Net Energy defines lean and fat deposition better than Digestible Energy

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Executive Summary

Net energy (NE) is the available energy for lean tissue and fat deposition, and therefore should be a more accurate predictor of pig growth performance and carcass quality. In the past, however, measuring net energy was, and still is, a very expensive and arduous process. French and Dutch researchers during the 1990's developed equations that accurately calculate net energy from known and/or cheaply measured diet components like Digestible Energy (DE), protein, fat and fibre. Several studies conducted at Rivalea suggested that dietary NE had a stronger relationship to carcass lean and fat deposition compared to DE, which was not predicted by AUSPIG. Further analysis strongly suggested that the manipulation of dietary NE and DE can significantly reduce carcass fat without reducing lean deposition while reducing diet costs up to $10/tonne.

An experiment was designed to manipulate dietary DE and NE to test the hypothesis that net energy defines lean and fat deposition better than digestible energy

There was no effect of DE or NE on daily gain, final weight or feed intake. There was a significant effect of DE on live weight FCR ($P<0.001$) and net energy influenced the ultra-sound leg fat thickness ($P=0.017$). The diet containing the lowest NE level of 9.0 MJ/kg produced the lowest carcass weight ($P<0.05$), although neither NE nor DE directly influenced this measurement. Carcass FCR was significantly affected by DE, however there was no effect of NE, even though the lowest NE level produced the worst FCR ($P<0.05$). The carcass characteristics of dressing percentage and P2 backfat were significantly influenced by NE, but not by the DE content of the diets.

There was no significant difference in carcass weight, carcass FCR, P2 backfat and dressing percentage when there was a measured difference in 0.7 MJ/kg DE, and no difference in NE level (9.7 MJ/kg NE). The difference in costs between the 14.0 and 13.3 MJ/kg DE diets is $8 to $9/tonne, for August 2009 South Eastern Australian raw material prices. If a finisher pig consumes 100 kg over the 42 day finisher period, formulating on NE would produce a saving of $0.85/pig, or $8,500 p.a. for a 500 sow unit.

Another method of attributing the benefits of NE in diet formulation is to maximise carcass weight, and/or limit P2 backfat thickness. Even through diets 1 and 2 were both 14 MJ DE/kg, reducing NE from 10.4 to 9.7 significantly reduced P2 by 0.5mm, which could add 2 to 3 cents per kg of carcass, or $1.4 to $2.1/pig for a 70 kg carcass. Lastly, the benefits of using NE in pig nutrition will help maximise carcass weight, and although not significant, there was 1.6 kg difference between the 13.1 MJ/kg DE diets 3 and 4, when NE was increased from 9.0 to 9.7 MJ/kg.

The present study highlights the inefficiencies of formulating Australian grower and finisher diets on digestible energy. For the Australian industry to be competitive, more commercial information needs to be generated to provide pig nutritionists NE requirements for different genotypes and also the confidence for them change away from using DE and implement a NE strategy.

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1. Introduction

The majority of Australian nutritionists formulate pig diets using digestible energy (DE) or a "modified" DE. Cereal grain studies conducted at QAF Meat Industries and later through the PGLP showed the DE value of the grain had very little relationship to the growth performance of the pig. In main cause was due to other nutritional or anti-nutritional factors (ANF) affecting voluntary feed or energy intake. Past research has reported the factors influencing (energy) feed intake to be level of crude protein, soluble and insoluble fibre, phytic acid and other factors which influence nutrient digestion or microbial balances. Majority of the anti-nutritional effects of fibre are being reduced with the uptake of exogenous xylanase and phytase supplementation across all progeny diets.

Net energy (NE) is the available energy for lean tissue and fat deposition, and therefore should be a more accurate predictor of pig growth performance and carcass quality. In the past, however, measuring net energy was, and still is, a very expensive and arduous process. French and Dutch researchers during the 1990's developed equations that accurately calculate net energy from known and/or cheaply measured diet components like DE, protein, fat and fibre. Several studies conducted at QAF suggested that dietary NE had a stronger relationship to carcass lean and fat deposition compared to DE, which was not predicted by AUSPIG. Further analysis strongly suggested that the manipulation of dietary NE and DE can significantly reduce carcass fat without reducing lean deposition while reducing diet costs up to $10/tonne.

When formulating on a DE basis, linear program diet formulation packages give an energy value for protein as well as source of animo acids. This allows protein to replace a portion of starch as an energy source, producing more of an "Atkins Diet" type of effect. Net energy naturally discounts the value of excessive non-essential protein and indirectly selects a diet that maximises the potential for higher energy intake. This is one example of the benefits of using net energy in diet formulation.

2. Methodology

The study was conducted at the Rivalea Research and Innovation unit, Corowa NSW. To demonstrate that the manipulation of dietary NE is a more effective method to change growth performance and carcass quality, compared to DE, 960 female pigs (Primegro genotype), at 60 kg live weight, were housed in pens of 40 for 42 days. The formulated diets were simulated on AUSPIG to make sure no amino acid deficiencies confound the results. The experimental animals were offered the experimental diets through electronic feeders, which produce very little to no feed wastage.

The treatments consisted of three dietary levels of net energy (NE) calculated from Noblet equation NEg4 (Noblet et al, 1994), and two levels of digestible energy (DE). The diets were formulated so that there were two NE levels at the one set DE. At the 14.0 MJ/kg diet, there were two NE levels of 10.4, and 9.7 MJ/kg. At the 13.1MJ/kg DE diet, two NE levels of 9.7 and 9.0 MJ/kg were set.

Faeces were collected and pooled between day 18 and 22 of the experiment, and oven dried at 100 C for 24 hours. Titanium Oxide was added to the diet at 1000ppm, and the Titanium oxide was measured in the diet and faeces to calculate the actual diet digestible energy using the following equation:

$$\textbf{DE (MJ/kgDM)} = \text{Diet GE} \times \left(1 - \frac{\text{Faecal GE (MJ/kg)/ Faecal marker (g/kg)}}{\text{Diet GE (MJ/kg) / Diet marker (g/kg)}}\right)$$

On day 42 of the experiment, pigs were weighed and leg fat thickness was measured by ultrasound. On day 43, the experimental animals were slaughtered and carcass weight and P2 backfat were recorded. Dressing percentage was calculated from the carcass weight and 42 day weight

3. Outcomes

During the first two of the four replicates, the average start weight was 10kg below the required 60kg. This potentially made the diets marginal in essential amino acids in the first 2 to 3 weeks of the experiment, potentially limiting protein deposition. Diets 2 and 4 were low in protein, and may have been more affected than diets 1 and 3. Another noticeable difference was the very low feed intakes, even when little feed wastage was built into the Calculations. Although some pigs were consuming over 2.5kg/d, the ability for the experimental animals to exhibit maximum voluntary feed intake, and hence adjust intake depending on energy levels, appears to be hampered.

There was no effect of DE or NE on daily gain, final weight or feed intake (Table 1). There was significant effect of DE on live weight FCR ($P<0.001$) and net energy influenced the ultra-sound leg fat thickness ($P=0.017$)

The diet containing the lowest NE level of 9.0 MJ/kg produced the lowest carcass weight (($P<0.05$), although neither NE nor DE directly influenced this measurement (Table 2). Carcass FCR was significantly affect by DE, however there was no effect of NE, even though the lowest NE level produce the worst FCR ($P<0.05$). The carcass characteristics of dressing percentage and P2 backfat were significantly influenced by NE, but no by the DE content of the diets.

Table 1. Growth performance during the 0 to 42 day period, starting at 55.3 kg live weight

Digestible Energy (MJ/kg)	Net Energy (MJ/kg)	Final Weight (kg)	Daily Gain (g)	FCR	Feed Intake (g/d)	Leg Fat RTU (mm)
14.0	10.4	90.3	832	2.33	1.938	11.4[a]
14.0	9.7	92.3	878	2.30	2.015	10.4[b]
13.1	9.7	90.5	838	2.48	2.076	10.8[ab]
13.1	9.0	90.1	833	2.47	2.051	10.2[b]
LSD		*0.110*	*0.110*	*0.000*	*0.082*	*0.024*
Significance						
DE		0.069	0.069	0.000	0.277	0.218
NE		0.104	0.104	0.657	0.359	0.017

Table 2. Carcass Performance effects

Digestible Energy (MJ/kg)	Net Energy (MJ/kg)	Carcass weight (kg)	Carcass FCR	P2 Backfat (mm)	Dressing %
14.0	10.4	69.2[ab]	2.68[s]	8.6[a]	76.6[a]
14.0	9.7	70.2[a]	2.70[a]	8.1[b]	76.0[ab]
13.1	9.7	69.0[ab]	2.88[ab]	8.2[ab]	76.2[a]
13.1	9.0	67.7[b]	2.96[b]	7.8[b]	75.1[b]
LSD		*0.043*	*0.000*	*0.005*	*0.024*
Significance					
DE		0.161	0.006	0.520	0.671
NE		0.176	0.352	0.010	0.040

The actual measured DE levels of diets 1 and 2 were 13.9 and 14.0 MJ/kg, respectively. This was very close to the predicted 14 MJ/kg DE formulated in both diets. The actual DE levels of the formulated or predicted 13.1 MJ/kg were actually 0.2 and 0.3 MJ/kg higher for diets 3 and 4, respectively. This increased the calculated NE levels of both these diets by 0.1 MJ/kg.

Table 3. Predicted and measured Digestible Energy levels using the Titanium Oxide maker

Predicted Digestible Energy (MJ/kg)	Net Energy (MJ/kg)	Actual Digestible Energy (MJ/kg)	Recalculated Net Energy (MJ/kg)
14.0	10.4	13.9	10.3
14.0	9.7	14.0	9.7
13.1	9.7	13.3	9.8
13.1	9.0	13.4	9.2

4. Application of Research

There was no significant difference in carcass weight, carcass FCR, P2 backfat and dressing percentage when there was a measured difference of 0.7 MJ/kg DE, and no difference in NE level (9.7 MJ/kg NE). The difference in cost between the 14.0 and 13.3 MJ/kg DE diets is $8 to $9/tonne, for August 2009 South East Australian raw material prices. This difference in cost will change, depending on cereal grain, protein meals and co-product pricing, in a range from $5 to $16/tonne. Using August 2009 raw material prices, if a finisher pig consumes 100 kg over the 42 day finisher period, formulating on NE would produce a saving of $0.85/pig, or $8,500 p.a. for a 500 sow unit.

Another method of attributing the benefits incorporating NE in diet formulation is to maximise carcass weight, and/or limit P2 backfat thickness. Even through diets 1 and 2 were both 14 MJ/kg, reducing NE from 10.4 to 9.7 significantly reduced P2 by 0.5mm, which could add 2 to 3 cents per kg of carcass, or $1.4 to $2.1/pig for a 70 kg carcass. Lastly, the benefits of using NE in pig nutrition will help maximise carcass weight, and although not significant, there was 1.6 kg difference between the 13.1 MJ/kg DE diets 3 and 4, when NE was increased from 9.0 to 9.7 MJ/kg.

In spite of the problems with implementing the initial experimental design, the limit on voluntary feed intake and marginal essential amino acid levels in the first 14 days, the results support past studies (Cadogan et al 2005) in which dietary NE had little influence on live weight performance, but had marked effect on dressing percentage, carcass lean and fat deposition. Digestible Energy did not affect carcass weight and fat measurements. There are significantly more risks formulating diets on DE, compared to NE, due to the potential inefficiencies of heat increment and the related negative impacts this has on carcass growth.

The majority of Australasian pig nutritionists have excellent information on the net energy figures of Australian raw materials, using the European approach of net energy tables and equations. Therefore there is no restriction with nutritionists formulating on net energy in Australia and New Zealand, and the present experiment will inject more confidence for technical personal involved in feed formulation to use net energy in their customers pig diets.

5. Conclusion

The present study highlights the inefficiencies of formulating Australian grower andfinisher diets on digestible energy, and for the Australian industry to be competitive, more commercial information needs to be generated to give nutritionists the pig NE requirements and also the confidence for them change away from using DE and implement a NE strategy.

6. Limitations/Risks

European and UK nutritionists have been formulating commercial pig diets on net energy for over 10 years. More recently a good proportion of North American nutritionists are doing the same. They are using figures from the net energy tables and equations used to generate NE values in the present study commercially.

Information from the present and past research, and commercial observations from Europe, UK and North America show that there is more risk using Digestible Energy compared to Net Energy in pig diet formulations

7. Recommendations

It is not recommended this project continue with measuring actual effects on lean and fat tissue deposition rates and final carcass composition, as the supporting information on using net energy commercially is very high.

Further work is highly recommended to measure actual growth and finisher NE requirements, for different Australian genotypes. Further more, research is warranted to demonstrate under commercial conditions that available lysine and other essential amino acids are better to be balanced to NE, rather than DE. The Feedlogic systems in WA and QLD would be idea to commercialise NE and available lysine:NE ratios in Australia.

8. References

CADOGAN, D.J., SMITH, C. and HENMAN, D.J. (2005). In “Manipulating Pig Production” *X* p.187, ed J.E Paterson. (Australasian Pig Science Association: Werribee, Australia)

NOBLET, J., FORTUNE, H., SHI X.S. and DUBIOS, S. (1994). *Journal of Animal Science.* **72**:648-657

Appendices

Appendix 1: Diets

Plant: 1 NORTHERN
Product: 2310 HIGH NE 14.0 MJ DE Version: 1

Ingr Code	Ingredient Name	Kgs	Pct	Owning $/Tonne	$ Total
1	WHEAT 13%	295.000	29.500	430.00	126.85
12	BARLEY 10 %	136.050	13.605	375.00	51.02
50	SORGHUM 9.0%	300.000	30.000	290.00	87.00
200	MILLMIX	150.000	15.000	350.00	52.50
301	CANOLA MEAL 34%	47.000	4.700	490.00	23.03
420	BLOODMEAL	13.000	1.300	950.00	12.35
502	PHYZYME (PIG WHEAT MATRIX) 5000	0.100	0.010	15,000.00	1.50
503	PORZYME 9310	0.150	0.015	9,250.00	0.79
520	TALLOW-MIXER	30.000	3.000	950.00	28.50
550	SALT	2.000	0.200	110.00	0.22
560	LIMESTONE	13.000	1.300	110.00	1.43
575	DICALPHOS	3.000	0.300	1,000.00	3.00
600	LYSINE-HCL	3.800	0.380	2,300.00	8.74
605	DL-METHIONINE	0.600	0.060	3,700.00	2.22
610	THREONINE	1.200	0.120	3,500.00	4.20
615	ISOLEUCINE H/A	0.200	0.020	45,000.00	9.00
620	TRYPTOPHAN H/A	0.200	0.020	44,000.00	8.80
641	COPPER PROTEINATE MICRO	1.000	0.100	6,000.00	6.00
704	GROWER PMX	0.700	0.070	6,000.00	4.20
911	RUMENSIN 100	1.000	0.100	0.00	0.00
950	RED MICRO-GRITS	1.000	0.100	15,000.00	15.00
1065	TITANIUM DIOXIDE	1.000	0.100	0.00	0.00
	Formula Totals:	1,000.00		446.35	446.35
	Owning Cost ($/Tonne):	446.35			

Nutrient Composition - As Mixed: (All Nutrients)

Nutr	Nutrient Name	Amount	Units
1	VOLUME	0.999	%
2	[DRYMAT]	89.655	%
3	DE_PIG	13.993	MJ/KG
4	NE4G	10.484	MJ/KG
5	POULTRY NE	8.835	MJ/KG
6	DEENZYME	14.164	MJ/KG
7	DEACTUAL	14.149	MJ/KG
8	PROTEIN	13.527	%
9	FAT	5.502	%
10	STARCH	46.409	%
11	FIBRE	4.048	%
12	ASH	4.346	%
13	CALCIUM	0.703	%
14	T:PHOS	0.506	%
15	AV:PHOS	0.300	%
16	ENZAVPHOS	0.355	%
17	P:PHOS	0.333	%
18	LYSINE	0.859	%
19	ALYSINE	0.759	%
20	METHION	0.272	%
21	M+C	0.571	%
22	THREO	0.610	%
23	ISOLEUC	0.512	%
24	TRYPTO	0.177	%
25	CYSTINE	0.306	%
26	VALINE	0.734	%
27	HISTIDIN	0.376	%
28	LEUCINE	1.218	%
29	PHENYLAL	0.630	%
30	P+T	1.008	%
31	ARGININE	0.677	%
32	TYROSINE	0.390	%
33	T:EAA	4.498	%
34	ALANINE	0.627	%

35	ASPARTIC	0.773	%
36	GLYCINE	0.509	%
37	GLUTAMIC	2.471	%
38	SERINE	0.510	%
39	GLUTAMIN	2.184	%
40	PROLINE	0.899	%
41	OH_PROLI	0.389	%
42	ASPARAG	0.797	%
55	AMETH	0.237	%
56	AM+C	0.490	%
57	ATHREO	0.519	%
58	AISOLEUC	0.428	%
59	ATRYPTO	0.126	%
60	AVALINE	0.614	%
61	ACYSTINE	0.255	%
62	AP+T	0.867	%
63	APHENYL	0.541	%
64	ALEUCINE	1.075	%
65	AHISTID	0.329	%
66	AARGININ	0.558	%
67	SALT	0.302	%
69	ABC	565.27	MEQ/KG
70	SODIUM	0.100	%
71	POTASS	0.517	%
72	CHLORIDE	0.305	%
73	MAGNES	0.177	%
74	NA+K_CL	95.768	MEQ/KG
75	CHOLINE	1,013.94	MG/KG
77	N:D:F:	19.038	%
78	LINOLEIC	1.141	%
79	A:D:F:	6.117	%

Nutrient Ratios

Nutr	Nutrient Name	Units	Per	Nutr	Nutrient Name	Units	Ratio Amount
24	TRYPTO	%	1.00	18	LYSINE	%	0.21
23	ISOLEUC	%	1.00	18	LYSINE	%	0.60
22	THREO	%	1.00	18	LYSINE	%	0.71
21	M+C	%	1.00	18	LYSINE	%	0.66
20	METHION	%	1.00	18	LYSINE	%	0.32
19	ALYSINE	%	1.00	4	NE4G	MJ/KG	0.07
19	ALYSINE	%	10.00	3	DE_PIG	MJ/KG	0.54
26	VALINE	%	1.00	18	LYSINE	%	0.85
55	AMETH	%	1.00	19	ALYSINE	%	0.31
56	AM+C	%	1.00	19	ALYSINE	%	0.65
57	ATHREO	%	1.00	19	ALYSINE	%	0.68
58	AISOLEUC	%	1.00	19	ALYSINE	%	0.56
59	ATRYPTO	%	1.00	19	ALYSINE	%	0.17
13	CALCIUM	%	1.00	14	T:PHOS	%	1.39
13	CALCIUM	%	1.00	15	AV:PHOS	%	2.35CFC

Plant: 1 NORTHERN
Product: 2311 LOW NE 14.0 DE Version: 1

Ingr Code	Ingredient Name	Kgs	Pct	Owning $/Tonne	$ Total
1	WHEAT 13%	63.000	6.300	430.00	27.09
12	BARLEY 10 %	205.150	20.515	375.00	76.93
50	SORGHUM 9.0%	350.000	35.000	290.00	101.50
110	LUPIN KERNELS 33%	120.000	12.000	550.00	66.00
301	CANOLA MEAL 34%	50.000	5.000	490.00	24.50
325	SOYABEANMEAL-48%	132.000	13.200	680.00	89.76
395	PALM KERNEL MEAL	50.000	5.000	265.00	13.25
502	PHYZYME (PIG WHEAT MATRIX) 5000	0.100	0.010	15,000.00	1.50
503	PORZYME 9310	0.150	0.015	9,250.00	0.79
520	TALLOW-MIXER	7.500	0.750	950.00	7.12
550	SALT	2.000	0.200	110.00	0.22
560	LIMESTONE	11.000	1.100	110.00	1.21
575	DICALPHOS	4.000	0.400	1,000.00	4.00
605	DL-METHIONINE	0.400	0.040	3,700.00	1.48
641	COPPER PROTEINATE MICRO	1.000	0.100	6,000.00	6.00
704	GROWER PMX	0.700	0.070	6,000.00	4.20
911	RUMENSIN 100	1.000	0.100	0.00	0.00
951	BLUE MICRO-GRITS	1.000	0.100	15,000.00	15.00
1065	TITANIUM DIOXIDE	1.000	0.100	0.00	0.00
	Formula Totals:	1,000.00		440.55	440.55
	Owning Cost ($/Tonne):	440.55			

Nutrient Composition - As Mixed: (All Nutrients)

Nutr	Nutrient Name	Amount	Units
1	VOLUME	0.999	%
2	[DRYMAT]	89.550	%
3	DE_PIG	13.986	MJ/KG
4	NE4G	9.704	MJ/KG
5	POULTRY NE	6.950	MJ/KG
6	DEENZYME	14.004	MJ/KG
7	DEACTUAL	14.068	MJ/KG
8	PROTEIN	18.963	%
9	FAT	3.940	%
10	STARCH	36.305	%
11	FIBRE	4.325	%
12	ASH	4.783	%
13	CALCIUM	0.710	%
14	T:PHOS	0.495	%
15	AV:PHOS	0.309	%
16	ENZAVPHOS	0.339	%
17	P:PHOS	0.288	%
18	LYSINE	0.930	%
19	ALYSINE	0.756	%
20	METHION	0.300	%
21	M+C	0.656	%
22	THREO	0.727	%
23	ISOLEUC	0.835	%
24	TRYPTO	0.241	%
25	CYSTINE	0.352	%
26	VALINE	0.948	%
27	HISTIDIN	0.491	%
28	LEUCINE	1.654	%
29	PHENYLAL	0.885	%
30	P+T	1.703	%
31	ARGININE	1.307	%
32	TYROSINE	0.754	%
33	T:EAA	6.518	%
34	ALANINE	0.633	%
35	ASPARTIC	1.078	%
36	GLYCINE	0.497	%
37	GLUTAMIC	2.237	%
38	SERINE	0.543	%

39	GLUTAMIN	1.917	%
40	PROLINE	0.773	%
41	OH_PROLI	0.083	%
42	ASPARAG	1.090	%
55	AMETH	0.250	%
56	AM+C	0.547	%
57	ATHREO	0.578	%
58	AISOLEUC	0.703	%
59	ATRYPTO	0.190	%
60	AVALINE	0.792	%
61	ACYSTINE	0.478	%
62	AP+T	1.309	%
63	APHENYL	0.733	%
64	ALEUCINE	1.421	%
65	AHISTID	0.408	%
66	AARGININ	1.066	%
67	SALT	0.308	%
68	%LEGUMES	12.000	%
69	ABC	587.43	MEQ/KG
70	SODIUM	0.094	%
71	POTASS	0.710	%
72	CHLORIDE	0.260	%
73	MAGNES	0.196	%
74	NA+K_CL	158.94	MEQ/KG
75	CHOLINE	1,625.52	MG/KG
77	N:D:F:	18.779	%
78	LINOLEIC	1.077	%
79	A:D:F:	9.119	%

Nutrient Ratios

Nutr	Nutrient Name	Units	Per	Nutr	Nutrient Name	Units	Ratio Amount
24	TRYPTO	%	1.00	18	LYSINE	%	0.26
23	ISOLEUC	%	1.00	18	LYSINE	%	0.90
22	THREO	%	1.00	18	LYSINE	%	0.78
21	M+C	%	1.00	18	LYSINE	%	0.71
20	METHION	%	1.00	18	LYSINE	%	0.32
19	ALYSINE	%	1.00	4	NE4G	MJ/KG	0.08
19	ALYSINE	%	10.00	3	DE_PIG	MJ/KG	0.54
26	VALINE	%	1.00	18	LYSINE	%	1.02
55	AMETH	%	1.00	19	ALYSINE	%	0.33
56	AM+C	%	1.00	19	ALYSINE	%	0.72
57	ATHREO	%	1.00	19	ALYSINE	%	0.77
58	AISOLEUC	%	1.00	19	ALYSINE	%	0.93
59	ATRYPTO	%	1.00	19	ALYSINE	%	0.25
13	CALCIUM	%	1.00	14	T:PHOS	%	1.43
13	CALCIUM	%	1.00	15	AV:PHOS	%	2.30

CFC TRIAL FORMULA Date: 06/04/2008
Page: 1

Plant: 1 NORTHERN
Product: 2312 HIGH NE 13.1 DE Version: 1

Ingr Code	Ingredient Name	Kgs	Pct	Owning $/Tonne	$ Total
1	WHEAT 13%	101.000	10.100	430.00	43.43
12	BARLEY 10 %	262.450	26.245	375.00	98.42
50	SORGHUM 9.0%	392.000	39.200	290.00	113.68
200	MILLMIX	180.000	18.000	350.00	63.00
301	CANOLA MEAL 34%	27.000	2.700	490.00	13.23
420	BLOODMEAL	8.000	0.800	950.00	7.60
502	PHYZYME (PIG WHEAT MATRIX) 5000	0.100	0.010	15,000.00	1.50
503	PORZYME 9310	0.150	0.015	9,250.00	0.79
550	SALT	2.000	0.200	110.00	0.22
560	LIMESTONE	13.000	1.300	110.00	1.43
575	DICALPHOS	3.500	0.350	1,000.00	3.50
600	LYSINE-HCL	3.900	0.390	2,300.00	8.97
605	DL-METHIONINE	0.800	0.080	3,700.00	2.96
610	THREONINE	1.097	0.110	3,500.00	3.84
620	TRYPTOPHAN H/A	0.300	0.030	44,000.00	13.20
641	COPPER PROTEINATE MICRO	1.000	0.100	6,000.00	6.00
704	GROWER PMX	0.700	0.070	6,000.00	4.20
911	RUMENSIN 100	1.000	0.100	0.00	0.00
952	GREEN MICRO-GRITS	1.000	0.100	15,000.00	15.00
1065	TITANIUM DIOXIDE	1.000	0.100	0.00	0.00
	Formula Totals:	1,000.00		400.97	400.97
	Owning Cost ($/Tonne):	400.97			

Nutrient Composition - As Mixed: (All Nutrients)

Nutr	Nutrient Name	Amount	Units
1	VOLUME	0.999	%
2	[DRYMAT]	89.057	%
3	DE_PIG	13.093	MJ/KG
4	NE4G	9.694	MJ/KG
5	POULTRY NE	8.334	MJ/KG
6	DEENZYME	13.192	MJ/KG
7	DEACTUAL	13.284	MJ/KG
8	PROTEIN	12.414	%
9	FAT	2.721	%
10	STARCH	46.927	%
11	FIBRE	4.470	%
12	ASH	4.547	%
13	CALCIUM	0.705	%
14	T:PHOS	0.539	%
15	AV:PHOS	0.310	%
16	ENZAVPHOS	0.386	%
17	P:PHOS	0.351	%
18	LYSINE	0.809	%
19	ALYSINE	0.710	%
20	METHION	0.273	%
21	M+C	0.544	%
22	THREO	0.562	%
23	ISOLEUC	0.467	%
24	TRYPTO	0.181	%
25	CYSTINE	0.285	%
26	VALINE	0.685	%
27	HISTIDIN	0.338	%
28	LEUCINE	1.190	%
29	PHENYLAL	0.578	%
30	P+T	0.934	%
31	ARGININE	0.625	%
32	TYROSINE	0.370	%
33	T:EAA	5.084	%
34	ALANINE	0.562	%
35	ASPARTIC	0.640	%
36	GLYCINE	0.395	%
37	GLUTAMIC	1.757	%

38	SERINE	0.403	%
39	GLUTAMIN	1.572	%
40	PROLINE	0.684	%
41	OH_PROLI	0.133	%
42	ASPARAG	0.659	%
55	AMETH	0.238	%
56	AM+C	0.467	%
57	ATHREO	0.469	%
58	AISOLEUC	0.391	%
59	ATRYPTO	0.127	%
60	AVALINE	0.567	%
61	ACYSTINE	0.232	%
62	AP+T	0.791	%
63	APHENYL	0.488	%
64	ALEUCINE	1.049	%
65	AHISTID	0.293	%
66	AARGININ	0.502	%
67	SALT	0.298	%
69	ABC	583.88	MEQ/KG
70	SODIUM	0.100	%
71	POTASS	0.535	%
72	CHLORIDE	0.325	%
73	MAGNES	0.187	%
74	NA+K_CL	96.795	MEQ/KG
75	CHOLINE	915.39	MG/KG
77	N:D:F:	22.026	%
78	LINOLEIC	1.086	%
79	A:D:F:	7.894	%

Nutrient Ratios

Nutr	Nutrient Name	Units	Per	Nutr	Nutrient Name	Units	Ratio Amount
24	TRYPTO	%	1.00	18	LYSINE	%	0.22
23	ISOLEUC	%	1.00	18	LYSINE	%	0.58
22	THREO	%	1.00	18	LYSINE	%	0.69
21	M+C	%	1.00	18	LYSINE	%	0.67
20	METHION	%	1.00	18	LYSINE	%	0.34
19	ALYSINE	%	1.00	4	NE4G	MJ/KG	0.07
19	ALYSINE	%	10.00	3	DE_PIG	MJ/KG	0.54
26	VALINE	%	1.00	18	LYSINE	%	0.85
55	AMETH	%	1.00	19	ALYSINE	%	0.34
56	AM+C	%	1.00	19	ALYSINE	%	0.66
57	ATHREO	%	1.00	19	ALYSINE	%	0.66
58	AISOLEUC	%	1.00	19	ALYSINE	%	0.55
59	ATRYPTO	%	1.00	19	ALYSINE	%	0.18
13	CALCIUM	%	1.00	14	T:PHOS	%	1.31
13	CALCIUM	%	1.00	15	AV:PHOS	%	2.28

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Ingr Code	Ingredient Name	Kgs	Pct	Owning $/Tonne	$ Total
1	WHEAT 13%	52.000	5.200	430.00	22.36
12	BARLEY 10 %	275.050	27.505	375.00	103.14
50	SORGHUM 9.0%	196.000	19.600	290.00	56.84
110	LUPIN KERNELS 33%	120.000	12.000	550.00	66.00
200	MILLMIX	80.000	8.000	350.00	28.00
301	CANOLA MEAL 34%	110.000	11.000	490.00	53.90
325	SOYABEANMEAL-48%	58.000	5.800	680.00	39.44
395	PALM KERNEL MEAL	88.000	8.800	265.00	23.32
502	PHYZYME (PIG WHEAT MATRIX) 5000	0.100	0.010	15,000.00	1.50
503	PORZYME 9310	0.150	0.015	9,250.00	0.79
550	SALT	2.000	0.200	110.00	0.22
560	LIMESTONE	12.000	1.200	110.00	1.32
575	DICALPHOS	2.000	0.200	1,000.00	2.00
641	COPPER PROTEINATE MICRO	1.000	0.100	6,000.00	6.00
704	GROWER PMX	0.700	0.070	6,000.00	4.20
911	RUMENSIN 100	1.000	0.100	0.00	0.00
953	ORANGE MICRO-GRITS	1.000	0.100	15,000.00	15.00
1065	TITANIUM DIOXIDE	1.000	0.100	0.00	0.00
	Formula Totals:	1,000.00		424.03	424.03
	Owning Cost ($/Tonne):	424.03			

Nutrient Composition - As Mixed: (All Nutrients)

Nutr	Nutrient Name	Amount	Units
1	VOLUME	0.999	%
2	[DRYMAT]	89.912	%
3	DE_PIG	13.092	MJ/KG
4	NE4G	8.995	MJ/KG
5	POULTRY NE	5.894	MJ/KG
6	DEENZYME	13.103	MJ/KG
7	DEACTUAL	13.222	MJ/KG
8	PROTEIN	18.376	%
9	FAT	3.577	%
10	STARCH	31.560	%
11	FIBRE	6.070	%
12	ASH	5.167	%
13	CALCIUM	0.719	%
14	T:PHOS	0.520	%
15	AV:PHOS	0.302	%
16	ENZAVPHOS	0.354	%
17	P:PHOS	0.360	%
18	LYSINE	0.883	%
19	ALYSINE	0.706	%
20	METHION	0.275	%
21	M+C	0.648	%
22	THREO	0.706	%
23	ISOLEUC	0.769	%
24	TRYPTO	0.235	%
25	CYSTINE	0.373	%
26	VALINE	0.911	%
27	HISTIDIN	0.474	%
28	LEUCINE	1.459	%
29	PHENYLAL	0.826	%
30	P+T	1.505	%
31	ARGININE	1.255	%

Plant: 1 NORTHERN
Product: 2313 LOW NE 13.0 DE Version: 1

Nutrient Composition - As Mixed: (All Nutrients)

Nutr	Nutrient Name	Amount	Units
32	TYROSINE	0.610	%
33	T:EAA	5.737	%
34	ALANINE	0.516	%
35	ASPARTIC	0.816	%
36	GLYCINE	0.484	%
37	GLUTAMIC	1.863	%
38	SERINE	0.438	%
39	GLUTAMIN	1.229	%
40	PROLINE	0.657	%
41	OH_PROLI	0.069	%
42	ASPARAG	0.834	%
55	AMETH	0.214	%
56	AM+C	0.524	%
57	ATHREO	0.554	%
58	AISOLEUC	0.636	%
59	ATRYPTO	0.172	%
60	AVALINE	0.750	%
61	ACYSTINE	0.385	%
62	AP+T	1.189	%
63	APHENYL	0.676	%
64	ALEUCINE	1.231	%
65	AHISTID	0.389	%
66	AARGININ	1.024	%
67	SALT	0.291	%
68	%LEGUMES	12.000	%
69	ABC	641.34	MEQ/KG
70	SODIUM	0.094	%
71	POTASS	0.738	%
72	CHLORIDE	0.268	%
73	MAGNES	0.212	%
74	NA+K_CL	156.96	MEQ/KG
75	CHOLINE	1,830.95	MG/KG
77	N:D:F:	24.351	%
78	LINOLEIC	1.127	%
79	A:D:F:	11.793	%

Nutrient Ratios

Nutr	Nutrient Name	Units	Per	Nutr	Nutrient Name	Units	Ratio Amount
24	TRYPTO	%	1.00	18	LYSINE	%	0.27
23	ISOLEUC	%	1.00	18	LYSINE	%	0.87
22	THREO	%	1.00	18	LYSINE	%	0.80
21	M+C	%	1.00	18	LYSINE	%	0.73
20	METHION	%	1.00	18	LYSINE	%	0.31
19	ALYSINE	%	1.00	4	NE4G	MJ/KG	0.08
19	ALYSINE	%	10.00	3	DE_PIG	MJ/KG	0.54
26	VALINE	%	1.00	18	LYSINE	%	1.03
55	AMETH	%	1.00	19	ALYSINE	%	0.30
56	AM+C	%	1.00	19	ALYSINE	%	0.74
57	ATHREO	%	1.00	19	ALYSINE	%	0.78
58	AISOLEUC	%	1.00	19	ALYSINE	%	0.90
59	ATRYPTO	%	1.00	19	ALYSINE	%	0.24
13	CALCIUM	%	1.00	14	T:PHOS	%	1.38
13	CALCIUM	%	1.00	15	AV:PHOS	%	2.38