116.8	0.69	0.74

Report 7. Mineral and Vitamin Supply and Requirements

7.1 Minerals

Item	Diet Density	Req Density	AC	Absorb Req (TAR)	Diet Supply (TDS)	Absorb Supp (TAS)	Diff TAS-TAR	Metab Fecal	Urine	Preg	Milk	Growth
Macro Mineral	% DM	% DM	g/100g	g/d	g/d	g/d	g/d	g/d	g/d	g/d	g/d	g/d
Ca	1.82	0.50	49.6	58	426	211	153	21	N/A	0	36	1
P	0.30	0.32	75.0	56	70	53	-3	23	0	0	31	1
Mg	0.17	0.15	32.4	11	39	13	1	7	0	0	4	0
Cl	0.18	0.28	92.0	61	42	39	-22	26	N/A	0	35	0
K	0.97	1.07	100.0	251	227	227	-24	59	140	0	53	0
Na	0.02	0.21	100.0	48	5	5	-43	34	N/A	0	14	0
S	0.14	0.20	N/A	47	32	N/A	-15	N/A	N/A	N/A	N/A	N/A
Micro Mineral (1)	mg/kg	mg/kg	g/100g	mg/d	mg/d	mg/d	mg/d	Total Maint mg/d		mg/d	mg/d	mg/d
Co	0.00	0.20	0.0	5	0	0	-5	N/A		N/A	N/A	N/A
Cu	14.58	10.01	5.0	12	342	17	5	10		0	1	0
Fe	127.81	16.36	10.0	38	3000	300	262	0		0	35	3
I	0.44	0.44	N/A	10	10	N/A	0	N/A		N/A	N/A	N/A
Mn	44.85	27.89	0.4	3	1053	5	2	2		0	1	0
Se	0.34	0.30	N/A	7	8	N/A	1	N/A		N/A	N/A	N/A
Zn	49.42	55.34	20.0	260	1160	232	-28	117		0	140	2

1. For S, Co, I, and Se required is based on diet concentration and not absorbed amounts.

Report 7. Mineral and Vitamin Supply and Requirements

7.2 Vitamin Supply and Requirements

Item	Diet Density	Required Density	Diet Supply	Required	Supply - Required
Fat-Soluble Vitamins	IU/kg	IU/kg	IU/d	IU/d	IU/d
A	16859.5	3280.6	395710	77000	318710
D	2479.3	1193.0	58193	28000	30193
E	264.5	23.9	6207	560	5647
Other Vitamins	mg/kg	mg/kg	mg/d	mg/d	mg/d
Beta Carotene	0.00	N/A	0	N/A	N/A
Biotin	0.00	N/A	0	N/A	N/A
Choline	0.00	N/A	0	N/A	N/A
Niacin	0.00	N/A	0	N/A	N/A

Report 8. Environmental Impact

8.1 Water, Volatile Solids, and Methane

Item	Value	Unit
Water Intake	72.7	kg/d
Wet Manure Output	68.2	kg/d
Manure Volatile Solids	8.27	kg/d
Enteric Methane Production	496	g/d
Enteric Methane Production	743	L/d
Water Intake	2.3	L H2O/kg Milk
Manure Water	2.1	L H2O/kg Milk
Manure Volatile Solids	2.1	kg/kg Milk
Enteric Methane Production	15	g CH4/kg Milk
Enteric Methane Production	23	L CH4/kg Milk

8.2 Nitrogen and Mineral Excretion

Item	Intake	Retained in Milk, Growth & Conceptus	Fecal & Urinary	Retained/Intake
Nitrogen and Macro-minerals	g/d	g/d	g/d	g/g
Nitrogen	471	165	265	0.35
Ca	426	37	389	0.09
P	70	32	38	0.45
Mg	39	4	35	0.10
Cl	42	35	7	0.83
K	227	53	175	0.23
Na	5	14	-9	2.80
Micro-minerals	mg/d	mg/d	mg/d	g/g
Cu	342	2	341	0.00
Fe	3000	38	2961	0.01
Mn	1053	1	1052	0.00
Zn	1160	142	1018	0.12

Report 9. Ingredient Mineral Contributions

Ingredient	Ca g/d	P g/d	Mg g/d	Cl g/d	K g/d	Na g/d	S g/d	Co mg/d	Cu mg/d	I mg/d	Fe mg/d	Mn mg/d	Se mg/d	Zn mg/d
Corn silage, typical	21	20	15	23	87	2	9	0	55	0	1456	261	0	242
Legume silage, immature	55	15	14	33	117	7	9	0	48	0	2866	258	1	127
Grass lg mixt, leg., hay, im	15	3	3	6	26	1	3	0	12	0	324	50	0	29
Corn grain dry, fine grind	2	21	9	7	37	1	7	0	14	0	260	48	0	156
Cottonseed, whole	4	16	10	2	30	0	6	0	19	0	184	45	0	93
DDGS, low fat	2	13	5	3	17	3	10	0	8	0	145	26	1	99
Soybean meal, solvent 48CP	6	11	5	1	34	0	6	0	23	0	266	59	0	75
Soybean meal, expellers	5	10	4	1	32	0	6	0	22	0	278	56	0	75
Fat, lard	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calcium carbonate	90	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium oxide	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Sodium chloride (salt)	0	0	0	86	0	56	0	0	0	0	0	0	0	0
Zinc sulfate (H2O)	0	0	0	0	0	0	0	0	0	0	0	0	0	364
Vit A premix	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VitTM Premix, generic	1	1	1	0	1	0	1	0	228	11	142	569	7	569
Totals	200	110	72	163	381	71	57	0	427	11	5921	1371	10	1830

Summary

- Program follows logic of the problem
- Pay attention to input and ingredient entry
- Lots of valuable biological information provided by the program
- Use it as a tool for diet evaluation and to diagnose problems