Appendix I. Typical Nutrient Composition of Selected Feed Ingredients

	Alfalfa Meal	Barley - Grain	Barley - Hulless	Beet Pulp	Blood Meal Spray Dried	Bone Meal
Energy, kcal/kg						
-Digestible	1850	3100	3250	3000	3050	--
-Metabolizable	1675	2960	3100	2850	2810	--
Proximate analysis, %						
-Crude protein	17.0	10.6	13.7	9.9	84.0	28.0
-Crude fibre	25.6	5.1	3.6	15.3	0.8	--
-Acid detergent fibre	29.2	7.1	1.2	17.7	--	--
-NDF	39.6	17.8	--	--	--	--
-Ash	9.5	2.4	--	--	4.4	--
-Ether extract	2.8	1.8	--	--	1.0	--
Total amino acids, %						
-Lysine	0.76	0.39	0.54	0.60	7.60	1.00
-Threonine	0.72	0.36	0.47	0.40	3.84	0.68
-Methionine	0.25	0.17	0.24	0.01	0.98	0.20
-T.S.A.A.	0.47	0.40	0.47	0.02	1.88	0.43
-Tryptophan	0.36	0.14	0.16	0.10	1.15	--
-Isoleucine	0.77	0.42	0.45	0.30	0.95	0.54
-Leucine	1.30	0.80	0.95	0.60	12.34	1.21
-Valine	0.93	0.58	0.62	0.40	7.66	1.03
-Phenylala nine	0.90	0.60	0.76	0.30	6.20	0.80
-Arginine	0.74	0.50	0.64	0.30	5.20	1.92
-Histidine	0.34	0.24	0.30	0.20	5.87	0.31
Apparent Ileal digestible amino acids, %						
-Lysine	0.36	0.27	--	--	6.38	0.77
-Threonine	0.34	0.23	--	--	3.11	0.51
-Methionine	0.16	0.13	--	--	0.76	0.16
-Cystine	0.05	0.17	--	--	0.67	0.09
-Tryptophan	0.19	0.10	--	--	0.92	--
-Isoleucine	0.42	0.31	--	--	0.63	0.41
-Valine	0.48	0.41	--	--	6.51	0.93
Macrominerals, %						
-Calcium	1.33	0.07	0.24	0.70	.40	30.00
-Phosphorus	0.23	0.35	0.37	0.08	.30	12.50
-Avail. phosphorus	0	0.11	--	--	--	--
-Magnesium	0.30	0.11	0.21	0.25	.15	0.30
-Potassium	2.27	0.55	--	1.00	.15	0.10
-Sodium	0.09	0.03	--	0.19	0.40	5.00
-Chloride	0.46	0.13	--	0.25	0.25	--
Microminerals, ppm						
-Iron	330	90	--	275	--	45
-Copper	10	7	9	13	--	10
-Zinc	21	24	--	1	--	12
-Manganese	37	20	44	35	--	5
-Selenium	0.6	0.2	--	0.04	--	--

	Buckwheat	Canola Meal	Canola Seed	Corn - Grain	Corn Distillers Grain	Corn Gluten Meal
Energy, kcal/kg						
-Digestible	3010	3100	4750	3550	3450	4150
-Metaboliz-able	2810	2900	4475	3360	3260	3840
Proximate analysis, %						
-Crude protein	11.2	37.7	20.7	8.5	27.6	60.0
-Crude fibre	13.3	11.8	7.0	2.2	12.0	3.1
-Acid detergent fibre	20.0	17.2	--	3.4	--	--
-NDF	--	--	--	12.0	--	--
-Ash	2.1	4.8	--	1.4	2.2	2.8
-Ether extract	2.5	3.5	--	3.6	9.0	2.4
Total amino acids, %						
-Lysine	0.64	2.16	1.20	0.26	0.79	1.03
-Threonine	0.42	1.65	1.01	0.31	0.91	2.05
-Methionine	0.21	0.75	0.40	0.19	0.35	1.60
-T.S.A.A.	0.40	1.79	0.85	0.37	0.80	2.80
-Tryptophan	0.18	0.46	0.27	0.06	0.17	0.35
-Isoleucine	0.39	1.55	0.89	0.32	0.98	2.40
-Leucine	0.63	2.64	1.65	1.04	2.50	10.04
-Valine	0.58	1.99	1.11	0.46	1.30	3.00
-Phenylala nine	0.49	1.49	0.90	0.40	1.45	3.80
-Arginine	0.95	2.26	1.43	0.45	0.95	1.89
-Histidine	0.28	1.34	0.62	0.21	0.60	1.39
Apparent Ileal digestible amino acids, %						
-Lysine	--	1.60	--	.17	--	--
-Threonine	--	1.12	--	.21	--	--
-Methionine	--	.59	--	.16	--	--
-Cystine	--	.78	--	.14	--	--
-Tryptophan	--	.29	--	.04	--	--
-Isoleucine	--	1.12	--	.25	--	--
-Valine	--	1.55	--	.36	--	--
Macrominerals, %						
-Calcium	0.08	0.63	0.39	0.02	0.12	0.06
-Phosphorus	0.32	1.01	0.64	0.25	0.65	0.38
-Avail. phosphorus	--	--	--	0.03	--	--
-Magnesium	0.10	0.51	0.38	0.11	0.15	0.07
-Potassium	0.45	1.22	0.73	0.30	0.43	0.24
-Sodium	0.05	--	--	0.01	0.40	0.07
-Chloride	0.05	--	--	0.04	0.18	0.06
Microminer-als, ppm						
-Iron	40	142	95	20	200	230
-Copper	9	6	4	3	50	15
-Zinc	9	69	37	15	55	30
-Manganese	34	49	22	4	23	8
-Selenium	--	1.1	0.6	0.05	0.35	0.8

	Fababeans	Feather Meal	Fish Meal-Herring[1]	Fish Meal-Menhaden[1]	Fish Meal-White[1]	Flaxseed Meal
Energy, kcal/kg						
-Digestible	3150	2250	3725	3700	3550	4550
-Metabolizable	2960	2070	2625	2930	2385	4250
Proximate analysis, %						
-Crude protein	26.7	85.0	71.0	61.2	63.8	25.3
-Crude fibre	7.8	1.4	0.8	0.9	0.5	9.5
-Acid detergent fibre	10.0	--	--	--	--	--
-NDF	--	--	--	--	--	--
-Ash	6.4	3.7	10.7	19.5	22.7	--
-Ether extract	1.2	2.5	9.4	9.9	5.4	--
Total amino acids, %						
-Lysine	1.62	1.67	5.82	4.82	4.34	1.20
-Threonine	0.90	3.63	3.09	2.49	2.71	1.10
-Methionine	0.19	0.47	2.19	1.80	1.76	0.44
-T.S.A.A.	0.45	4.13	2.91	2.42	2.41	0.80
-Tryptophan	0.26	0.49	0.77	0.69	0.67	0.40
-Isoleucine	0.98	3.79	3.12	2.77	2.81	1.20
-Leucine	1.83	6.20	5.41	4.94	4.57	1.80
-Valine	1.08	5.85	4.83	3.27	3.48	1.40
-Phenylala nine	1.04	3.60	2.81	2.42	2.75	1.60
-Arginine	2.29	5.90	5.26	3.65	3.97	3.00
-Histidine	0.60	0.47	1.83	1.48	1.62	0.70
Apparent Ileal digestible amino acids, %						
-Lysine	--	1.09	4.95	4.10	3.69	--
-Threonine	--	2.54	2.41	1.94	2.11	--
-Methionine	--	.30	1.80	1.48	1.44	--
-Cystine	--	2.64	0.46	0.40	0.42	--
-Tryptophan	--	0.29	0.58	0.52	0.50	--
-Isoleucine	--	2.99	2.53	2.24	2.28	--
-Valine	--	4.50	3.96	2.68	2.85	--
Macrominerals, %						
-Calcium	0.12	0.34	2.75	5.11	6.97	0.20
-Phosphorus	0.49	0.53	1.75	2.92	3.94	0.70
-Avail. phosphorus						
-Magnesium	0.13	0.13	0.18	0.14	0.20	0.40
-Potassium	1.08	0.20	1.22	0.72	1.01	0.80
-Sodium	0.08	0.35	0.81	0.45	1.13	0.05
-Chloride	--	0.23	0.83	0.55	2.00	0.04
Microminer-als, ppm						
-Iron	65	76	110	443	120	--
-Copper	4	7	5	11	5	12
-Zinc	42	72	135	150	80	--
-Manganese	12	15	7	35	18	--
-Selenium	--	0.90	2.0	2.1	1.5	0.4

[1] Published Ileal digestibilities for fish meal do not differentiate the source of the product. Variation is likely.

	Lentils	Meat Meal	Meat and Bone Meal	Molasses-Beet	Oats Grain	Oats Naked
Energy, kcal/kg						
-Digestible	3065	2850	2825	2475	2800	3600
-Metabolizable	2865	2585	2570	2350	2650	3420
Proximate analysis, %						
-Crude protein	24.6	55.0	50.0	7.1	10.8	13.2
-Crude fibre	3.9	1.3	2.7	0.0	11.0	3.6
-Acid detergent fibre	--	--	4.1	0.0	15.3	--
-NDF	--	--	--	--	--	--
-Ash	--	23.2	31.9	8.9	3.4	2.0
-Ether extract	--	10.1	8.4	0.0	4.2	8.7
Total amino acids, %						
-Lysine	1.63	2.99	2.70	--	0.40	0.50
-Threonine	0.81	1.85	1.65	--	0.35	0.40
-Methionine	0.18	0.79	0.70	--	0.20	0.20
-T.S.A.A.	0.51	1.40	1.20	--	0.40	0.54
-Tryptophan	0.25	0.35	0.30	--	0.14	0.15
-Isoleucine	0.88	1.85	1.75	--	0.42	0.50
-Leucine	1.64	3.45	3.20	--	0.78	1.00
-Valine	1.00	2.60	2.30	--	0.59	0.75
-Phenylalanine	1.09	1.85	1.75	--	0.59	0.68
-Arginine	1.79	3.70	3.50	--	0.80	0.89
-Histidine	0.56	1.10	1.05	--	0.20	0.27
Apparent Ileal digestible amino acids, %						
-Lysine	--	2.48	1.89	--	0.26	--
-Threonine	--	1.55	1.09	--	0.19	--
-Methionine	--	0.67	0.54	--	0.15	--
-Cystine	--	0.38	0.27	--	--	--
-Tryptophan	--	0.21	0.17	--	0.08	--
-Isoleucine	--	1.52	1.24	--	--	--
-Valine	--	2.13	1.66	--	--	--
Macrominerals, %						
-Calcium	0.08	8.10	9.50	0.10	0.10	0.12
-Phosphorus	0.33	3.63	4.70	0.02	0.35	0.40
-Avail. phosphorus						
-Magnesium	0.94	0.30	0.30	0.20	0.15	0.11
-Potassium	--	0.62	0.65	4.60	0.40	0.45
-Sodium	0.04	1.20	0.80	1.20	0.05	0.05
-Chloride	--	0.90	0.70	1.20	0.10	0.08
Macrominerals, ppm						
-Iron	88	450	500	70	75	75
-Copper	7	10	10	15	5	9
-Zinc	46	80	100	15	30	36
-Manganese	--	10	10	5	40	44
-Selenium	--	0.4	0.4	--	0.3	--

	Peas	Potatoes Dried	Poultry By-Product Meal	Rye Grain	Screenings #1 Feed	Screenings #1 Wheat
Energy, kcal/kg						
-Digestible	3400	3350	3250	3300	3100	3250
-Metabolizable	3175	3160	3020	3085	2930	3075
Proximate analysis, %						
-Crude protein	23.4	7.7	60.0	11.5	11.2	12.9
-Crude fibre	5.5	5.1	2.5	2.4	4.9	5.5
-Acid detergent fibre	8.2	--	--	--	5.9	4.4
-NDF	14.7	--	--	--	--	--
-Ash	3.3	3.3	17.0	1.6	--	--
-Ether extract	1.3	0.2	13.0	1.6	--	--
Total amino acids, %						
-Lysine	1.50	0.40	2.11	0.40	0.39	0.37
-Threonine	0.90	0.24	1.57	0.38	0.38	0.37
-Methionine	0.25	0.08	0.70	0.18	0.19	0.23
-T.S.A.A.	0.50	0.16	1.47	0.38	0.44	0.54
-Tryptophan	0.24	0.14	0.50	0.14	0.14	0.14
-Isoleucine	1.10	0.25	1.56	0.45	0.40	0.50
-Leucine	1.80	0.60	2.82	0.69	0.80	0.85
-Valine	1.15	0.35	1.97	0.55	0.58	0.53
-Phenylalanine	1.04	0.40	1.45	0.59	0.57	0.53
-Arginine	1.40	0.27	2.76	0.52	0.56	0.58
-Histidine	0.72	0.15	0.96	0.27	0.24	0.25
Apparent Ileal digestible amino acids, %						
-Lysine	1.25	--	--	0.26	--	--
-Threonine	0.62	--	--	0.23	--	--
-Methionine	0.19	--	--	0.13	--	--
-Cystine	0.15	--	--	0.14	--	--
-Tryptophan	0.16	--	--	--	--	--
-Isoleucine	0.86	--	--	0.29	--	--
-Valine	0.82	--	--	0.36	--	--
Macrominerals, %						
-Calcium	0.09	1.20	4.30	0.06	0.07	0.04
-Phosphorus	0.50	0.85	2.30	0.32	0.29	0.32
-Avail. phosphorus	0.15					
-Magnesium	0.13	0.13	0.39	0.12	0.11	0.13
-Potassium	1.01	1.70	0.40	0.45	0.64	0.30
-Sodium	0.04	1.85	0.82	0.02	0.03	0.02
-Chloride	0.05	1.50	0.54	0.03	0.15	0.05
Microminer-als, ppm						
-Iron	60	14	450	75	57	30
-Copper	9	45	14	6	7	6
-Zinc	28	3	120	32	24	36
-Manganese	23	4	11	57	21	29
-Selenium	0.4	0.06	--	0.03	0.2	0.1

	Skim Milk Powder	SBM-44%	SBM - 47%	Soybean Seeds, Raw	Sugar	Sunflower Meal - Dehulled
Energy, kcal/kg						
-Digestible	3850	3500	3675	4200	3800	3115
-Metabolizable	3565	3190	3350	3875	3610	2920
Proximate analysis, %						
-Crude protein	33.4	44.3	47.5	37.2	--	40.5
-Crude fibre	0.0	6.9	3.9	17.2	--	14.9
-Acid detergent fibre	--	8.3	7.4	8.0	--	--
-NDF	--	12.0	9.3	--	--	--
-Ash	8.0	6.4	6.5	4.0	--	6.8
-Ether extract	1.8	0.7	1.4	15.0	--	5.0
Total amino acids, %						
-Lysine	2.70	2.86	3.18	2.25	--	1.39
-Threonine	1.60	1.70	1.85	0.55	--	1.35
-Methionine	0.85	0.65	0.64	1.10	--	0.93
-T.S.A.A.	1.30	1.30	1.44	1.54	--	1.42
-Tryptophan	0.50	0.58	0.62	0.47	--	0.46
-Isoleucine	1.75	2.26	2.30	1.95	--	1.56
-Leucine	3.40	3.55	3.68	2.75	--	2.32
-Valine	2.25	2.17	2.69	1.85	--	1.88
-Phenylala nine	1.65	2.17	2.44	2.00	--	1.78
-Arginine	1.15	3.35	3.49	2.65	--	3.05
-Histidine	0.95	1.14	1.26	0.90	--	0.84
Apparent Ileal digestible amino acids, %						
-Lysine	2.43	2.40	2.70	--	--	1.03
-Threonine	1.31	1.29	1.44	--	--	0.97
-Methionine	0.73	0.55	0.54	--	--	0.81
-Cystine	0.36	0.48	0.62	--	--	0.36
-Tryptophan	--	0.46	0.50	--	--	0.35
-Isoleucine	1.49	1.85	1.91	--	--	1.22
-Valine	1.91	1.71	2.18	--	--	1.41
Macrominerals, %						
-Calcium	1.20	0.29	0.29	0.25	--	0.42
-Phosphorus	1.00	0.61	0.60	0.59	--	0.90
-Avail. phosphorus						
-Magnesium	0.12	0.26	0.30	0.21	--	0.70
-Potassium	1.55	1.90	2.10	1.70	--	1.10
-Sodium	0.55	0.04	0.01	0.02	--	0.20
-Chloride	0.95	0.03	0.03	0.02	--	0.20
Microminerals, ppm						
-Iron	15	140	125	80	--	30
-Copper	11	25	20	16	--	4
-Zinc	40	55	60	26	--	100
-Manganese	3	30	40	30	--	20
-Selenium	0.10	0.10	0.10	0.10	--	0.10

	Triticale	Wheat Grain HRS	Wheat Bran	Wheat Shorts	Whey Powder
Energy, kcal/kg					
-Digestible	3375	3425	2475	3140	3350
-Metabolizable	3150	3210	2310	2905	3150
Proximate analysis, %					
-Crude protein	13.6	13.5	15.5	17.5	14.0
-Crude fibre	2.5	2.7	10.5	7.5	0.0
-Acid detergent fibre	--	3.5	13.1	--	0.0
-NDF	--	10.8	35.0	--	--
-Ash	--	1.9	6.2	8.2	9.1
-Ether extract	1.5	1.8	3.6	4.2	0.7
Total amino acids, %					
-Lysine	0.40	0.40	0.59	0.70	0.95
-Threonine	0.43	0.40	0.49	0.54	0.77
-Methionine	0.19	0.24	0.19	0.23	0.19
-T.S.A.A.	0.44	0.57	0.49	0.50	0.46
-Tryptophan	0.14	0.16	0.27	0.23	0.21
-Isoleucine	0.53	0.53	0.55	0.60	0.83
-Leucine	0.82	0.89	0.92	1.02	1.23
-Valine	0.63	0.56	0.70	0.78	0.70
-Phenylalanine	0.65	0.56	0.57	0.66	0.40
-Arginine	0.71	0.61	1.04	0.98	0.40
-Histidine	0.35	0.26	0.32	0.40	0.22
Apparent Ileal digestible amino acids, %					
-Lysine	0.29	.29	0.32	0.50	0.77
-Threonine	0.28	.28	0.25	0.32	0.63
-Methionine	0.16	.20	0.14	0.18	0.17
-Cystine	0.21	.27	--	0.21	0.24
-Tryptophan	0.10	.13	0.16	0.18	0.17
-Isoleucine	0.42	.44	--	0.42	0.73
-Valine	0.49	.44	--	0.57	0.61
Macrominerals, %					
-Calcium	0.05	0.04	0.12	0.10	0.98
-Phosphorus	0.32	0.34	1.16	0.85	0.79
-Avail. phosphorus					
-Magnesium	0.12	0.14	0.53	0.27	0.13
-Potassium	0.47	0.32	1.23	0.90	1.62
-Sodium	0.03	0.02	0.05	0.03	1.57
-Chloride	0.03	0.05	0.05	0.04	1.50
Microminerals, ppm					
-Iron	30	31	150	85	140
-Copper	9	6	11	12	45
-Zinc	45	38	95	105	5
-Manganese	25	30	110	110	5
-Selenium	--	0.10	0.60	0.50	0.06

	Canola Oil	Lard	Poultry Grease	Soybean Oil	Tallow
Energy, kcal/kg					
-Digestible	8800	7850	8625	8800	8200
-Metabolizable	7300	7550	8200	7275	7900

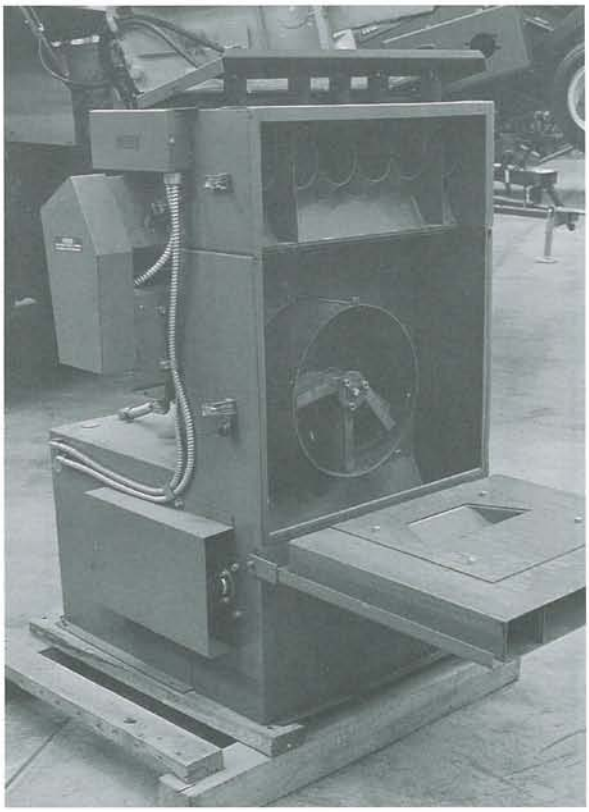
Disclaimer:Every attempt has been made to provide accurate information on each ingredient. Due to the nature of these materials, variability among samples will occur.

Appendix II. Calibrating Proportioner-type Mills

1. Ensure that the dial settings for the mill are correctly set for the diet being tested. Record the setting for each dial.

2. Remove the back housing cover from the mill to expose the proportioning augers and attach the testing tray. Place collecting containers below the tray to ensure accurate collection of each ingredient from each auger.

Photo III-1.



3. Turn on the mill and collect the ingredients until a reasonable amount is added to all containers. The more material that can be collected properly, the more accurate the test will be.

4. Weight the ingredients in each container and subtract the weight of the empty container. Be sure to use a small scale that can accurately weigh ingredients such as premixes and medications.

5. Complete the calculations. Add up the quantity of all ingredients to obtain the total. Divide the weight of each ingredient by the total weight to determine the proportion of each in the mix. If the proportions do not agree with the desired formula, reset the mill and repeat the procedure.

6. Once the expected formulation has been achieved on the mill, collect half a dozen samples the next time feed is mixed. Thoroughly mix the samples into a single sample and submit it to a laboratory for analysis. Refer to Chapter 5 for a recommended schedule for feed analysis.

Useful Conversion Factors

Length

To convert:	Multiply by:
Centimetres to inches	0.394
Inches to centimetres	2.540
Millimetres to inches	0.039
Inches to millimetres	25.40
Feet to metres	0.305
Metres to feet	3.281
Metres to inches	39.37
Inches to metres	0.254
Kilometres to miles	0.621
Miles to kilometres	1.609

Area

To convert:	Multiply by:
Square foot to square metre	0.093
Square metre to square foot	10.75
Acres to hectares	0.405
Hectares to acres	2.469

Volume

To convert:	Multiply by:
Millilitres to fluid ounces	0.033
Fluid ounces to millilitres	30.00
Litres to quarts	0.880
Quarts to litres	1.137
Gallons to litres	4.546
Litres to gallons	0.220
Litres to millilitres	1000

Miscellaneous

To convert:	Multiply by:
Calories to joules	4.184
Kilocalories to calories	1000
Megacalories to kilocalories	1000
Joules to calories	0.239
Percent to grams per kilogram	10.00
Grams per kilogram to percent	0.100
Gallons of water to pounds	10.00
Megajoules to kilocalories	239

Temperature

°F	°C	°F	°C
212	100.0		
106	41.1	55	12.8
104	40.0	50	10.0
102	38.9	45	7.2
100	37.8	40	4.4
98	36.7	35	1.7
96	35.6	30	-1.1
94	34.4	25	-3.9
92	33.3	20	-6.7
90	32.2	15	-9.4
88	31.1	10	-12.2
85	29.4	5	-15.0
80	26.7	0	-17.8
75	23.9	-5	-20.6
70	21.1	-10	-23.3
65	18.3	-15	-26.1
60	15.6		

Common Abreviations

Weights	
To convert:	**Multiply by:**
Grams to ounces	0.035
Ounces to grams	28.35
Kilograms to pounds	2.205
Pounds to kilograms	0.454
Micrograms to milligrams	0.001
Milligrams to grams	0.001
Kilograms to tonnes	0.001
Tonnes to kilograms	1000
Tonnes to tons	0.984
Tons to kilograms	1102
Tons to tonnes	1.016
Tons to pounds	2000
Parts/million to grams/tonne	1.000
Grams/kilogram to grams/tonne	1000
$/bushel to $/tonne	
(barley)	45.94
(wheat)	36.75
(oats)	61.25
(corn)	39.37
$/tonne to $/bushel	
(barley)	0.0218
(wheat)	0.0272
(oats)	0.0163
(corn)	0.0254

Length	
Kilometer	km
Meter	m
Centimeter	cm
Millimeter	mm
Mile	mi
Yard	yd
Foot	ft

Volume	
Litre	L
Millilitre	mL
Microlitre	mcL
Gallon	gal
Quart	qt

Mass	
Kilogram	kg
Gram	g
Milligram	mg
Pound	lb
Ounce	oz
Hundredweight	cwt
Tonne (metric)	T

Glossary

Abscess - Collection of pus formed by breakdown of tissues.

Absorption - The uptake of nutrients through the intestinal wall.

Acclimatization - The process of becoming accustomed to a new climate or other environmental conditions.

Acute - Having a short and severe course of development; opposite of chronic.

Adaptation - The adjustment of an animal to a new or changing environmental condition.

ADF (acid detergent fibre) - Fibre extracted with acidic detergent in a technique used in appraising the quality of forages.

ADG (average daily gain) - Rate of body weight gain, expressed on a 'per day' basis.

Adipose - Fat.

Ad lib feeding - See ad libitum.

Ad libitum - Self-feeding, or allowing swine to consume feed to appetite.

Agalactia - Absence of milk production by the sow.

Albumin - A water soluble plant (and animal) protein.

Aleurone - The protein portion of the endosperm of a seed.

Alfatoxin - Any carcinogenic mycotoxin produced by molds in stored agricultural crops.

Alkyl resorcinol - A colorless crystalline compound used in making dyes and pharmaceutical.

Amino acids - The building blocks of proteins; hundreds are known, but only about 20 are normally found in proteins.

Amylase - An enzyme that breaks down starches.

Anabolic - The process by which food is changed into living tissue. Building tissue; opposite of catabolic.

Anemia - A condition in which the blood is deficient in the amount of needed hemoglobin or in the number of red blood cells or in both.

Anion - An ion carrying a negative electric charge. Chloride is an anion.

Anorexia - Lack of loss of appetite.

Anti-nutritional factors - Factors that work against the nutritional value of a feedstuff.

Anti-oxidant - A substance that prevents fats from becoming rancid through oxidation.

APF (animal protein factor) - original name for vitamin B_{12}.

Apparent digestibility - The amount of a nutrient absorbed from the gut.

Arginine - An essential amino acid.

Arthritis - Inflammation of a joint and its adjacent tissues.

As fed - Refers to the nutrient composition of feedstuffs; including moisture normally present in the feed at the time it is fed; differs from dry matter basis, which defines nutrient concentration after all the water is removed.

Assay - The determination of the chemical composition of a feed or ingredient.

Ataxia - Lack of muscle coordination.

ATP - Adenosine triphosphate: a source of energy for the cell.

Atrophic rhinitis - Inflammation of the mucous membranes and turbinate bones of the nose, often resulting in distortion in shape or size.

Atrophy - Wasting away of cell or tissue.

Availability - That proportion of a nutrient that is available to the animal.

Available amino acids - The proportion of the total dietary amino acids that can be absorbed from the gut of the pig, and thus are actually used for growth and production.

Bacterin - A suspension of killed bacteria (vaccine) used to increase disease resistance.

Bacteria - Single celled living organism that multiplies by simple division; some are beneficial and others cause disease.

Barrow - A young castrated male pig.

Basal (energy) feeds - A group of grain and grain by-products containing not more than 16% CP and 18% CF.

Basal metabolism (BM) - The chemical changes that occur in the pig in the fasting and resting state, when it uses just enough energy to maintain basic metabolic activity.

Beta carotene - A source of vitamin A found in some plant and plant products.

Beta-glucan - A polysaccharide that interferes with digestion.

Bile salts - Compounds released from the gall bladder into the intestine which help emulsify and digest fats.

Bioassay - Using animals to evaluate feed quality.

Biopsy - The collection and analysis of tissue collected from alive animal.

Biotin - A vitamin found in high levels in liver, egg yolk and yeast.

Boar - Uncastrated male pig.

Bomb calorimeter - An apparatus for measuring the gross energy content of feed.

Bone meal (steamed) - Ground animal bones that are steamed under pressure. It can be used as a source of calcium and phosphorus.

Bran - The seed coat of cereal grains.

Brewer's grains - A by-product of the brewing industry.

Bushel - Eight-gallon measure.

Caecum (cecum) - A section of the large intestine in which bacterial action breaks down some fibre that escaped digestion i the small intestine.

Calciferol - Commonly known as vitamin D_2.

Calorie (cal) - A unit of energy measurement defined as the amount of heat required to raise the temperature of one gram of water from 14.5 to 15.5°C. Equivalent to 4.184 joules.

Calorimetry - Measurement of the amount of heat produced during normal metabolism.

Capillary - Small blood vessel delivering arterial blood to the tissues and venous blood from the tissues. Walls of the capillaries are in close contact with individual cells of the tissues.

Carbohydrates - A class of compounds in the feed, including starches, sugar, cellulose, and gums.

Casein - The major protein of milk.

Catabolism - A breakdown of tissues; opposite of anabolism.

Catalyst - A substance that increases the rate of a chemical reaction. Enzymes are catalysts. Catalysts are absolutely essential for the normal body processes.

Cathartic - A compound that acts as a laxative.

Cation - An ion carrying a positive electrical charge (i.e. sodium, potassium, and calcium).

Cecum, ceca - See caecume.

Cellulose - The carbohydrate constituent of plant cell walls that are resistant to normal digestive processes in the pig.

Chelating agent - A compound that can bind mineral ions to improve their utilization by the pig.

Cholecalciferol - Vitamin D_3.

Coenzyme - A substance, usually a vitamin or mineral, which works with an enzyme to help it catalyze (speed up) metabolic processes.

Colitis - An inflammation of the colon.

Colon - The lower portion of the large intestine.

Colostrum - The first milk, produced by the sow during the first few days of lactation; rich in fats and antibodies essential for piglet survival.

Comfort zone - The temperature range in which pigs will not expend energy to keep warm.

Complete feed - Provides all the nutrients required except water. A balanced diet.

Condition - Refers to the amount of flesh (fat) on the body; the general health of animals.

Congenital - Characteristics of the fetus acquired before birth, i.d. during the gestation period.

Connective tissue - Tough fibrous tissue that supports and connects tissues of an animal body.

Creatine phosphate - A storage form of energy for cell metabolism.

Critical temperature - Environmental temperature below which extra energy is required to maintain the pig's body temperature, and less energy is thus available for growth purposes.

Crude fibre (CF) - That portion of feedstuffs composed of cellulose, hemicellulose, lignin, and other complex carbohydrates.

Crude protein (CP) - An estimate of the protein in a feed. In calculating the protein percentage, the feed is first chemically analyzed for its nitrogen content. Since proteins average about 16% (1/6.25) nitrogen, the amount of nitrogen in the analysis is multiplied by 6.25 to give the CP percentage.

Crumbles - Pelleted feed reduced to granular form with corrugated rollers.

Cyanocobalamine - Vitamin B_{12}.

Cyst - A sac or bag-like structure, especially one that contains a liquid or semi-solid material.

Cystine - Amino acid that can replace up to one half of a pig's requirement for methionine.

Dermatitis - An inflammation of the skin.

Dextrose - Glucose.

Dicoumarol - A chemical compound found in spoiled sweet clover, which acts as an anticoagulant causing internal hemorrhages when eaten.

Digestibility - A measure of the extent to which a feed is digested and absorbed by the animal.

Digestible energy (DE) - Gross energy minus fecal energy; generally pertains to feeds.

Digestion - The processes which feed undergoes within the gastrointestinal tract to prepare it for absorption.

Diuresis - Increased urination.

DL-methionine - Synthetic source of methionine.

DNA - Deoxyribonucleic acid; also called the blueprint of life because it directs cells in the body to build proteins in certain ways.

Dressing percent - The portion of the carcass remaining after removal of most internal organs, feet, and in some cases the head.

Duodenum - The first portion of the small intestine.

Ear notches - Slits or perforations in an ear used for identification.

Eczema - Skin disease characterized by redness, itching, loss of hair, and the formation of scales.

Edema - Swelling due to accumulation of fluid.

EFA (essential fatty acid) - A fatty acid that cannot be synthesized in the body in sufficient quantities for the body's needs.

Electrolyte - Any charged article: an ion.

Electrolyte solution - A solution of simple sugars and minerals often used in the treatment of scours.

Endogenous - Internally produced in the body, such as hormones.

Endogenous proteins - Sloughed enterocytes together with enzymes.

Endosperm - Part of the seed which provides food for the developing embryo.

Endotoxins - Toxic substances stored inside bacterial cells.

Enteritis - Inflammation of the intestinal tract.

Enterotoxin - A toxin produced by microorganisms that disturbs the gastrointestinal tract.

Enzyme - Biological catalysts that increase the rate of chemical reactions.

Enzyme activator - A substance which the enzyme requires in order to be active.

Epidemiology - The study of relationships of various factors that interact to cause or prevent disease or other health related problems.

Ergocalciferol - Vitamin D_2.

Ergosterol - A plant sterol that (upon activation by ultraviolet rays) becomes vitamin D_2.

Ergot - Undesirable fungi found in rye.

Ergonovine - A toxic alkaloid found in ergot.

Ergotamine - A toxic alkaloid found in ergot.

Ergotoxine - A toxic alkaloid found in ergot.

Erythropoieses - The production of red blood cells. Occurs in bone marrow.

Esophagus - Structure extending from mouth to stomach.

Essential amino acid - An amino acid that cannot be synthesized in the body in sufficient quantities for the body's needs; therefore required in diet.

Estrogen - A female sex hormone; promotes estrus and stimulates the development of female secondary sex characteristics.

Estrus - Heat.

Estrous cycle - The recurring sexual cycle.

Ether extract - Substances in feeds which are soluble in ether. Used in feed analysis to estimate fat content of a feed.

Etiology - The study of the causes of diseases.

Exogenous - Produced or supplied from outside the body.

F_1 generation - First-generation progeny.

F_2 generation - The second generation resulting from the mating of F_1 individuals.

Fagopyrin - Photosensitizing agent found in buckwheat.

Fagopyrism - Buckwheat poisoning.

Farrow - To give birth.

Fat soluble vitamins - Vitamins A, D, E and K.

Fatty acid - A part of a fat molecule.

Feed conversion - Amount of feed used per unit of gain.

Folacin - Compounds derived from folic acid.

Gastric - Referring to the stomach.

Gastrointestinal - Referring to the stomach and intestines.

GE - Gross energy.

Gluconeogenesis - Formation of glucose.

Glutelin - A cereal protein.

Glycolysis - Degradation of simple sugars.

Goiter - Enlargement of the thyroid gland caused by iodine deficiency.

Gossypol - A toxic yellow pigment found in cottonseed.

GRAS - "Generally recognized as safe". Used by the USDA as related to feed or feed ingredients.

Gross energy (GE) - The amount of heat released when a substance is completely oxidized (burned).

Gut - The digestive tract.

Heat increment (HI) - Heat of nutrient metabolism. This heat may be used to keep the body warm.

Hemagglutinin - An antibody which causes red blood cells to stick together.

Hemicellulose - A simple cellulose.

Hemoglobin - A protein that imparts a red color in red blood cells.

Hepatic - Referring to the liver.

Histidine - The mechanisms by which animals maintain a constant internal environment.

Homeostasis - The mechanisms by which animals maintain a constant internal environment.

Hormone - A substance, secreted by one gland, which has an effect on other tissues.

HRS Wheat - Hard red spring wheat.

Hulls - Outer covering of seeds.

Hybrid vigor - Increased stamina or vitality of crossbred animals.

Hydrocephalus - Accumulation of fluid on brain.

Ileum - The lower portion of the small intestine.

Immunoglobulins - Proteins (also known as antibodies) that produce a state of immunity.

International units (IU) - An arbitrary scale, used to compare sources of vitamins.

Intestine - The portion of the gastrointestinal tract from the stomach to the anus.

Intrinsic factor - A substance secreted by the stomach which allows absorption of vitamin B_{12}.

In utero - Within the uterus.

In vitro - Outside the animal in an artificial environment such as a test tube.

in vivo - Within the living body.

Ion - Charged molecule.

Kcal (kilocalorie) - A unit of energy equal to 1000 calories.

Keratin - Protein that composes hair, horn, claws, and feathers.

Kjeldahl -0 A method of determining the quantity of crude protein based on the nitrogen content.

Lactose - A simple sugar found in milk.

Lesion - Change in the structure, color or size of a part of the body.

Lignin - A complex carbohydrate that is almost completely indigestible.

Linoleic acid - An essential fatty acid.

Lipase - An enzyme that breaks down fat.

Lipid - Fat.

Lucerne - Alfalfa.

Macro (or major) minerals - Minerals present or required in large amounts e.g., calcium, phosphorus, sodium, potassium, magnesium, and chloride.

Mastitis - An inflammation of the udder.

Megacalorie (Mcal) - Unit of energy equal to 10^6 joules.

Menadione - Vitamin K.

Metabolic body size - The weight of the animal raised to the 3/4 power ($W^{0.75}$).

Metabolism - The sum total of the chemical changes in the body, including building up (anabolism) and breaking down (catabolism).

Metabolizable energy (ME) - Gross energy minus fecal energy and urinary energy.

Metabolite - Substance produced by metabolism.

Microvilli - Projections from the villi.

Middlings - A by-product of flour milling containing endosperm, bran, and germ.

Mycotoxicosis - Poisoning due to fungal or bacterial toxin.

Mycotoxins - Toxic substances produced by molds.

Myrosinase - An enzyme found in rapeseed meal capable of breaking down glucosinolates.

National Research Council - See NRC.

NDF (neutral detergent fibre) - Fibre in the plant cell wall, which is undigested by swine. Developed to evaluate forages for ruminants.

Necropsy - Autopsy; postmortem examination.

Necrosis - Tissue death.

Neurotransmitter - A substance involved in the transmission of signals by the nervous system.

Niacin - A vitamin.

Nicotinamide - Niacin.

NFE (nitrogen-free extract) - An approximation of the carbohydrate content in feeds.

NPN - Non-protein nitrogen.

NRC - National Research Council. A division of the National Academy of Sciences promoting utilization of scientific and technical information.

Ochratoxin - A mycotoxin, produced by the mold *aspergillus*, which attacks the kidneys, reduces pig performance and may lead to birth defects.

Odd chain fatty acids - Those fatty acids with uneven chain lengths e.g. containing 7, 9 or 11 carbon atoms.

Osteogenesis - Formation of bone.

Osteomalacia - Softening of the bones.

Osteoporosis - Reduction in bone mass.

Pantothenic acid - Vitamin B^5.

Parakeratosis - Skin disease.

Parasite - An organism that lives at the expense of living animals.

Pepsin - A stomach enzyme which breaks up proteins.

Pepsinogen - Precursor to pepsin;. Secreted by the stomach.

pH - Measure of the acidity or alkalinity of a fluid. pH = 7 is neutral.

Phytin - A naturally occurring compound in many cereal grains containing phosphorus of low availability to the pig.

Pneumonia - Inflammation of the lung.

ppm - Parts per million.

Premix - Mixture of vitamins, trace minerals, and sometimes macrominerals.

Prolapse - Displacement of tissue from its normal position, most often the rectum or the uterus.

Proteolytic - Protein degrading.

Pyrodoxine - Vitamin B_6.

Renal - Pertaining to the kidney.

Retinol - Vitamin A.

Riboflavin - Vitamin B_2.

Ridgling - Any male whose testicles fail to descend; cryptorchid.

Screenings - Residual from the cleaning of grains.

Serotonin - A hormone and neurotransmitter.

Starch - A white, tasteless, odorless complex carbohydrate found in large quantities in potatoes, rice and wheat.

Tetany - A condition where muscles become rigid and have spasms.

Thiamine - Vitamin B_1.

Tocopherols - One of the compounds that make up Vitamin E.

Tocotrienols - One of the compounds that make up Vitamin E.

Total sulfur amino acids (TSAA) - Methionine plus cystine.

Tricothecene - A group of mycotoxins, including vomitoxin (deoxynivalenol), HT-2 toxin, T2 toxin and diacetoxyscirpenol, produced by the *fusarium* molds. They are very toxic compounds, causing vomiting, depressed growth and suppression of the immune system. The pig is especially sensitive.

Ulcer - Erosion or disintegration of tissues; often refers to stomach.

USDA - United States Department of Agriculture.

USP - United States Pharmacopeia.

VFA - Volatile fatty acids.

Villi - Finger-like projections on the surface of the gut.

Vitamin A - Retinol.

Vitamin B_1 - Thiamine.

Vitamin B_2 - Riboflavin.

Vitamin B_5 - Pantothenic acid.

Vitamin B_6 - Pyridoxine.

Vitamin B_{12} - Cyanocobalamine.

Vitamin C - Ascorbic acid.

Vitamin D_2 - Ergo-calciferol.

Vitamin D_3 - Cholecalciferol.

Vitamin E - Tocopherol plus tocotrienol.

Vitamin K - Menadione.

Volatile fatty acids - The short chain fatty acids such as those produced in the rumen of cattle and the cecume and colon of swine.

Zearalerone - Also called F2 toxin, is a mycotoxin produced by the *fusarium* molds.

Index

Authors

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Dr. Patience received his B.Sc.(Agr.), majoring in Animal Science and M.Sc. in Animal Science from the University of Guelph. Following employment in extension and in the feed industry, Dr. Patience returned to school, earning a Ph.D. in Nutritional Biochemistry from Cornell University in 1985. He was employed as a Visiting Fellow at the Animal Research Centre in Ottawa and, in 1987, joined the University of Saskatchewan as a Research Scientist and Director of the Prairie Swine Centre. When Prairie Swine Centre was incorporated in 1991, Dr. Patience was appointed its first President and Chief Executive Officer. His research interests include nutrition of the growing-finishing pig, dietary influences on acid-base balance and water quality and requirements.

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Dr. Thacker is currently a Professor in the Department of Animal and Poultry Science at the University of Saskatchewan where he teaches both graduate and undergraduate courses and conducts research in swine reproduction, enzyme utilization in swine diets and alternative feed ingredients. Dr. Thacker received his B.S.A. and M.Sc. from the University of British Columbia and a Ph.D. in Animal Nutrition from the University of Alberta. Prior to joining the University of Saskatchewan faculty, he was employed as an extension swine specialist with Alberta Agriculture.

C.F.M. (Kees) de Lange, Ph.D.

Dr. de Lange received his early education in the Netherlands where he was born. He earned his B.Sc. and M.Sc. in Animal Nutrition from Wageningen Agricultural University. In 1985, he enrolled at the University of Alberta where he earned a Ph.D. in Animal Nutrition. Following graduation, he was Research and Technical Service Manager for swine nutrition at Ralston Purina Canada. During this period, Dr. de Lange developed his keen interest in the development and application of growth models in swine production. In 1992, he joined the staff of the Prairie Swine Centre Inc. in Saskatoon. In 1994, he was appointed Assistant Professor of Swine Nutrition at the University of Guelph, where he continues his interest in growth models and conducts research in amino acid metabolism.