Study on the Kenyan Animal Feed and Fodder Sub-sectors

Quality Analysis of Animal Feedstuffs and Fodders in Kenya

(Sub-report V)

BLGG Research bv

BLGG RESEARCH

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SNV

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SUMMARY

This sub-study covers the quality analysis of animal feed and fodders in Kenya regarding their nutritional value and presence of contaminants. This report is made up of two parts; the first part (Chapter 2) describes the analysis of an animal feed database and the second part (Chapter 3 up to 8) covers the analysis results of approximately 130 feedstuffs and fodders in Kenya which were analysed as part of this study.

The animal feed database analysis, which is describes in Chapter 2, was provided by Dr. Makoni (ABS TCM Ltd.) and contained in total 78 dairy meals of feed manufacturers from Kenya which were analysed by Near-infrared spectroscopy (NIRS) on nutrient composition in 2011/2012.

The second part of this study covers the analysis results of approximately 130 feedstuffs and fodders in Kenya, including dairy meals and raw materials. All the raw materials and the dairy meals were analysed for their nutritional value by BLGG AgroXpertus (Wageningen, the Netherlands) using wet chemistry according to the ISO standards for each nutritional parameter. The nutritional value of the fodders were analysed by BLGG AgroXpertus using Near-infrared spectroscopy (NIRS).
Mycotoxins and pesticides were analysed by SiCa-AgriQ (Vicar, Spain) using LC-MS/MS and LC-MS/MS or GC-MS/MS, respectively. The heavy metals were analysed by BLGG Deutschland (Parchim, Germany) using inductively coupled plasma (ICP) and the presence of salmonella was analysed by CCL Nutricontrol (Veghel, the Netherlands).

The results of the nutritional analysis of both the dairy meal database from ABS and dairy meals analysed by BLGG as part of this study show a relative high variance in the different nutrients and that a high % of the dairy meals did not meet the KEBs standard for crude ash (± 50%) and crude protein (± 30%). For the raw materials wheat bran and wheat pollard it was shown that most samples met the KEBS standards for the different nutrients, except for dry matter, which can cause problems (moulds and/or mycotoxins) when stored for a longer period of time. The results for maize germ meal show that a high % of samples did not meet KEBS standard for dry matter (90%), crude ash (90%) and crude protein (70%). For both cottonseed cake and sunflower seed cake it was shown that 60% of the analysed samples did not meet the KEBS standard for crude fat, indicating an inefficient fat extraction. In addition, for sunflower seed cake 90% of the analysed samples did not meet the KEBS standard for crude fibre, indicating inefficient dehulling of the sunflower seeds. None of the examined fish meal samples meet the KEBS standards for ash and crude protein. The average crude ash and protein content of the fish meal samples were ±50% and ±40% where the KEBS standard stipulates a maximum ash content of 20% and a minimum of 60% for crude protein. This shows that the fish meal samples that were analysed are of very poor nutritional quality.

The analysis of the fodders show that the maize silages that were analysed are of relative good quality in terms of nutrition, except that starch content was generally low. This indicates that the maize silages might have been harvested too early, before the cob (kernels) were fully developed. The Boma Rhodes hay samples show a relative low protein and high crude fibre content, indicating that fertilization was not optimal (not enough nitrogen) or that the grass was cut too late (high stem to leaf ratio). Results of the Lucerne hay samples show that the fibre content is relatively low and that the protein, OM digestibility and the net energy content is relatively high.

This indicates that the Lucerne hay samples that were analysed are high quality fodders in terms of their nutritional composition.

The mycotoxin analysis revealed that for both dairy meals and maize germ cake/meals, 3 out of the 5 examined samples contained aflatoxins above the maximum level (KEBS; 10ppb) for dairy feedstuffs. On the contrary, none of the 10 examined maize silages contained mycotoxins above the maximum levels.

The presence of pesticides was examined in 10 dairy meals, 5 cottonseed meals and 5 sunflower seed meals which were randomly selected as part of this study. In the dairy meals that were investigated only a low amount of pesticides (just above the detection limit) were found. In the cottonseed meals only 2 very low pesticide residues were found in the sunflower seed meal no pesticide residue at all was found. These results indicate that pesticide residues are not a major issue in the animal feeds that were analysed as part of this study.

The presence of heavy metals was tested in 10 limestone, 7 fish meal and 2 bone meal samples which were randomly selected as part of this study. Out of the 10 limestone samples, 1 sample exceeded the maximum limit for lead and arsenic stipulated by the EU.
Seven fish meals and 2 bone meals were selected for testing on the presence of salmonella. In none of the analysed fish and bone meal samples salmonella was detected.

1. INTRODUCTION / BACKGROUND

The BLGG consortium was contracted by SNV Kenya to carry out an Animal Feed and Fodder study in the context of the Kenya Market-led Dairy Program (KMDP). The goal of this study was to identify the gaps/bottlenecks that hamper the development and growth of the Kenyan feed and fodder sub-sectors, and as a result the Kenyan dairy industry (for further details on the consortium and objectives of this study see sub-report I: “Summary Report”).

This comprehensive assignment was divided in a number of sub-studies which resulted in the sub-reports as listed below. This document is sub-report V.

Study on the Kenyan animal feed and fodder sub-sectors: Overview of the sub-reports

No	Title	Author
I	Summary report	BLGG Consortium
II	Kenya dairy sector structure	BLGG Research bv
III	Kenya feed industry policy and regulatory issues	ABS TCM Ltd
IV	Interviews and HACCP audits of Kenyan feed manufacturers	BLGG Kenya Ltd/ AgriQ Quest Ltd
V	**Quality analysis of animal feedstuffs and fodders in Kenya**	**BLGG Research bv**
VI	Trends in the Kenyan fodder sub-sector	Perfometer Solutions
VII	Trends in the Dutch fodder sub-sector	BLGG Research bv

This sub-study V covers the quality analysis of animal feed and fodders in Kenya regarding their nutritional value and presence of contaminants. This report is made up of two parts; the first part (Chapter 2) describes the analysis of an animal feed database and the second part (Chapter 3 up to 8) covers the analysis results of approximately 130 feedstuffs and fodders in Kenya which were analysed as part of this study.

The animal feed database analysis, which is describes in Chapter 2, was provided by Dr. Makoni (ABS TCM Ltd.) and contained in total 78 dairy meals of feed manufacturers from Kenya which were analysed by Near-infrared spectroscopy (NIRS) on nutrient composition in 2011/2012. The results were compared with the KEBS Standard for dairy meals (KS 62: 2009) and the variation was examined. The results are split up in high yield dairy meals (>20 ltr/day) and ordinary dairy meals (up to 20 ltr/day).

The second part of this study covers the analysis results of approximately 130 feedstuffs and fodders in Kenya. Table 1 on the next page gives an overview of the number and types of feedstuffs and fodders that were sampled and analysed for nutritional value and the presence of contaminants (mycotoxins, pesticides, heavy metals and salmonella). All the raw materials were sampled directly at the different feed manufacturers which were visited as part of this study. Of the 40 dairy meals, 29 dairy meals were sampled directly at the different feed manufacturers and 11 dairy meals were collected at different retail markets that were visited as part of this study. The animal fodders (maize silage, Boma hay and Lucerne hay) were sampled at several different farms (smallholder farms as well as large scale silage producers) that were visited as part of this study.

Table 1. Sampling scheme (amount and type) of animal feedstuffs and fodders for quality analysis (nutrition and contaminants) in this study.

		Contaminants			
	Nutritional value	**Myco-toxins**	**Pesti-cides**	**Heavy metals**	**Salmo-nella**
Wheat bran	10				
Wheat pollard	10				
Maize germ cake/meal	10	5			
Cotton seed cake/meal	10		5		
Sunflower cake/meal	10		5		
Fish meal	7			7	7
Bone meal	2			2	2
Limestone				10	
Total raw materials	**59**	**5**	**10**	**19**	**9**
Dairy meal (high yield)	23	1	6		
Dairy meal (ordinary)	17	4	4		
Total dairy meals	**40**	**5**	**10**		
Maize silage	20	10			
Boma Rhodes hay	6				
Lucerne hay	3				
Total fodder	**29**	**10**			
Total analysis	**128**	**20**	**20**	**19**	**9**

All the raw materials and the dairy meals were analysed for their nutritional value by BLGG AgroXpertus (Wageningen, the Netherlands) using wet chemistry according to the ISO standards for each nutritional parameter. The nutritional value of the fodders were analysed by BLGG AgroXpertus using Near-infrared spectroscopy (NIRS).

Mycotoxins and pesticides were analysed by SiCa-AgriQ (Vicar, Spain) using LC-MS/MS and LC-MS/MS or GC-MS/MS, respectively.

The heavy metals (lead, cadmium, mercury, arsenic, chromium, nickel, zinc and copper) were analysed by BLGG Deutschland (Parchim, Germany) using inductively coupled plasma (ICP).

The presence of salmonella was analysed by CCL Nutricontrol (Veghel, the Netherlands).

The results of all the analysis are presented including their variance. In addition, the results are compared with the KEBS standard.

In addition to the quality analysis of the Kenyan dairy meals, also the price of the dairy meals was recorded (chapter 8). This information was used to establish the price/quality ratio of the dairy meals which was compared with the price/quality ratio of dairy meals in other countries (international benchmark).

2. DATABASE ANALYSIS OF KENYAN DAIRY MEALS

As part of this study, an animal feed database was analysed regarding nutritional value and the variation therein. This database was provided by Dr. Makoni (ABS TCM Ltd.) and contained in total 78 dairy meals from Kenya which were analysed by ABS TCM using Near-infrared spectroscopy (NIRS) on nutrient composition in 2011/2012. The results were compared with the KEBS Standard for dairy meals (KS 62: 2009) and their variation was examined. The results are split up in high yield dairy meals (>20 ltr/day) and ordinary dairy meals (up to 20 ltr/day).

2.1 High yield dairy meals

The database that was used in this study contains 32 "High yield" dairy meals. The analysis results of these high yield dairy meals for their nutritional value are presented in Table 2.

- The average dry matter (DM) value of the 32 "high yield" dairy meals that were analysed is 90.53 % with a standard deviation of 2.02 and a coefficient of variation (CV) of 2.2 %. The KEBS Standard for DM requires a minimum of 88 % and 3 samples had a DM value below the KEBS Standard.
- The average ether extract (EE or crude fat) value of the analysed samples is 6.31 % with a standard deviation of 2.06 and a CV of 32.6 %. The KEBS Standard for EE is set at a maximum of 8 % and 7 samples had a EE value below the KEBS Standard.
- The average crude protein (CP) value of the dairy meals that were analysed is 18.30 % with a standard deviation of 2.04 and a CV of 11.2 %. The KEBS Standard for CP requires a minimum of 17 % and 9 samples had a CP value below the KEBS Standard.
- The average crude fibre (CF) value of the analysed samples is 8.70 % with a standard deviation of 2.52 and a CV of 29.0 %. The KEBS Standard for CF is set at a maximum of 12 % and 3 samples had a CF value below the KEBS Standard.
- The average (crude) ash value of the dairy meals that were analysed is 9.98 with a standard deviation of 2.49 and a CV of 24.9 %. The KEBS Standard for ash is set at a maximum of 10 % and 16 samples had a ash value below the KEBS Standard.
- The average metabolizable energy (ME) value of the analysed samples is 11.65 MJ/kg DM with a standard deviation of 0.72 and a CV of 6.2 %. The KEBS Standard for ME requires a minimum of 11.5 MJ/ kg DM and 5 samples had a ME value below the KEBS Standard.

Table 2. Nutritional value (DM=dry matter, EE=ether extract, CP= crude protein, CF=crude fibre, ME=metabolizable energy) of 32 dairy meals for high yielding dairy cows (>20ltr/day) in Kenya, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	EE (%)	CP (%)	CF (%)	Ash (%)	ME (MJ/kg)
005/0111	91.80	6.61	15.73	8.58	7.45	11.99
032/0111	92.08	8.68	15.71	8.17	10.07	12.02
072/0111	92.99	5.60	19.19	3.32	8.89	12.03
093/0111	90.88	5.13	19.54	9.04	10.48	12.20
097/0211	89.21	5.55	17.16	7.56	6.60	12.00
118/0211	92.72	10.02	17.47	9.04	11.51	11.93
159/0211	92.38	7.50	16.26	9.27	9.11	11.84
181/0311	93.92	10.81	15.12	14.07	15.83	10.05
199/0311	91.57	7.85	15.61	8.19	11.74	11.64
203/0311	92.33	7.98	17.76	10.84	12.41	11.29
262/0311	89.84	3.64	21.33	6.50	8.10	12.47
326/0411	91.36	6.60	15.53	11.04	12.71	9.17
466/0711	91.03	7.99	15.14	5.68	9.57	12.21
574/0911	87.52	4.08	20.74	5.70	10.82	11.25
713/1011	88.65	2.58	20.43	11.02	7.33	12.01
715/1011	88.70	7.20	17.49	12.66	12.54	11.98
769/1111	89.59	3.13	18.91	7.46	10.76	11.97
845/1111	90.25	5.46	19.69	8.88	14.59	10.69
079/0112	92.71	8.01	19.72	10.72	7.21	11.99
099/0212	85.87	4.01	19.42	5.72	12.48	11.03
100/0212	84.85	4.52	20.59	4.55	7.88	11.84
127/0212	89.49	4.47	18.55	5.67	7.42	11.84
273/0312	89.36	5.85	20.18	9.98	8.48	11.51
309/0312	88.80	4.13	19.13	5.43	5.27	12.09
336/0312	91.30	8.53	18.35	13.14	9.11	11.63
338/0312	92.14	8.26	17.64	9.01	9.05	11.97
346/0312	91.41	9.10	20.99	10.62	8.10	13.04
352/0312	91.01	5.49	20.31	9.19	11.56	11.08
407/0412	89.64	5.31	20.77	7.83	7.94	11.67
408/0412	90.85	4.98	20.14	10.23	10.07	11.11
449/0412	92.25	7.50	15.38	9.09	14.20	11.20
485/0512	90.33	5.40	15.64	10.13	10.13	12.05
Min	84.85	2.58	15.12	3.32	5.27	9.17
Max	93.92	10.81	21.33	14.07	15.83	13.04
Average	**90.53**	**6.31**	**18.30**	**8.70**	**9.98**	**11.65**
Standard deviation	2.02	2.06	2.04	2.52	2.49	0.72
Coefficient of Variation (%)	**2.2**	**32.6**	**11.2**	**29.0**	**24.9**	**6.2**
KEBS Standard Min	**88**	**-**	**17**	**-**	**-**	**11.5**
Max	**-**	**8**	**-**	**12**	**10**	**-**

From the analysis results of the 32 "high yield" dairy meals it can be concluded that the variation in nutrients is high, especially for crude fat, crude fibre and ash with a coefficient of variation of 32.6, 29.0 and 24.9, respectively. The variation in dry matter and metabolizable energy was relatively low, with a coefficient of variation of 2.2 and 6.2, respectively.
In addition to the high variation in nutrients, a relatively high number of "high yield" dairy meals did not meet the KEBS Standards regarding nutritional value. Figure 1 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

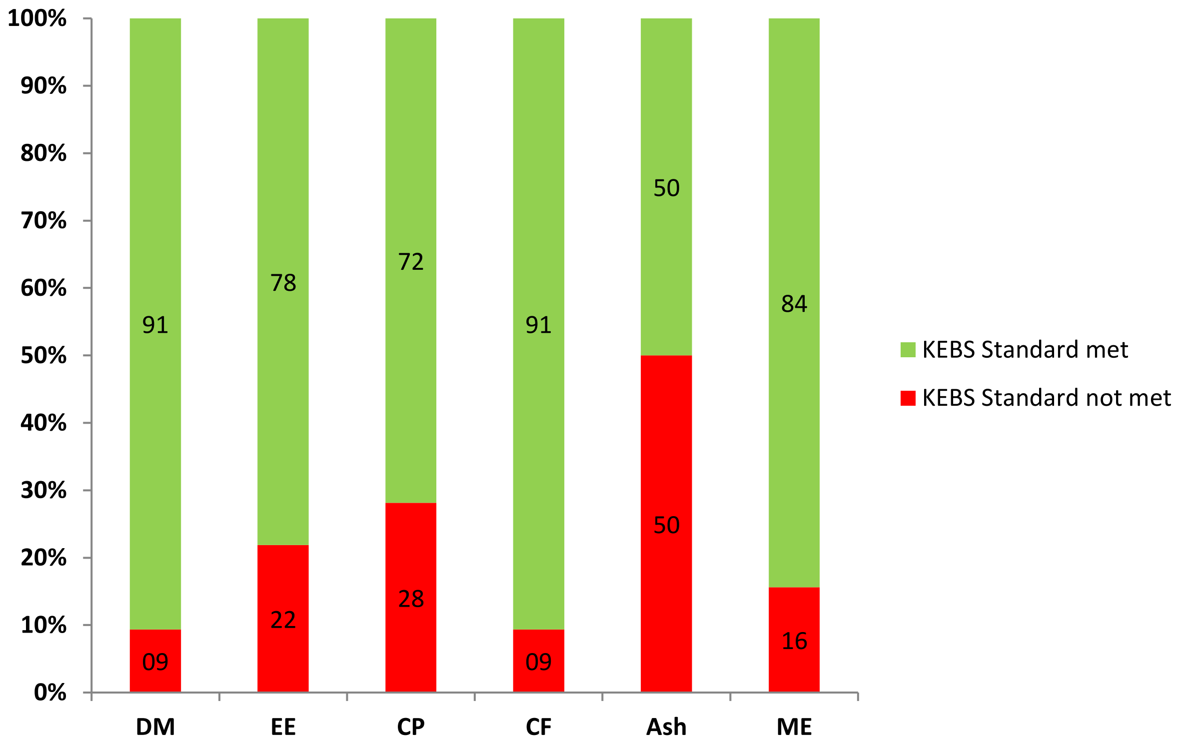

Figure 1. Percentage of the total (32) "high yield" dairy meals that did (not) meet the KEBS Standard for the nutrients that were analysed.

Especially for crude ash and crude protein a relative high number of dairy meals did not meet the KEBS Standard, 50 % and 28 %, respectively. Also for ether extract and metabolizable energy, a relative high number of dairy meals did not meet the KEBS Standard, 22 % and 16 %, respectively.

2.2 Ordinary dairy meals

The database that was used in this study contains 46 “Ordinary” dairy meals. The analysis results of these ordinary dairy meals for their nutritional value are presented in Table 3.

Table 3. Nutritional value (DM=dry matter, EE=ether extract, CP= crude protein, CF=crude fibre, ME=metabolizable energy) of 46 ordinary dairy meals for dairy cows (up to 20ltr/day) in Kenya, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	EE (%)	CP (%)	CF (%)	Ash (%)	ME (MJ/kg)
006/0111	91.52	6.17	13.34	10.64	9.22	11.53
031/0111	92.18	7.81	14.49	11.76	11.60	11.36
038/0111	92.43	7.29	15.85	10.75	7.61	11.89
052/0111	91.32	7.16	15.86	5.28	8.88	12.18
117/0211	92.39	9.46	15.33	8.94	11.42	11.90
145/0211	91.60	7.95	10.91	5.78	3.93	13.06
149/0211	91.57	9.95	12.26	4.82	11.37	12.42
182/0211	93.58	6.30	10.41	20.33	15.50	9.82
275/0211	91.97	4.59	12.72	10.08	11.20	12.05
297/0411	91.48	7.82	15.61	8.47	10.22	12.82
238/0411	91.44	5.47	16.46	8.03	9.35	11.57
343/0511	91.86	7.17	13.83	7.87	11.07	11.68
343/0511	91.86	7.17	13.83	7.87	11.07	11.68
351/0511	90.72	5.51	21.22	5.61	8.18	10.32
343/0511	91.86	7.17	13.83	7.87	11.07	11.68
392/0611	90.46	6.03	16.96	9.49	9.30	12.53
434/0611	92.52	9.40	11.49	11.91	17.10	9.52
465/0711	90.76	6.85	14.14	4.96	8.31	12.27
644/0911	87.50	2.14	15.48	5.27	6.58	11.66
653/0911	90.79	5.19	19.32	6.36	9.12	12.65
654/0911	90.42	6.86	16.17	7.70	10.81	12.73
673/1011	91.32	7.95	16.31	11.30	15.44	11.85
712/1011	88.91	2.66	18.91	12.94	8.51	11.72
786/1111	90.91	7.98	16.37	9.93	13.28	11.28
794/1111	89.82	6.46	14.00	6.57	8.94	12.98
802/1111	89.61	5.57	16.90	8.02	9.68	11.53
571/1211	90.98	6.90	14.67	10.77	10.10	11.50
570/1211	91.30	6.67	14.15	10.10	9.79	11.57
592/1211	90.43	5.48	14.11	9.15	7.91	11.75
598/1211	89.96	5.09	14.37	6.87	7.86	11.86
060/0112	93.22	7.43	12.72	11.78	11.82	11.29
063/0112	91.14	7.13	13.19	10.83	10.77	11.47
074/0112	89.33	4.82	14.32	7.61	6.53	11.94
082/0112	93.27	7.09	14.72	12.21	9.82	11.44
112/0212	90.77	7.39	14.22	10.91	8.13	11.85
155/0212	89.58	5.58	19.86	7.98	10.10	12.42
176/0212	91.37	6.16	16.25	7.99	8.38	11.83
528/0312	89.56	3.71	15.88	12.10	7.51	11.17
287/0312	90.99	5.15	14.52	8.01	7.19	12.86

Sample no	DM (%)	EE (%)	CP (%)	CF (%)	Ash (%)	ME (MJ/kg)
323/0312	91.45	8.12	14.47	5.76	6.57	12.65
343/0312	89.61	6.74	12.07	4.12	8.14	12.39
366/0412	93.04	4.60	15.74	16.52	12.18	10.28
432/0412	90.91	3.60	15.63	6.38	7.08	12.73
430/0412	95.01	10.07	9.47	8.78	17.77	11.25
482/0412	90.89	5.83	11.93	13.16	11.66	11.94
517/0512	90.04	7.45	15.16	7.10	9.39	12.02
Min	87.50	2.14	9.47	4.12	3.93	9.52
Max	95.01	10.07	21.22	20.33	17.77	13.06
Average	**91.17**	**6.50**	**14.77**	**9.06**	**9.94**	**11.80**
Standard deviation	1.34	1.71	2.34	3.14	2.74	0.76
Coefficient of Variation (%)	**1.5**	**26.3**	**15.8**	**34.7**	**27.5**	**6.5**
KEBS Standard Min	**88**	**-**	**14**	**-**	**-**	**11.5**
Max	**-**	**8**	**-**	**12**	**10**	**-**

- The average dry matter (DM) value of the 46 “ordinary” dairy meals that were analysed is 91.17 % with a standard deviation of 1.34 and a coefficient of variation (CV) of 1.5 %. The KEBS Standard for DM requires a minimum of 88 % and 1 sample had a DM value below the KEBS Standard.
- The average ether extract (EE or crude fat) value of the analysed samples is 6.50 % with a standard deviation of 1.71 and a CV of 26.3 %. The KEBS Standard for EE is set at a maximum of 8 % and 5 samples had a EE value below the KEBS Standard.
- The average crude protein (CP) value of the dairy meals that were analysed is 14.77 % with a standard deviation of 2.34 and a CV of 15.8 %. The KEBS Standard for CP requires a minimum of 14 % and 14 samples had a CP value below the KEBS Standard.
- The average crude fibre (CF) value of the analysed samples is 9.06 % with a standard deviation of 3.14 and a CV of 34.7 %. The KEBS Standard for CF is set at a maximum of 12 % and 6 samples had a CF value below the KEBS Standard.
- The average (crude) ash value of the dairy meals that were analysed is 9.94 with a standard deviation of 2.74 and a CV of 27.5 %. The KEBS Standard for ash is set at a maximum of 10 % and 20 samples had a ash value below the KEBS Standard.
- The average metabolizable energy (ME) value of the analysed samples is 11.80 MJ/kg DM with a standard deviation of 0.76 and a CV of 6.5 %. The KEBS Standard for ME requires a minimum of 11.5 MJ/ kg DM and 10 samples had a ME value below the KEBS Standard.

From the analysis results of the 46 "ordinary" dairy meals it can be concluded that the variation in nutrients is high, especially for crude fibre, ash and crude fat with a coefficient of variation of 34.7, 27.5 and 26.3, respectively. The variation in dry matter and metabolizable energy was relatively low, with a coefficient of variation of 1.5 and 6.5, respectively.

In addition to the high variation in nutrients, a relatively high number of "ordinary" dairy meals did not meet the KEBS Standards regarding nutritional value. Figure 2 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

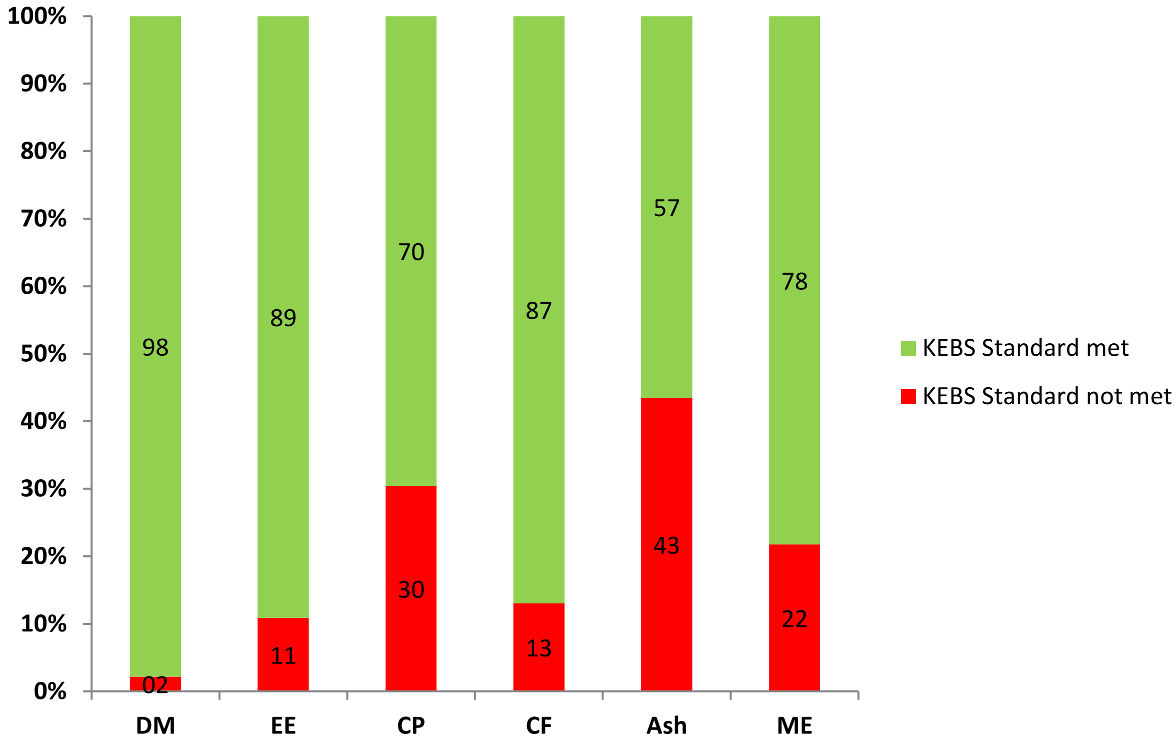

Figure 2. Percentage of the total (46) "ordinary" dairy meals that did (not) meet the KEBS Standard for the nutrients that were analysed.

3. NUTRITIONAL COMPOSITION OF DAIRY FEEDS AND INGREDIENTS

3.1 Dairy meals

As part of this study, in total 40 Kenyan dairy meals were analysed for their nutritional composition. All the analyses were carried out by BLGG AgroXpertus (Wageningen, the Netherlands) using wet chemistry according to the ISO standards for each nutritional parameter. The 40 dairy meals were divided in the following groups: 16 "ordinary" dairy meals (up to 20ltr/day) and 23 "high yield" dairy meals (> 20ltr/day). In addition, one dairy meal which was composed (mixed) by the retail market was also analysed.

3.1.1 Ordinary dairy meals

The results of the nutritive analyses of the 16 ordinary dairy meals are presented in Table 4.

Table 4. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 16 "ordinary" dairy meals for dairy cows (up to 20ltr/day) in Kenya, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991074	90.0	14.6	17.2	16.8	4.5	16.7	5.0	38.0	18.7	5.1
991188	90.0	15.8	13.3	14.2	6.8	23.6	4.0	30.5	15.9	4.1
991079	87.8	8.8	17.5	11.2	6.7	21.0	5.9	34.0	13.6	3.5
991086	88.1	11.5	16.8	11.3	5.3	25.8	5.3	26.9	15.3	0.9
991089	88.1	13.2	14.8	12.0	7.0	22.8	5.2	31.7	14.6	3.5
991094	88.7	17.9	9.2	19.4	5.3	23.0	3.7	37.0	21.1	5.9
991096	87.8	11.7	13.0	9.6	7.2	25.9	5.9	30.1	12.0	2.9
991102	88.6	12.5	13.3	20.5	4.2	20.3	3.3	40.4	24.4	6.8
991105	87.9	19.4	15.7	9.4	6.8	21.5	4.8	24.7	11.2	3.1
991109	85.6	9.0	16.8	13.3	7.3	19.4	6.5	34.4	16.9	4.5
991168	89.4	12.4	14.3	16.9	9.1	19.9	4.3	32.0	18.0	4.5
991169	89.6	9.6	15.6	14.1	7.5	22.4	5.3	34.2	16.3	4.0
991171	89.5	7.0	17.9	10.8	7.4	22.0	6.0	35.1	14.0	3.2
991182	87.1	8.4	16.7	10.6	5.4	28.6	5.8	30.0	12.5	3.1
991187	89.1	7.8	18.7	10.9	5.2	23.0	5.4	32.5	14.5	4.4
991190	88.1	9.4	16.8	12.1	4.8	22.3	7.8	34.5	12.3	3.1
Min	85.6	7.0	9.2	9.4	4.2	16.7	3.3	24.7	11.2	0.9
Max	90.0	19.4	18.7	20.5	9.1	28.6	7.8	40.4	24.4	6.8
Average	**88.5**	**11.8**	**15.5**	**13.3**	**6.3**	**22.4**	**5.3**	**32.9**	**15.7**	**3.9**
Standard dev.	1.2	3.6	2.4	3.4	1.4	2.8	1.1	4.0	3.5	1.4
CV (%)	**1.3**	**30.9**	**15.6**	**25.7**	**21.5**	**12.6**	**21.2**	**12.1**	**22.5**	**34.7**
KEBS min	**88**	**-**	**14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**10**	**-**	**12**	**8**	**-**	**-**	**-**	**-**	**-**

From the nutritional analysis of the 16 "ordinary" dairy meals it can be concluded that the variation in nutrients is high, especially for ash, crude fibre and crude fat (ether extract) with a coefficient of variation of 30.9, 25.7 and 21.5, respectively. The variation in dry matter was relatively low, with a coefficient of variation of 1.3.

In addition to the high variation in nutrients, a relatively high number of "ordinary" dairy meals did not meet the KEBS Standards regarding nutritional value. Figure 3 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

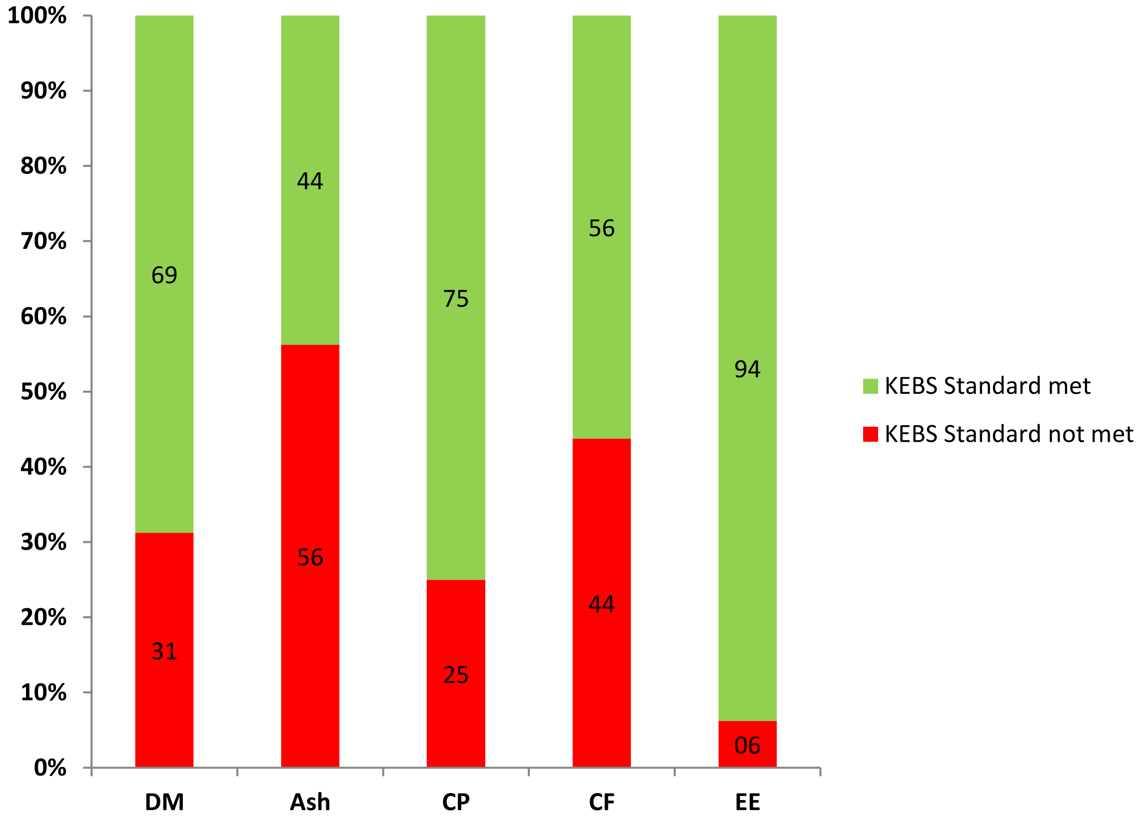

Figure 3. Percentage of the total (16) "ordinary" dairy meals that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially ash and CF show high variation and around half of the analysed dairy meals do not meet the KEBS standard (ash: 56% and CF: 44%). Also for DM and CP a relative high percentage did not meet the KEBS standard (31% and 25%, respectively).

3.1.2 High yield dairy meals

The results of the nutritive analyses of the 23 high yield dairy meals are presented in Table 5.

Table 5. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 23 "high yield" dairy meals for dairy cows (> 20ltr/day) in Kenya, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991111	86.2	7.8	13.3	7.3	7.2	43.0	3.2	22.6	10.1	2.5
991070	88.4	9.0	17.9	8.4	11.1	25.1	4.6	26.2	10.5	2.9
991076	89.1	13.3	16.7	16.5	4.4	20.4	4.4	35.8	19.6	5.7
991083	89.0	11.8	18.5	13.9	8.9	16.4	4.0	37.3	16.1	4.4
991195	90.5	15.6	17.5	11.8	9.6	18.2	3.6	31.4	12.6	3.3
991087	87.6	10.3	20.8	12.9	5.3	26.6	4.7	27.6	15.7	4.3
991185	89.6	14.2	17.3	11.5	3.7	26.6	4.0	29.8	13.5	3.7
991088	88.7	11.4	18.4	12.1	7.4	19.6	6.2	28.8	14.2	3.5
991093	87.3	12.1	16.7	10.7	3.7	23.4	7.0	30.5	13.2	3.1
991095	88.7	13.9	18.1	11.0	4.3	19.2	5.7	32.4	13.6	2.9
991186	90.2	12.7	14.7	12.2	3.6	24.4	6.4	30.8	13.7	3.4
991101	88.0	5.0	15.2	10.2	6.1	34.7	4.0	29.4	13.0	3.9
991104	87.6	16.5	15.6	9.6	7.6	23.1	4.9	25.8	11.2	3.1
991167	89.9	12.4	14.0	14.3	8.9	24.8	3.8	30.3	16.4	4.3
991170	88.9	10.7	14.5	12.6	7.6	27.1	4.3	30.6	14.5	3.4
991172	89.7	7.2	18.3	10.8	7.9	25.0	5.1	31.9	13.8	3.3
991184	89.8	7.0	18.1	10.4	7.7	25.3	5.4	30.8	13.3	3.2
991193	89.4	6.2	18.4	11.1	7.5	25.8	4.9	31.2	13.7	3.5
991183	87.3	7.5	17.7	10.9	6.6	26.3	6.4	31.0	13.1	3.0
991189	87.7	10.2	20.4	12.9	7.1	15.7	9.6	33.3	13.4	3.3
991191	88.2	10.1	21.7	10.7	7.1	14.8	8.5	32.6	12.6	3.1
991192	90.2	14.7	17.2	13.4	7.4	19.8	4.0	29.8	15.8	4.2
991196	89.2	8.7	14.9	12.0	7.9	28.2	4.7	31.4	13.2	2.7
Min	86.2	5.0	13.3	7.3	3.6	14.8	3.2	22.6	10.1	2.5
Max	90.5	16.5	21.7	16.5	11.1	43.0	9.6	37.3	19.6	5.7
Average	**88.7**	**10.8**	**17.2**	**11.6**	**6.9**	**24.1**	**5.2**	**30.5**	**13.8**	**3.5**
Standard dev.	1.1	3.1	2.2	2.0	2.0	6.2	1.6	3.1	2.0	0.7
CV (%)	**1.3**	**29.2**	**12.6**	**16.9**	**28.5**	**25.8**	**30.3**	**10.2**	**14.7**	**20.1**
KEBS min	**88**	-	**17**	-	-	-	-	-	-	-
KEBS max	-	**10**	-	**12**	**8**	-	-	-	-	-

From the nutritional analysis of the 23 "high yield" dairy meals it can be concluded that the variation in nutrients is high, especially for ash, crude fat (ether extract) and crude fibre with a coefficient of variation of 29.2, 28.5 and 16.9, respectively. The variation in dry matter was relatively low, with a coefficient of variation of 1.3.

In addition to the high variation in nutrients, a relatively high number of "high yield" dairy meals did not meet the KEBS Standards regarding nutritional value. Figure 4 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

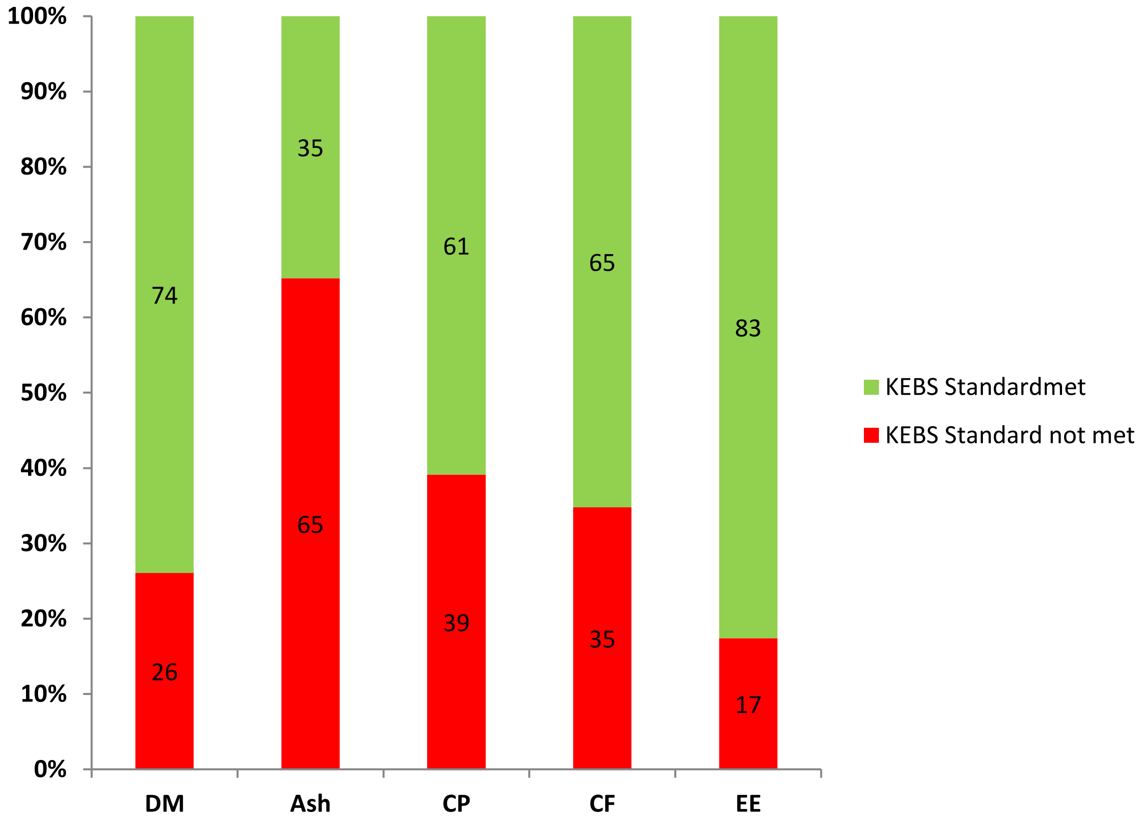

Figure 4. Percentage of the total (23) "high yield" dairy meals that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially ash and EE show high variation and that a high percentage of the analysed dairy meals do not meet the KEBS standard (ash: 65%, CP: 39% and CF: 35%). Also for DM a quarter of the samples (26%) did not meet the KEBS standard.

3.1.3 Retail market composed dairy meal

In Kenya it also customary that dairy meal is composed at the retail market. Different raw materials are mixed together on the spot to create a dairy meal which is usually cheaper than the pre-manufactured dairy meals. Table 6 shows the results of the nutritive analyses of one retail market composed dairy meal.

Table 6. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of a retail market composed dairy meal, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991194	93.5	45.5	14.1	11.3	3.8	8.2	3.2	22.2	14.2	2.3
KEBS min	**88**	**-**	**14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**10**	**-**	**12**	**8**	**-**	**-**	**-**	**-**	**-**

Since only one dairy meal which was composed at the retail market was analysed, nothing can be concluded on variation or trends of the different nutrients. Remarkably, the ash content of this sample was very high with almost half the sample (45.5%) consisting of ash.

3.2 Raw materials

The following raw materials were analysed for their nutritional composition: wheat bran (10), wheat pollard (10), maize germ cake/meal (10), cottonseed cake/meal (10), sunflower cake/meal (10), fish meal (7) and bone meal (2). The result are shown in the following sub-chapters.

3.2.1 Wheat bran

Wheat bran is widely used as ingredient for dairy meals in Kenya. In this study we analysed 10 wheat bran samples from different feed manufacturers and the results are presented in Table 7.

Table 7. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 10 wheat bran samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991112	88.5	6.3	15.7	13.1	3.8	14.0	6.6	50.4	16.9	4.0
991071	88.1	6.2	16.6	13.7	4.2	15.2	6.0	48.2	16.0	4.1
991077	87.0	6.1	17.7	12.1	4.1	19.1	5.4	43.9	14.7	3.8
991080	86.9	6.3	18.3	11.7	3.6	18.1	6.7	44.3	13.8	3.7
991084	87.3	5.8	18.9	10.5	3.9	22.0	6.2	41.2	13.4	3.2
991092	86.9	5.6	18.9	11.4	3.8	15.6	6.7	46.0	14.6	3.7
991099	86.2	5.2	17.9	10.4	3.7	22.6	6.8	39.1	12.9	3.5
991108	84.6	4.9	15.5	10.8	3.0	26.7	5.7	40.4	13.6	2.9
991175	87.3	4.8	16.7	10.8	4.2	22.4	6.6	42.4	14.1	3.3
991176	88.7	5.0	17.1	10.7	4.0	19.5	7.5	42.0	14.1	3.4
Min	84.6	4.8	15.5	10.4	3.0	14.0	5.4	39.1	12.9	2.9
Max	88.7	6.3	18.9	13.7	4.2	26.7	7.5	50.4	16.9	4.1
Average	**87.2**	**5.6**	**17.3**	**11.5**	**3.8**	**19.5**	**6.4**	**43.8**	**14.4**	**3.6**
Standard dev.	1.2	0.6	1.2	1.1	0.4	4.0	0.6	3.6	1.2	0.4
CV (%)	**1.4**	**10.7**	**7.0**	**9.9**	**9.3**	**20.4**	**9.5**	**8.1**	**8.5**	**10.4**
KEBS min	**88**	**-**	**13.5**	**-**	**2.5**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**10**	**-**	**12**	**-**	**-**	**-**	**-**	**-**	**-**

From the nutritional analysis of the 10 wheat bran samples it can be concluded that the variation in nutrients is relatively high, especially for starch with a coefficient of variation of 20.4. The variation in dry matter was relatively low, with a coefficient of variation of 1.4.

In addition to the high variation in nutrients, a relatively high number of wheat bran samples did not meet the KEBS Standards regarding nutritional value. Figure 5 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

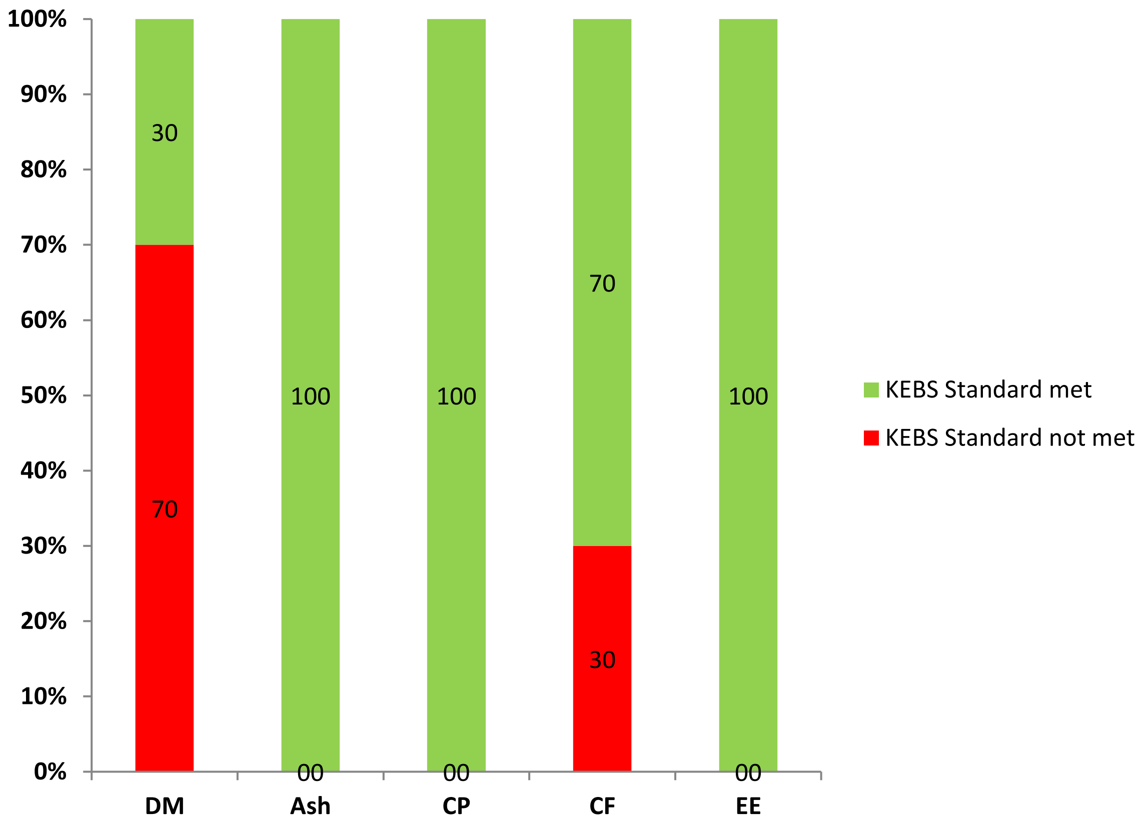

Figure 5. Percentage of the total (10) wheat bran samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially starch shows high variation and that a high percentage of the analysed wheat bran samples do not meet the KEBS standard (DM: 70% and CF: 30%).

3.2.2 Wheat pollard

Wheat pollard is widely used as ingredient for dairy meals in Kenya. In this study we analysed 10 wheat pollard samples from different feed manufacturers and the results are presented in Table 8.

Table 8. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 10 wheat pollard samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991110	90.0	12.2	13.4	16.9	6.3	15.3	5.2	41.9	21.3	5.9
991113	84.3	1.8	13.5	2.9	2.2	59.9	4.1	14.2	4.1	0.9
991072	87.8	4.2	17.0	8.4	5.3	25.8	7.9	33.9	10.1	2.9
991078	88.5	6.0	17.7	10.8	4.7	19.1	6.8	40.9	13.7	3.6
991082	88.3	3.7	16.7	7.5	4.3	30.5	7.2	31.4	10.3	2.5
991091	88.1	4.4	18.1	8.7	4.3	19.6	8.5	39.0	12.1	3.3
991097	86.9	2.8	15.8	4.5	3.2	46.7	6.0	21.1	5.8	1.8
991107	85.2	2.7	15.0	4.5	3.5	49.5	5.1	21.9	5.9	1.4
991173	88.9	3.1	16.3	6.0	3.7	41.0	6.3	27.1	8.4	2.1
991174	89.1	3.2	16.5	6.3	4.0	37.3	7.0	27.8	8.9	2.4
Min	84.3	1.8	13.4	2.9	2.2	15.3	4.1	14.2	4.1	0.9
Max	90.0	12.2	18.1	16.9	6.3	59.9	8.5	41.9	21.3	5.9
Average	**87.7**	**4.4**	**16.0**	**7.7**	**4.2**	**34.5**	**6.4**	**29.9**	**10.1**	**2.7**
Standard dev.	1.8	3.0	1.6	4.0	1.1	14.9	1.4	9.2	4.9	1.4
CV (%)	**2.0**	**67.3**	**10.0**	**52.3**	**27.4**	**43.1**	**21.1**	**30.8**	**49.0**	**52.3**
KEBS min	**88**	**-**	**13.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**10**	**-**	**12**	**-**	**-**	**-**	**-**	**-**	**-**

From the nutritional analysis of the 10 wheat pollard samples it can be concluded that the variation in nutrients is relatively high, especially for ash, CF, ADF and starch with a coefficient of variation of 67.3, 52.3, 49.0 and 43.1 respectively. The variation in dry matter was relatively low, with a coefficient of variation of 2.0.

In addition to the high variation in nutrients, some wheat pollard samples did not meet the KEBS Standards regarding nutritional value. Figure 6 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

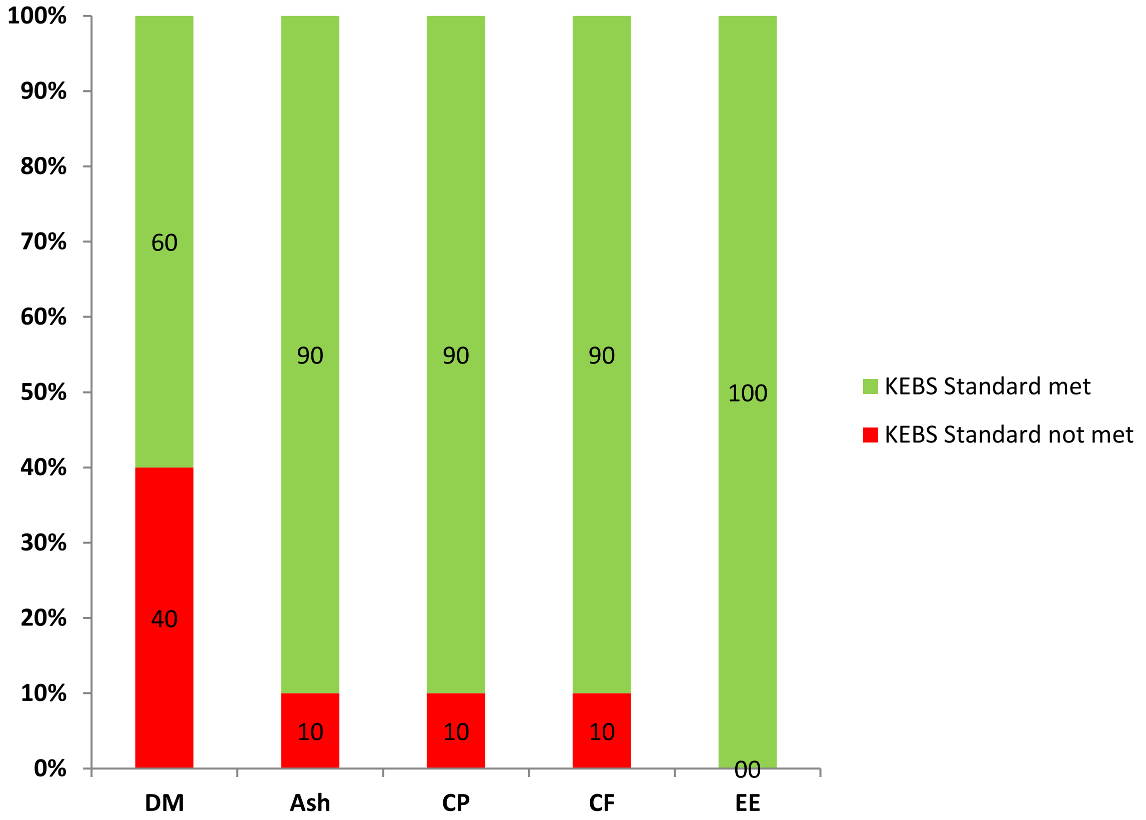

Figure 6. Percentage of the total (10) wheat pollard samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially ash, CF, ADF and starch show high variation and that some of the analysed wheat bran samples do not meet the KEBS standard (DM: 40%).

3.2.3 Maize germ cake/meal

Maize germ meal is widely used as feed ingredient for dairy cows in Kenya. In this study we analysed 10 maize germ meal samples from different feed manufacturers and the results are presented in Table 9.

Table 9. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 10 maize germ meal samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Starch (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991114	86.0	3.3	10.6	5.5	7.8	46.0	2.1	26.2	7.4	1.0
991073	88.8	6.4	12.3	6.2	13.1	32.1	4.6	25.2	7.3	0.4
991075	85.2	3.1	10.7	7.6	11.4	31.5	3.3	36.5	9.7	0.6
991081	88.4	5.6	15.6	6.1	2.9	35.1	7.7	27.9	7.8	0.7
991085	85.3	7.3	10.6	10.5	9.0	30.5	2.2	34.3	12.8	2.0
991090	91.7	4.1	14.1	9.2	5.6	25.4	6.8	41.8	11.8	1.1
991098	88.8	5.8	16.0	7.7	1.2	30.0	8.3	35.0	9.7	1.0
991100	89.5	20.2	5.7	34.8	4.0	10.1	1.4	53.3	38.9	12.2
991103	86.6	4.3	8.4	4.9	7.9	50.6	2.7	20.2	6.0	0.7
991106	86.2	2.5	10.6	5.2	7.5	48.9	2.3	25.2	6.2	0.5
Min	85.2	2.5	5.7	4.9	1.2	10.1	1.4	20.2	6.0	0.4
Max	91.7	20.2	16.0	34.8	13.1	50.6	8.3	53.3	38.9	12.2
Average	**87.7**	**6.3**	**11.5**	**9.8**	**7.0**	**34.0**	**4.1**	**32.6**	**11.8**	**2.0**
Standard dev.	2.1	5.1	3.2	9.0	3.7	12.1	2.6	9.8	9.8	3.6
CV (%)	**2.4**	**82.1**	**27.7**	**91.9**	**52.7**	**35.7**	**61.8**	**30.1**	**83.4**	**178.5**
KEBS min	**90**	**-**	**14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**3**	**-**	**13**	**12**	**-**	**-**	**-**	**-**	**-**

From the nutritional analysis of the 10 maize germ meal samples it can be concluded that the variation in nutrients is high, especially for ADL, CF, ADF and ash with a coefficient of variation of 178.5, 91.9, 83.4 and 82.1 respectively. The variation in dry matter was relatively low, with a coefficient of variation of 2.4.

In addition to the high variation in nutrients, a high percentage of the 10 maize germ meal samples did not meet the KEBS Standards regarding nutritional value. Figure 7 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

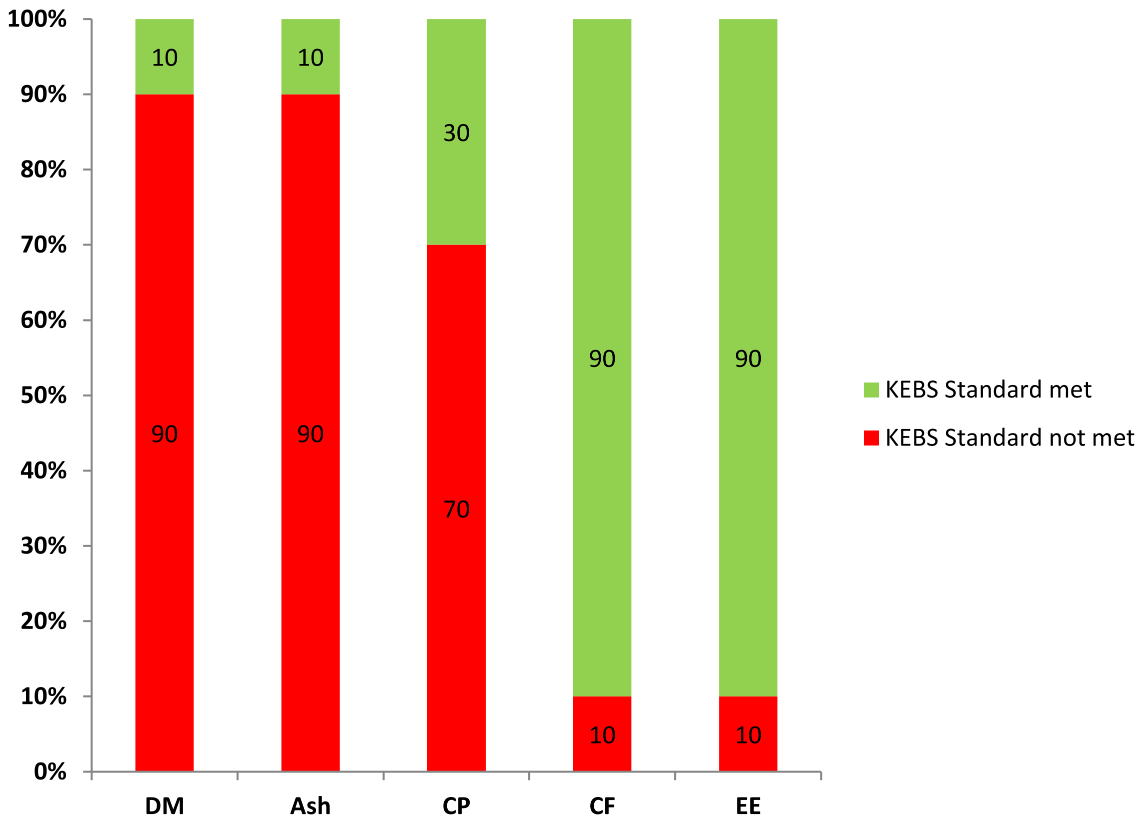

Figure 7. Percentage of the total (10) maize germ meal samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially ADL, CF, ADF and ash show high variation and that a high percentage of the analysed maize germ meal samples do not meet the KEBS standard (DM: 90%, ash: 90% and CP: 70%).

3.2.4 Cottonseed cake/meal

Cottonseed meal is widely used as feed ingredient for dairy cows in Kenya. In this study we analysed 10 cottonseed meal samples from different feed manufacturers and the results are presented in Table 10.

Table 10. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 10 cottonseed meal samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991054	91.9	6.0	35.7	20.8	7.1	6.1	42.8	25.9	8.6
991055	88.8	6.8	39.8	20.0	0.8	4.4	50.8	27.4	11.2
991057	92.0	6.2	36.5	18.4	9.5	6.7	39.1	27.3	6.7
991060	91.5	5.9	34.9	18.8	11.7	3.9	42.5	28.5	8.2
991062	90.0	6.0	37.4	14.3	11.8	6.0	35.9	21.5	6.8
991063	91.4	5.5	32.9	22.8	8.7	5.9	38.4	31.3	8.0
991064	91.6	5.9	29.4	24.5	7.3	5.0	45.4	31.1	10.7
991066	95.2	5.6	33.6	14.2	18.4	4.0	35.2	19.7	8.3
991068	90.3	5.5	29.7	23.6	7.5	5.0	42.8	30.2	9.3
991116	91.7	5.5	29.9	17.7	17.7	5.3	34.3	25.0	7.5
Min	88.8	5.5	29.4	14.2	0.8	3.9	34.3	19.7	6.7
Max	95.2	6.8	39.8	24.5	18.4	6.7	50.8	31.3	11.2
Average	**91.4**	**5.9**	**34.0**	**19.5**	**10.1**	**5.2**	**40.7**	**26.8**	**8.5**
Standard dev.	1.7	0.4	3.5	3.6	5.2	0.9	5.1	3.9	1.5
CV (%)	**1.8**	**6.9**	**10.4**	**18.3**	**51.9**	**18.1**	**12.6**	**14.5**	**17.6**
KEBS min	**90.0**	-	**23.0**	-	-	-	-	-	-
KEBS max	-	**6.0**	-	**25.0**	**7.5**	-	-	-	-

From the nutritional analysis of the 10 cottonseed meal samples it can be concluded that the variation in nutrients is relatively low, with the exception of EE with a coefficient of variation of 51.9.

In addition to the relatively high variation in EE, some of the 10 cottonseed meal samples did not meet the KEBS Standards regarding nutritional value. Figure 8 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

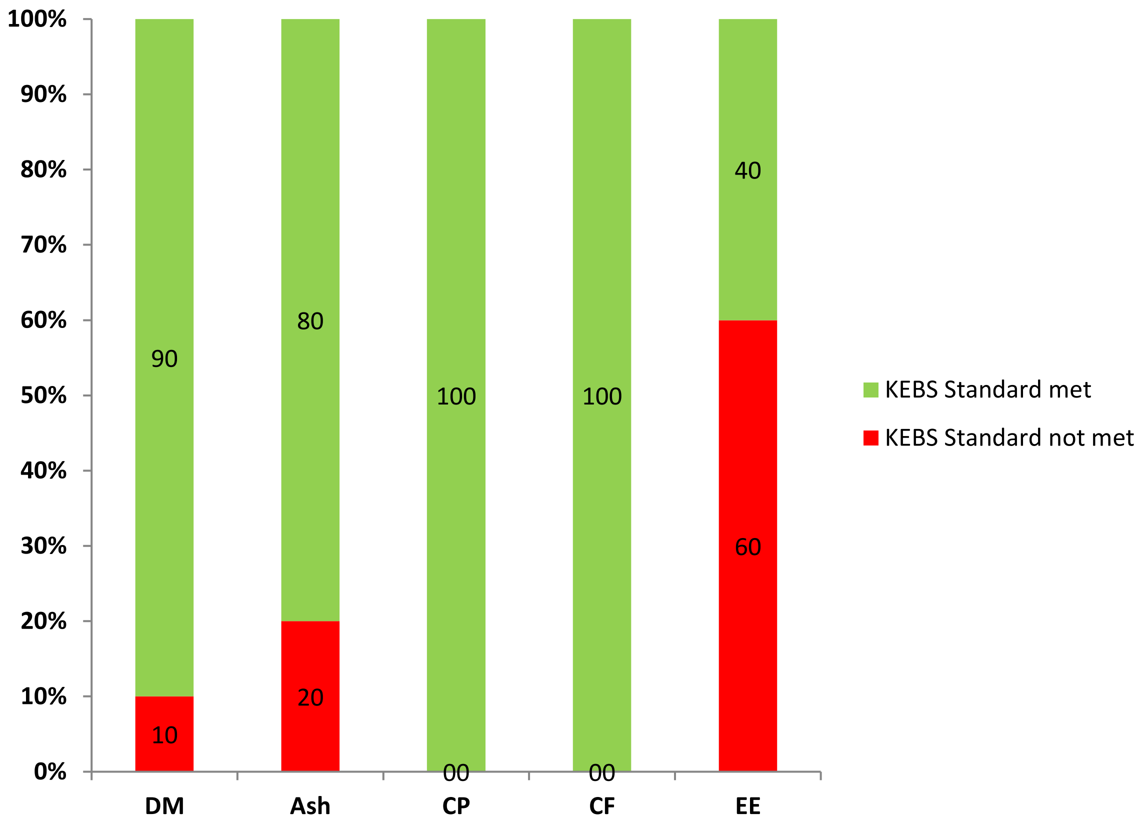

Figure 8. Percentage of the total (10) cottonseed meal samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially EE (crude fat) shows high variation and that for EE a high percentage of the analysed cottonseed meal samples do not meet the KEBS standard (60%).

3.2.5 Sunflower seed cake/meal

Sunflower seed meal is widely used as feed ingredient for dairy cows in Kenya. In this study we analysed 10 sunflower seed meal samples from different feed manufacturers and the results are presented in Table 11.

Table 11. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 10 sunflower seed meal samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	Sugar (%)	NDF (%)	ADF (%)	ADL (%)
991056	92.5	6.4	25.0	34.3	2.6	5.2	52.4	40.0	12.3
991058	90.4	6.8	33.1	27.2	4.7	6.7	44.9	30.8	8.7
991059	92.1	5.0	23.5	31.7	13.5	4.7	45.2	37.0	12.2
991061	93.9	4.7	24.5	32.5	14.0	4.2	47.0	34.7	12.0
991065	91.8	5.9	26.8	34.5	2.6	5.1	51.5	37.8	11.5
991067	89.2	6.0	24.9	31.7	9.9	4.4	47.4	34.8	10.4
991069	93.3	4.7	22.4	32.8	14.6	4.3	46.9	34.8	12.9
991115	91.5	4.9	23.4	31.6	13.6	4.8	47.0	37.5	11.6
991117	92.7	4.5	23.8	32.0	13.2	4.6	43.7	35.4	10.3
991118	92.2	4.4	20.4	34.7	13.9	4.6	47.7	37.6	12.7
Min	89.2	4.4	20.4	27.2	2.6	4.2	43.7	30.8	8.7
Max	93.9	6.8	33.1	34.7	14.6	6.7	52.4	40.0	12.9
Average	**92.0**	**5.3**	**24.8**	**32.3**	**10.3**	**4.9**	**47.4**	**36.0**	**11.5**
Standard dev.	1.4	0.9	3.4	2.2	5.0	0.7	2.7	2.5	1.3
CV (%)	**1.5**	**16.2**	**13.6**	**6.7**	**48.7**	**14.8**	**5.8**	**7.0**	**11.4**
KEBS min	**90.0**	**-**	**20.0**	**-**	**-**	**-**	**-**	**-**	**-**
KEBS max	**-**	**8.0**	**-**	**28.0**	**8.0**	**-**	**-**	**-**	**-**

From the nutritional analysis of the 10 sunflower seed meal samples it can be concluded that the variation in nutrients is relatively low, with the exception of EE with a coefficient of variation of 48.7.

In addition to the relatively high variation in EE, a relatively high percentage of the 10 sunflower seed meal samples did not meet the KEBS Standards regarding nutritional value. Figure 9 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

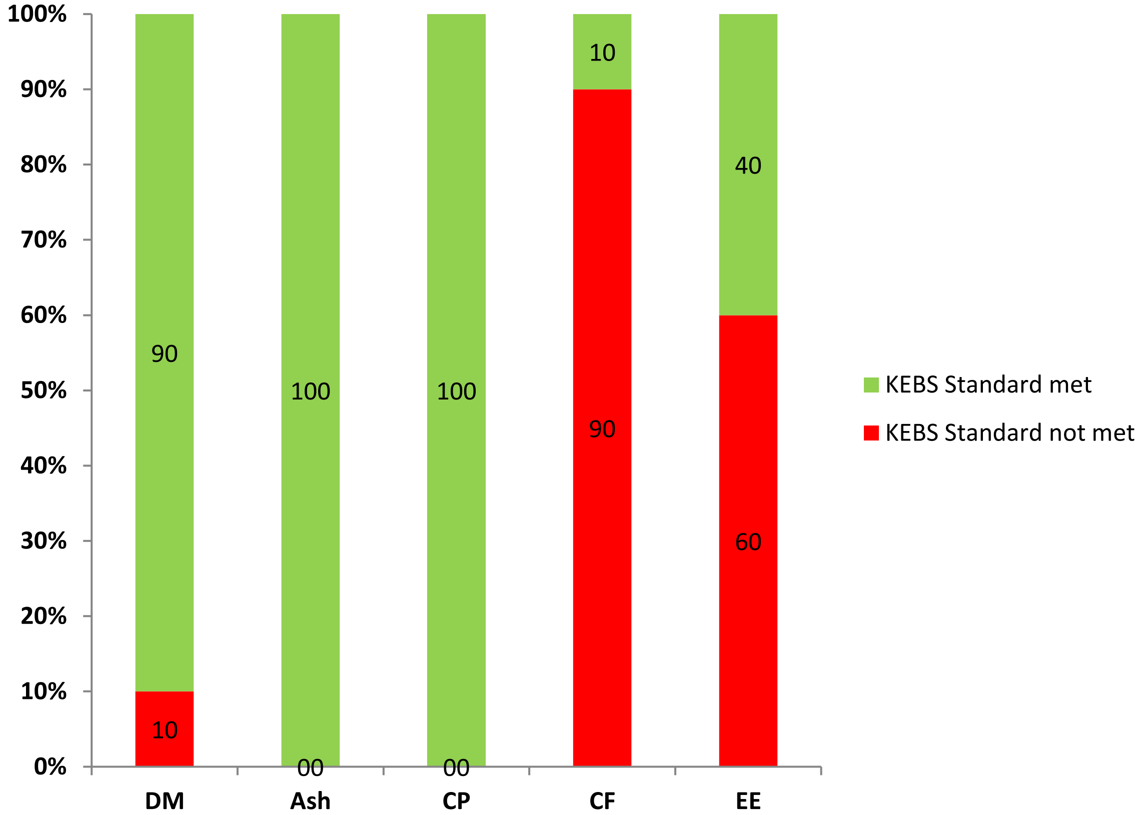

Figure 9. Percentage of the total (10) sunflower seed meal samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially EE (crude fat) shows high variation and that a high percentage of the analysed sunflower seed meal samples do not meet the KEBS standard for CF (90%) and EE (60%).

3.2.6 Fish meal

Fish meal is used as feed ingredient for dairy cows in Kenya since it is good source of (resistant) protein. In this study we analysed 7 fish meal samples from different feed manufacturers and the results are presented in Table 12.

Table 12. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 7 fish meal samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	EE (%)
991119	93.8	38.1	53.2	9.4
991121	93.2	48.3	42.0	7.8
991122	92.0	53.0	36.0	7.1
991123	93.6	53.8	29.2	14.7
991124	94.2	43.4	44.3	3.9
991125	91.5	51.4	44.6	4.3
991126	91.7	58.3	33.1	7.5
Min	91.5	38.1	29.2	3.9
Max	94.2	58.3	53.2	14.7
Average	**92.9**	**49.5**	**40.3**	**7.8**
Standard dev.	1.1	6.8	8.1	3.6
CV (%)	**1.2**	**13.8**	**20.2**	**46.2**
KEBS min	**90.0**	**-**	**60.0**	**-**
KEBS max	**-**	**20.0**	**-**	**10.0**

From the nutritional analysis of the 7 fish meal samples it can be concluded that the variation in nutrients is relatively high or EE and CP with a coefficient of variation of 42.5 and 20.0 respectively.

In addition to the relatively high variation in EE and CP, all fish meal samples did not meet the KEBS Standards regarding nutritional value. Figure 10 gives an overview the percentage of samples that did not meet the KEBS standard for the different nutrients that were analysed.

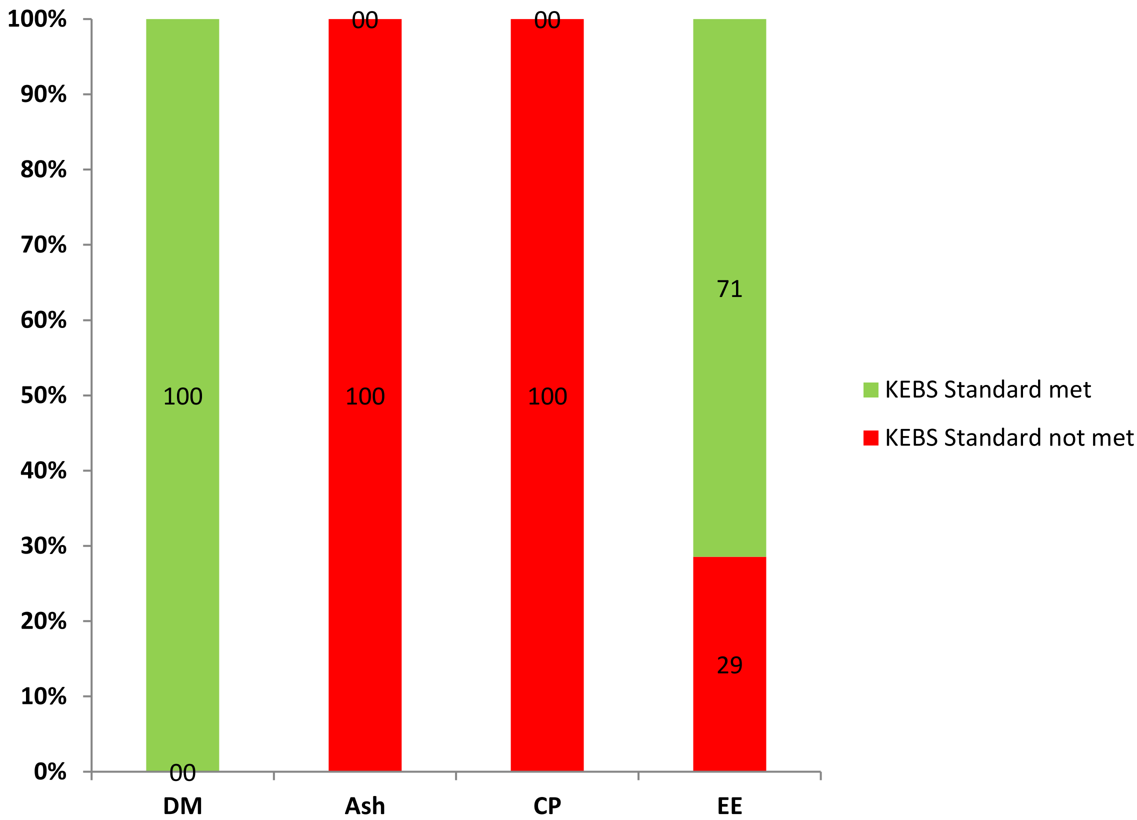

Figure 10. Percentage of the total (7) fish meal samples that did (not) meet the KEBS Standard for the nutrients that were analysed.

It can be concluded that especially EE (crude fat) and CP show high variation and that all analysed fish meal samples do not meet the KEBS standard for ash and CP.

3.2.7 Bone meal

Bone meal is used as feed ingredient for dairy cows in Kenya. In this study we analysed 2 bone meal samples from different feed manufacturers and the results are presented in Table 13.

Table 13. Nutritional value (DM=dry matter, CP= crude protein, CF=crude fibre, EE=ether extract, NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 2 bone meal samples, including comparison with the KEBS standard (orange = KEBS standard not met).

Sample no	DM (%)	Ash (%)	CP (%)	EE (%)
991120	92.4	65.3	26.9	5.9
991127	90.5	67.6	26.2	5.3
Average	**91.5**	**66.5**	**26.6**	**5.6**
Standard dev.	1.3	1.6	0.5	0.4
CV (%)	**1.5**	**2.4**	**1.9**	**7.6**
KEBS min	**92.5**	**-**	**20.0**	**-**
KEBS max	**-**	**65.0**	**-**	**3.0**

Since only 2 bone meal samples were analysed, not much can be concluded on variation or trends of the different nutrients. The 2 bone meal samples that were analysed did not meet the KEBS Standards regarding DM, ash and EE.

3.3 Fodders

In addition to dairy meals and raw materials, also several fodders were sampled and analysed for nutritional value. In total 20 maize silages, 5 Boma Rhodes hay and 3 Lucerne hay were analysed. The results are shown in the following sub-chapters.

3.3.1 Maize silage

Table 14 shows the results of the nutritional analysis of the 20 maize silage samples that were analysed as part of this study.

Table 14. Nutritional value (NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 20 maize silages, including the recommended values by BLGG.

Sample ID	pH	Net Energy (kcal/kg)	Crude ash (g/kg)	OM digesti-bility (%)	Crude protein (g/kg)	Crude fat (g/kg)	Starch (g/kg)	Sugar (g/kg)	Crude fibre (g/kg)	NDF (g/kg)	NDF digesti-bility (%)	ADF (g/kg)	ADL (g/kg)
700398	4.5	1267	76	66.9	83	23	81	< 12	280	603	57.2	343	26
700400	4.3	1513	80	75.0	78	29	169	12	212	483	58.0	249	16
700402	3.8	1493	38	71.6	92	35	222	< 12	211	446	48.0	253	23
700403	4.6	1234	60	62.4	94	26	103	< 12	301	619	54.3	346	30
700405	4.2	1371	70	68.6	90	29	164	< 12	245	528	56.8	302	23
700406	4.2	1454	46	70.5	68	30	261	< 12	226	463	51.6	267	21
700408	3.9	1394	62	69.1	76	28	155	< 12	269	538	57.1	308	24
700409	4	1500	41	72.0	88	31	190	< 12	242	472	54.4	278	20
700412	4.2	1239	55	62.3	81	27	155	< 12	276	575	51.3	323	30
700413	3.9	1561	37	74.1	73	30	241	< 12	232	448	57.1	274	23
700414	4.3	1393	41	67.8	65	32	278	< 12	247	493	48.7	281	26
700415	4.5	1338	54	66.3	70	28	254	< 12	233	482	49.6	283	25
700416	4.5	1548	46	74.2	49	30	304	21	212	438	55.9	241	18
700417	4.5	1549	40	73.9	51	25	237	12	216	472	53.6	245	17
700418	4	1421	45	69.1	61	27	258	< 12	225	451	45.5	253	27
700420	4.9	1579	58	76.2	60	17	155	48	217	441	46.9	268	22
700421	4.2	1388	80	69.9	77	28	126	< 12	249	511	61.8	316	24
700422	4.1	1290	81	65.9	79	29	129	< 12	296	557	58.0	346	22
700430	4.2	1271	66	64.2	75	30	163	< 12	273	549	49.7	310	27
700431	4.3	1426	56	70.0	74	31	243	< 12	247	500	56.8	290	20
Min	3.8	1234	37	62.3	49	17	81	12	211	438	45.5	241	16
Max	4.9	1579	81	76.2	94	35	304	48	301	619	61.8	346	30
Average	**4.3**	**1411**	**57**	**69.5**	**74**	**28**	**194**	**14**	**245**	**503**	**53.6**	**289**	**23**
Standard dev.	0.27	112.3	14.9	4.07	12.6	3.7	63.1	8.2	28.4	54.8	4.45	34.1	3.9
CV (%)	**6.4**	**8.0**	**26.4**	**5.9**	**17.0**	**13.1**	**32.4**	**57.5**	**11.6**	**10.9**	**8.3**	**11.8**	**16.8**
BLGG recommendation													
min	**3.8**	**1518**	**35**	**73**	**75**	**25**	**320**	**1**	**180**	**370**	**30**	**190**	**14**
max	**4.2**	**1650**	**50**	**78**	**85**	**35**	**400**	**15**	**200**	**420**	**70**	**220**	**20**

Compared the recommended values of BLGG, the average nutritional value of the maize silages show that the fibre content is relatively high (CF: 245, NDF: 503, ADF: 289 and ADL: 23 g/kg) and that the starch content is quite low (194 g/kg). In addition, the average OM digestibility and therefore Net Energy values of the analysed maize silages are relatively low compared to the recommended values of BLGG.

3.3.2 Boma Rhodes hay

Table 15 shows the results of the nutritional analysis of the 5 Boma Rhodes hay samples that were analysed as part of this study.

Table 15. Nutritional value (NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 5 Boma Rhodes hay samples, including the recommended values by BLGG and the average values in NL.

Sample ID	Net Energy (kcal/kg)	Crude ash (g/kg)	OM digesti-bility (%)	Crude protein (g/kg)	Crude fat (g/kg)	Sugar (g/kg)	Crude fibre (g/kg)	NDF (g/kg)	NDF digesti-bility (%)	ADF (g/kg)	ADL (g/kg)
700404	861	82	50.6	42	20	< 12	425	751	39.7	445	49
700410	549	64	34.7	46	17	< 12	442	834	29.9	487	55
700424	881	96	51.2	65	26	< 11	399	755	46.6	435	46
700428	512	78	33.5	46	15	< 12	451	799	22.5	505	77
700429	799	91	48.1	43	18	< 11	412	755	31.3	446	56
Min	512	64	33.5	42	15	11	399	751	22.5	435	46
Max	881	96	51.2	65	26	12	451	834	46.6	505	77
Average	**720**	**82**	**43.6**	**48**	**19**	**12**	**426**	**779**	**34.0**	**464**	**57**
Standard dev.	176.5	12.4	8.78	9.4	4.2	0.5	21.3	36.6	9.32	30.6	12.1
CV (%)	**24.5**	**15.1**	**20.1**	**19.5**	**21.9**	**4.7**	**5.0**	**4.7**	**27.4**	**6.6**	**21.4**
BLGG recom-mendation											
min	**1419**	**80**	**75**	**110**	**20**	**70**	**210**	**450**	**40**	**250**	**20**
max	**1518**	**120**	**79**	**190**	**35**	**150**	**260**	**575**	**70**	**350**	**50**
Avg NL	**1196**	**86**	**64.9**	**106**	**23**	**102**	**291**	**584**	**51.5**	**324**	**37**

Compared the recommended values of BLGG, the average nutritional value of the Boma Rhodes hay samples show that the fibre content is quite high (CF: 426, NDF: 779, ADF: 464 and ADL: 57 g/kg) and that the protein and sugar content are quite low (48 and < 12 g/kg, respectively). In addition, the average OM digestibility and therefore Net Energy values of the analysed Boma Rhodes hay samples are relatively low compared to the recommended values of BLGG.

3.3.3 Lucerne hay

Table 16 shows the results of the nutritional analysis of the 3 Lucerne hay samples that were analysed as part of this study.

Table 16. Nutritional value (NDF = neutral detergent fibre, ADF = acid detergent fibre and ADL = acid detergent lignin) of 3 Lucerne hay samples, including the average values in NL.

Sample ID	Net Energy (kcal/kg)	Crude ash (g/kg)	OM digesti-bility (%)	Crude protein (g/kg)	Crude fat (g/kg)	Sugar (g/kg)	Crude fibre (g/kg)	NDF (g/kg)	NDF digesti-bility (%)	ADF (g/kg)	ADL (g/kg)
700425	1178	84	64.8	199	18	35	286	455	50.8	350	65
700426	962	155	59.8	174	10	24	294	473	41.2	371	72
700435	1101	99	61.8	193	22	< 11	315	563	47.5	355	53
Min	962	84	59.8	174	10	24	286	455	41.2	350	53
Max	1178	155	64.8	199	22	35	315	563	50.8	371	72
Average	**1080**	**113**	**62.1**	**189**	**17**	**30**	**298**	**497**	**46.5**	**359**	**63**
Standard dev.	109.5	37.4	2.52	13.1	6.1	7.8	15.0	57.9	4.88	11.0	9.6
CV (%)	**10.1**	**33.2**	**4.1**	**6.9**	**36.7**	**26.4**	**5.0**	**11.6**	**10.5**	**3.1**	**15.2**
Avg NL	**1069**	**103**	**60.8**	**177**	**20**	**-**	**322**	**584**	**-**	**326**	**63**

Compared to the average nutritional values of NL, the averages of the analysed Lucerne hay samples show that the fibre content is relatively low (CF: 298, NDF: 497, ADF: 359 and ADL: 63 g/kg) and that the protein content is quite high (189 g/kg). In addition, the average OM digestibility (62.1 %) and therefore net energy (1080 kcal/kg) values of the analysed Lucerne hay samples are relatively high compared to the average values in NL.

4. MYCOTOXINS IN DAIRY FEEDS AND INGREDIENTS

Several dairy feeds and ingredients were randomly selected for analyses of mycotoxins. The analysis was carried out by SiCa AgriQ (Vicar, Spain) and the list of mycotoxins and their detection limits are presented in Table 17.

Table 17. List of mycotoxins, their limit of quantification (LOQ) and method which were used for mycotoxin analysis by SiCa AgriQ.

	LOQ (ug/kg)	Method
Aflatoxin B1	1.0	LC-MS/MS
Aflatoxin B2	1.0	LC-MS/MS
Aflatoxin G1	1.0	LC-MS/MS
Aflatoxin G2	1.0	LC-MS/MS
Aflatoxin Total (B1+B2+G1+G2)	4.0	LC-MS/MS
Deoxynivalenol	250.0	LC-MS/MS
Ocratoxin A	2.0	LC-MS/MS
Zearalenone	25.0	LC-MS/MS
T-2 Toxine	25.0	LC-MS/MS
HT-2 Toxine	25.0	LC-MS/MS
Fumonisin B1	200.0	LC-MS/MS
Fumonisin B2	200.0	LC-MS/MS
Fumonisin B1+B2	400.0	LC-MS/MS

4.1 Dairy meals

Five dairy meals were randomly selected and analysed for mycotoxins (Table 17). The results are presented in Table 18 and only the mycotoxins which were above the LOQ are shown.

Table 18. Levels of mycotoxins (µg/kg = ppb) in the 5 selected dairy meals (orange = KEBS standard not met).

Sample no	Afl. B1	Afl. B2	Afl. G1	Afl. G2	Afl. Total (B1+B2+G1+G2)	Zearalenone
991079	15.0	3.5	11.0	2.4	32.0	64.0
991086	35.0	5.1	15.0	2.5	58.0	-
991105	5.5	1.1	2.6	-	9.2	150.0
991167	13.0	2.3	4.5	-	20.0	52.0
991171	5.4	1.9	1.0	-	8.3	58.0

The maximum limit of aflatoxins in dairy meals is 10 ppb (=µg/kg; KEBS). This means that 3 out of the 5 dairy meals which were analysed are above the maximum limit for aflatoxins.

There is no maximum limit for Zearalenone in dairy meals in Kenya, but the EU stipulates a maximum of 500 ppb for dairy meals. This means that all 5 dairy meals are below the maximum limit for Zearalenone according to EU regulation.

4.2 Maize germ cake/meal

Five maize germ meals were randomly selected and analysed for mycotoxins (Table 17). The results are presented in Table 19 and only the mycotoxins which were above the LOQ are shown.

Table 19. Levels of mycotoxins (µg/kg = ppb) in the 5 selected maize germ meals (orange = KEBS standard not met).

Sample no	Afl. B1	Afl. B2	Afl. G1	Afl. G2	Afl. Total (B1+B2+G1+G2)	Deoxynivalenol	Zearalenone
991075	150	100	38	12	300	-	100
991085	150	85	21	12	260	-	76
991090	-	-	-	-	-	260	47
991103	120	18	15	1.9	160	1100	440
991114	1.5	1.1	-	-	2.6	-	-

The maximum limit of aflatoxins in maize germ meals is 10 ppb (=µg/kg; KEBS). This means that 3 out of the 5 maize germ meals which were analysed are above the maximum limit for aflatoxins.
There are no maximum limits for Deoxynivalenol and Zearalenone in maize germ meals in Kenya, but the EU stipulates a maximum of 2400 ppb and 1000 ppb for Deoxynivalenol and Zearalenone in maize germ meals. This means that all 5 maize germ meals are below the maximum limit for Deoxynivalenol and Zearalenone according to EU regulation.

4.3 Maize silage

As part of this study, also maize silages were sampled at different farms and analysed. Ten maize silages were randomly selected and analysed for mycotoxins (Table 17). The results are presented in Table 20 and only the mycotoxins which were above the LOQ are shown.

Table 20. Levels of mycotoxins (µg/kg = ppb) in the 10 selected maize silages.

Sample no	Deoxinivalenol	Zearalenone
991141	-	66
991142	350	78
991143	-	55
991145	-	-
991147	-	-
991149	-	-
991150	-	-
991151	-	-
991153	-	-
991154	760	52

There are no maximum limits for Deoxynivalenol and Zearalenone in maize silages in Kenya, but the EU stipulates a maximum of 2400 ppb and 1000 ppb for Deoxynivalenol and Zearalenone in maize silages. This means that all 10 maize silages are well below the maximum limit for Deoxynivalenol and Zearalenone according to EU regulation.

5. PESTICIDES IN DAIRY FEEDS AND INGREDIENTS

Several dairy feeds and ingredients were randomly selected for analyses of pesticides. The analysis was carried out by SiCa AgriQ (Vicar, Spain) and the list of pesticides and their detection limits are presented in Table 21.

Table 21. List of pesticides, their limit of quantification (LOQ) and method which were used for pesticides analysis by SiCa AgriQ.

Compound	LOQ (mg/kg)	Method	Compound	LOQ (mg/kg)	Method
2-Phenylphenol	0.01	GC-MS/MS	Phorate sulfoxide	0.01	LC-MS/MS
3-Cloroanilina	0.01	GC-MS/MS	Forchlofenuron	0.01	LC-MS/MS
3,5-Dichloroaniline	0.01	GC-MS/MS	Formetanate	0.01	LC-MS/MS
Abamectin	0.01	LC-MS/MS	Formothion	0.01	GC-MS/MS
Acephate	0.01	LC-MS/MS	Phosalone	0.01	LC-MS/MS
Acetamiprid	0.01	LC-MS/MS	Phosphamidon	0.01	LC-MS/MS
Azibenzolar-S-methyl	0.01	LC-MS/MS	Phosmet	0.01	GC-MS/MS
Acrinathrin	0.01	GC-MS/MS	Fostiazate	0.01	LC-MS/MS
Alachlor	0.01	GC-MS/MS	Phoxim	0.01	LC-MS/MS
Aldicarb (sum)	0.01	LC-MS/MS	Fuberidazole	0.01	LC-MS/MS
Aldicarb	0.01	LC-MS/MS	Furathiocarb	0.01	LC-MS/MS
Aldicarb sulfon	0.01	LC-MS/MS	Halfenprox	0.01	GC-MS/MS
Aldicarb sulfoxid	0.01	LC-MS/MS	Haloxyfop (sum)	0.01	LC-MS/MS
Aldrin	0.01	GC-MS/MS	Haloxyfop	0.01	LC-MS/MS
Asulam	0.01	LC-MS/MS	Haloxyfop-2-etoxyethyl	0.01	LC-MS/MS
Atrazine	0.01	LC-MS/MS	Haloxyfop methyl	0.01	LC-MS/MS
Azaconazole	0.01	LC-MS/MS	Halosulfuron methyl	0.01	LC-MS/MS
Azadirachtin	0.04	LC-MS/MS	Heptachlor (sum)	0.01	GC-MS/MS
Azamethiphos	0.01	LC-MS/MS	Heptachlor	0.01	GC-MS/MS
Azinphos ethyl	0.01	LC-MS/MS	Heptachloroepoxide cis	0.01	GC-MS/MS
Azinfos methyl	0.01	LC-MS/MS	Heptachloroepoxide trans	0.01	GC-MS/MS
Azoxystrobin	0.01	LC-MS/MS	Heptenophos	0.01	LC-MS/MS
Azimsulfuron	0.01	LC-MS/MS	Hexachlorobenzene	0.01	GC-MS/MS
Sulfur	10	GC-MS/MS	Hexaconazole	0.01	GC-MS/MS
Benalaxyl	0.01	GC-MS/MS	Hexazinone	0.01	LC-MS/MS
Bendiocarb	0.01	LC-MS/MS	Hexytiazox	0.01	LC-MS/MS
Benfluralin	0.01	GC-MS/MS	Hymexazol	0.01	LC-MS/MS
Benomyl	0.01	LC-MS/MS	Imazalil	0.01	LC-MS/MS
Benthiavalicarb isopropyl	0.01	LC-MS/MS	Imazamox	0.01	LC-MS/MS
Beta cifluthrin	0.01	GC-MS/MS	Imazosulfuron	0.01	LC-MS/MS
Bifenazate	0.01	GC-MS/MS	Imidacloprid	0.01	LC-MS/MS
Biphenyl	0.01	GC-MS/MS	Indoxacarb	0.01	LC-MS/MS
Bifenthrin	0.01	GC-MS/MS	Iprobenfos	0.01	LC-MS/MS
Bitertanol	0.01	LC-MS/MS	Iprodione	0.01	GC-MS/MS
Bispyribac	0.01	LC-MS/MS	Iprovalicarb	0.01	LC-MS/MS
Boscalid	0.01	GC-MS/MS	Isocarbofos	0.01	GC-MS/MS
Bromacil	0.01	GC-MS/MS	Isophenphos	0.01	GC-MS/MS

Compound	LOQ (mg/kg)	Method	Compound	LOQ (mg/kg)	Method
Bromophos methyl	0.01	GC-MS/MS	Isofenphos methyl	0.01	GC-MS/MS
Bromopropilate	0.01	GC-MS/MS	Isoproturon	0.01	LC-MS/MS
Bromuconazole	0.01	LC-MS/MS	Isoxathion	0.01	LC-MS/MS
Bupirimate	0.01	GC-MS/MS	Kresoxim methyl	0.01	GC-MS/MS
Buprofezin	0.01	GC-MS/MS	Lambda cyhalothrin	0.01	GC-MS/MS
Butocarboxim (sum)	0.01	LC-MS/MS	Lenacil	0.01	LC-MS/MS
Butocarboxim	0.01	LC-MS/MS	Lindan	0.01	GC-MS/MS
Butoxicarboxim	0.01	LC-MS/MS	Linuron	0.01	LC-MS/MS
Cadusafos	0.01	GC-MS/MS	Lufenuron	0.02	LC-MS/MS
Captafol	0.02	LC-MS/MS	Malaoxon	0.01	LC-MS/MS
Captan	0.01	GC-MS/MS	Malathion (sum)	0.01	LC-MS/MS
Carbaryl	0.01	LC-MS/MS	Malathion	0.01	LC-MS/MS
Carbendazim (sum)	0.01	LC-MS/MS	Mandipropamid	0.01	LC-MS/MS
Carbemdazim	0.01	LC-MS/MS	Mecarbam	0.01	GC-MS/MS
Carbophenothion	0.01	GC-MS/MS	Mepanipyrim	0.01	GC-MS/MS
Carbofuran (sum)	0.01	LC-MS/MS	Mepronil	0.01	GC-MS/MS
Carbofuran	0.01	LC-MS/MS	Methabenzthiazuron	0.01	LC-MS/MS
Carbofuran-3-Hydroxy	0.01	LC-MS/MS	Metaflumizone	0.01	LC-MS/MS
Carbosulfan	0.01	LC-MS/MS	Metalaxyl (inc.metalaxyl-M)	0.01	GC-MS/MS
Carboxin	0.01	LC-MS/MS	Methamidophos	0.01	LC-MS/MS
Carfentrazone-Ethyl	0.01	LC-MS/MS	Metamitron	0.01	LC-MS/MS
Cyazofamid	0.01	LC-MS/MS	Metazachlor	0.01	GC-MS/MS
Cycloxydim	0.01	LC-MS/MS	Metconazol	0.01	LC-MS/MS
Cyhalofop-butyl	0.01	LC-MS/MS	Methidathion	0.01	LC-MS/MS
Cihexatin	0.01	LC-MS/MS	Methiocarb (sum)	0.01	LC-MS/MS
Cymoxanil	0.01	LC-MS/MS	Mehtiocarb	0.01	LC-MS/MS
Cypermethrin	0.01	GC-MS/MS	Methiocarb sulfone	0.01	LC-MS/MS
Cyproconazole	0.01	GC-MS/MS	Methiocarb sulfoxide	0.01	LC-MS/MS
Cyprodinil	0.01	LC-MS/MS	Metobromuron	0.01	LC-MS/MS
Cyromazine	0.01	LC-MS/MS	Metolachlor	0.01	LC-MS/MS
Clethodim (sum)	0.01	LC-MS/MS	Methomyl (sum)	0.01	LC-MS/MS
Clethodim	0.01	LC-MS/MS	Methomyl	0.01	LC-MS/MS
Clofentezine	0.01	LC-MS/MS	Methoxychlor	0.01	GC-MS/MS
Clomazone	0.01	LC-MS/MS	Methoxyfenocide	0.01	LC-MS/MS
Clorantraniliprole	0.01	LC-MS/MS	Metoxuron	0.01	LC-MS/MS
Chlorbromuron	0.01	LC-MS/MS	Metrafenon	0.01	LC-MS/MS
Chlordane	0.01	GC-MS/MS	Metribuzin	0.01	GC-MS/MS
Chlorfenapyr	0.01	GC-MS/MS	Mevinphos	0.01	LC-MS/MS
Chlorfenvinphos	0.01	GC-MS/MS	Myclobutanil	0.01	GC-MS/MS
Chlorfuazuron	0.01	LC-MS/MS	Molinate	0.01	LC-MS/MS
Chlorbenzilate	0.01	GC-MS/MS	Monocrotophos	0.01	LC-MS/MS
Chlorpyrifos	0.01	GC-MS/MS	Monolinuron	0.01	LC-MS/MS
Chlorpyrifos methyl	0.01	GC-MS/MS	Nitempyram	0.01	LC-MS/MS
Chlorpropham	0.01	GC-MS/MS	Nitrofen	0.01	GC-MS/MS

Compound	LOQ (mg/kg)	Method	Compound	LOQ (mg/kg)	Method
Chlortal dimethyl	0.01	GC-MS/MS	Nuarimol	0.01	GC-MS/MS
Chlorthalonil	0.01	GC-MS/MS	2,4´-DDE	0.01	GC-MS/MS
Chlothianidin	0.01	LC-MS/MS	2,4´-DDT	0.01	GC-MS/MS
Chlozolinate	0.01	GC-MS/MS	Ofurace	0.01	LC-MS/MS
Diethyltoluamide	0.01	GC-MS/MS	Omethoate	0.01	LC-MS/MS
Deltamethrin	0.01	GC-MS/MS	Oxadiargyl	0.01	LC-MS/MS
Demeton-S	0.01	LC-MS/MS	Oxadiazon	0.01	LC-MS/MS
Demeton-S-methyl	0.01	LC-MS/MS	Oxadixyl	0.01	GC-MS/MS
Demeton-S-methyl sulfon	0.01	LC-MS/MS	Oxamyl	0.01	LC-MS/MS
Desmedipham	0.01	LC-MS/MS	Oxycarboxin	0.01	LC-MS/MS
Diafenthiuron	0.01	LC-MS/MS	Oxydemeton methyl (sum)	0.01	LC-MS/MS
Daizinon	0.01	GC-MS/MS	Oxydemeton methyl	0.01	LC-MS/MS
Dichlobenil	0.01	GC-MS/MS	Oxyfluorfen	0.01	GC-MS/MS
Dichlofenthion	0.01	GC-MS/MS	Paclobutrazol	0.01	LC-MS/MS
Dichlofluanid (sum)	0.01	LC-MS/MS	Paraoxon ethyl	0.01	GC-MS/MS
Dichlofluanid	0.01	LC-MS/MS	Parathion	0.01	GC-MS/MS
Dicloran	0.01	GC-MS/MS	Parathion methyl	0.01	GC-MS/MS
Dichlorvos	0.01	LC-MS/MS	Pencycuron	0.01	LC-MS/MS
Dicofol	0.01	GC-MS/MS	Penconazole	0.01	GC-MS/MS
Dicrotophos	0.01	LC-MS/MS	Pendimethalin	0.01	GC-MS/MS
Dieldrin (sum)	0.01	GC-MS/MS	Penoxsulam	0.01	LC-MS/MS
Dieldrin	0.01	GC-MS/MS	Pentachloroaniline	0.01	GC-MS/MS
Diethofencarb	0.01	GC-MS/MS	Pentachloroanisol	0.01	GC-MS/MS
Diphenylamine	0.01	GC-MS/MS	Permethrin	0.01	GC-MS/MS
Difenoconazol	0.01	GC-MS/MS	Picolinafen	0.01	LC-MS/MS
Diflubenzuron	0.01	LC-MS/MS	Picoxystrobin	0.01	LC-MS/MS
Dimethoate (sum)	0.01	LC-MS/MS	Pymetrozine	0.01	LC-MS/MS
Dimethoate	0.01	LC-MS/MS	Piperonyl butoxide	0.01	LC-MS/MS
Dimethomorph	0.01	LC-MS/MS	Pyraclostrobin	0.01	LC-MS/MS
Dimoxystrobin	0.01	LC-MS/MS	Pitazophos	0.01	GC-MS/MS
Diniconazole	0.01	LC-MS/MS	Piridaben	0.01	GC-MS/MS
Disulfoton	0.01	LC-MS/MS	Pyridafenthion	0.01	GC-MS/MS
Disulfoton (sum)	0.01	LC-MS/MS	Pyridalyl	0.01	LC-MS/MS
Disulfoton sulfon	0.01	LC-MS/MS	Pyrifenox	0.01	GC-MS/MS
Disulfoton sulfoxide	0.01	LC-MS/MS	Pyrimethanil	0.01	GC-MS/MS
Ditalimfos	0.01	GC-MS/MS	Pirimicarb (sum)	0.01	LC-MS/MS
Diuron	0.01	LC-MS/MS	Pirimicarb	0.01	LC-MS/MS
DMSA	0.01	LC-MS/MS	Pirimicarb desmethyl	0.01	LC-MS/MS
DMST	0.01	LC-MS/MS	Pirimiphos ethyl	0.01	GC-MS/MS
Dodemorph	0.01	LC-MS/MS	Pirimiphos methyl	0.01	GC-MS/MS
Dodine	0.01	LC-MS/MS	Pyriproxifen	0.01	LC-MS/MS
Edifenphos	0.01	LC-MS/MS	4,4´-DDE	0.01	GC-MS/MS
Emamectin benzoate	0.01	LC-MS/MS	4,4´-DDT	0.01	GC-MS/MS
Endosulfan (a+ β+ sulfate)	0.01	GC-MS/MS	Profenofos	0.01	GC-MS/MS

Compound	LOQ (mg/kg)	Method	Compound	LOQ (mg/kg)	Method
Endosulfan a	0.01	GC-MS/MS	Profluralin	0.01	GC-MS/MS
Endosulfan β	0.01	GC-MS/MS	Procymodone	0.01	GC-MS/MS
Endosulfan sulfate	0.01	GC-MS/MS	Prochloraz	0.01	LC-MS/MS
Endrin	0.01	GC-MS/MS	Propham	0.01	LC-MS/MS
Epoxiconazole	0.01	LC-MS/MS	Profoxydim	0.01	LC-MS/MS
EPTC	0.01	LC-MS/MS	Promecarb	0.01	LC-MS/MS
Spirodiclofen	0.01	GC-MS/MS	Prometryn	0.01	GC-MS/MS
Spiromesifen	0.01	LC-MS/MS	Propachlor	0.01	LC-MS/MS
Spirotetramat (sum)	0.01	LC-MS/MS	Propamocarb	0.01	LC-MS/MS
Spirotetramat	0.01	LC-MS/MS	Propargite	0.01	GC-MS/MS
Spirotetramat-enol	0.01	LC-MS/MS	Propaquizafop	0.01	LC-MS/MS
Spirotetramat-monohydroxy	0.01	LC-MS/MS	Propiconazole	0.01	GC-MS/MS
Spirotetramat-ketohydroxy	0.01	LC-MS/MS	Propyzamide	0.01	GC-MS/MS
Spirotetramat-enol-glucoside	0.01	LC-MS/MS	Propoxur	0.01	LC-MS/MS
Spirpxamine	0.01	LC-MS/MS	Proquinazid	0.01	LC-MS/MS
Ethiofencarb (sum)	0.01	LC-MS/MS	Prosulfocarb	0.01	LC-MS/MS
Ethiofencarb	0.01	LC-MS/MS	Prothiofos	0.01	GC-MS/MS
Ethiofencarb sulfone	0.01	LC-MS/MS	Quinalphos	0.01	GC-MS/MS
Ethiofencarb sulfoxide	0.01	LC-MS/MS		0.01	GC-MS/MS
Ethion	0.01	GC-MS/MS	Chinosol	0.01	GC-MS/MS
Etiprol	0.01	LC-MS/MS	Quinoxyfen	0.01	GC-MS/MS
Ethirimol	0.01	LC-MS/MS	Quintozene (sum)	0.01	GC-MS/MS
Etofenprox	0.01	GC-MS/MS	Quintozene	0.01	GC-MS/MS
Ethofuumesate	0.01	LC-MS/MS	Rotenone	0.01	LC-MS/MS
Ethoprophos	0.01	LC-MS/MS	Sethoxydim	0.01	LC-MS/MS
Etoxazole	0.01	LC-MS/MS	Simazine	0.01	LC-MS/MS
Ethoxyquin	0.01	GC-MS/MS	Spinosad (A+D)	0.01	LC-MS/MS
Etridiazole	0.01	GC-MS/MS	Sulfotep	0.01	LC-MS/MS
Etrimfos	0.01	GC-MS/MS	Tau-fluvalinate	0.01	GC-MS/MS
Famoxadone	0.01	LC-MS/MS	Tebuconazole	0.01	GC-MS/MS
Fenamidone	0.01	LC-MS/MS	Tebufenozide	0.01	LC-MS/MS
Fenamiphos (sum)	0.01	LC-MS/MS	Tebufenpyrad	0.01	LC-MS/MS
Fenamiphos	0.01	LC-MS/MS	Tebupirimfos	0.01	LC-MS/MS
Fenamiphos sulphone	0.01	LC-MS/MS	Tecnazene	0.01	GC-MS/MS
Fenamiphos sulfoxide	0.01	LC-MS/MS	Teflubenzuron	0.01	GC-MS/MS
Fenarimol	0.01	GC-MS/MS	Tefluthrin	0.01	GC-MS/MS
Fenazaquin	0.01	LC-MS/MS	Temephos	0.01	LC-MS/MS
Fenbuconazole	0.01	LC-MS/MS	Tepraloxydim	0.01	LC-MS/MS
Fenbutatin oxide	0.01	LC-MS/MS	Terbufos	0.01	LC-MS/MS
Fenhexamid	0.01	LC-MS/MS	Terbufos sulfone	0.01	LC-MS/MS
Fenitrothion	0.01	GC-MS/MS	Terbufos sulfoxide	0.01	LC-MS/MS
Phenmedipham	0.01	LC-MS/MS	Terbutylazin	0.01	LC-MS/MS
Fenoxycarb	0.01	LC-MS/MS	Tetrachlorvinphos	0.01	LC-MS/MS
Fenpyroximate	0.01	LC-MS/MS	Tetraconazole	0.01	GC-MS/MS

Compound	LOQ (mg/kg)	Method	Compound	LOQ (mg/kg)	Method
Fenpiclonil	0.01	LC-MS/MS	Tetradifon	0.01	GC-MS/MS
Fenpropathrin	0.01	GC-MS/MS	Thiabendazole	0.01	LC-MS/MS
Fenpropidin	0.01	LC-MS/MS	Thiacloprid	0.01	LC-MS/MS
Fenpropimorph	0.01	LC-MS/MS	Thiuametoxam (sum)	0.01	LC-MS/MS
Fensulfothion	0.01	LC-MS/MS	Thiametoxam	0.01	LC-MS/MS
Fensulfothion-oxon	0.01	LC-MS/MS	Thiocyclam	0.01	LC-MS/MS
Fensulfothion sulfone	0.01	LC-MS/MS	Thiodicarb	0.01	LC-MS/MS
Fentin	0.01	LC-MS/MS	Thiophanate methyl	0.01	LC-MS/MS
Fenthion (sum)	0.01	LC-MS/MS	Thiofanox (sum)	0.01	LC-MS/MS
Fenthion	0.01	LC-MS/MS	Thiofanox	0.01	LC-MS/MS
Fenthion sulfona	0.01	LC-MS/MS	Thiofanox sulfone	0.01	LC-MS/MS
Fenthion sulfoxide	0.01	LC-MS/MS	Thiofanox sulfoxide	0.01	LC-MS/MS
Phenthoate	0.01	GC-MS/MS	Tolclofos methyl	0.01	GC-MS/MS
Fenvalerate (incl.esfenvalerate)	0.01	GC-MS/MS	Tolylfluanid (sum)	0.01	LC-MS/MS
Fipronil (sum)	0.005	GC-MS/MS	Tolylfluanid	0.01	LC-MS/MS
Fipronil	0.005	GC-MS/MS	Triadimefon + Triadimenol	0.01	GC-MS/MS
Fipronil sulfone	0.01	GC-MS/MS	Triadimefon	0.01	GC-MS/MS
Flonicamid	0.01	LC-MS/MS	Triadimenol	0.01	GC-MS/MS
Fluacifop-p-buthyl	0.01	GC-MS/MS	Triallate	0.01	LC-MS/MS
Flubendiamide	0.01	LC-MS/MS	Triazoxide	0.01	LC-MS/MS
Flucythrinate	0.01	GC-MS/MS	Triciclazole	0.01	LC-MS/MS
Fludioxonil	0.01	GC-MS/MS	Trichlorfon	0.01	LC-MS/MS
Flefenacet	0.01	LC-MS/MS	Tricresylphosphate	0.01	LC-MS/MS
Flufenoxuron	0.01	LC-MS/MS	Trifloxystrobin	0.01	LC-MS/MS
Fluopicolide	0.01	LC-MS/MS	Triflumizole	0.01	LC-MS/MS
Fluquinconazole	0.01	LC-MS/MS	Triflumuron	0.01	LC-MS/MS
Flusilazole	0.01	GC-MS/MS	Trifluralina	0.01	GC-MS/MS
Flutolanil	0.01	LC-MS/MS	Triforine	0.01	LC-MS/MS
Flutriafol	0.01	LC-MS/MS	Triticonazole	0.01	LC-MS/MS
Folpet	0.01	GC-MS/MS	Vamidothion	0.01	LC-MS/MS
Fonofos	0.01	GC-MS/MS	Vinclozolin	0.01	GC-MS/MS
Phorate sulfone	0.01	LC-MS/MS	Zoxamide	0.01	LC-MS/MS

5.1 Dairy meals

Ten dairy meals were randomly selected and analysed for pesticides (Table 21). The results are presented in Table 22 and only the pesticides which were above the LOQ are shown.

Table 22. Levels of pesticides (mg/kg = ppm) in the 10 selected dairy meals.

Sample no	Chlorpy-rifos	Delta-methrin	Fenitro-thion	Ethoxy-quin	Lambda cyhalothrin	Malathion (sum)	Perme-thrin	Piperonyl butoxide	Pirimiphos methyl
991076	0.01	0.05	-	0.02	-	0.09	0.10	0.05	0.24
991079	0.01	-	-	0.14	-	-	-	-	0.07
991083	-	-	-	-	-	0.07	-	-	0.01
991086	0.02	0.13	0.01	-	-	-	-	0.14	0.05
991101	0.01	0.04	-	0.08	-	0.02	0.03	0.03	0.06
991105	-	0.04	0.02	-	-	0.48	0.47	-	0.70
991111	-	-	-	-	-	1.10	0.18	0.01	0.05
991167	-	-	-	0.57	-	0.06	-	-	0.02
991170	-	0.02	-	-	0.08	0.37	0.04	-	0.15
991171	-	-	-	0.02	-	0.13	-	0.01	0.02

There are no maximum limits for pesticides residue for animal feeds. The amounts of pesticides found in the ten dairy meals are generally low and just above the limit of quantification (LOQ). Therefore it seems that pesticide residues is not a major problem in the 10 dairy meals that were selected for analysis.

5.2 Cottonseed cake/meal

Five cottonseed meals were randomly selected and analysed for pesticides (Table 21). The results are presented in Table 23 and only the pesticides which were above the LOQ are shown.

Table 23. Levels of pesticides (mg/kg = ppm) in the 5 selected cottonseed meals.

Sample no	Thiuame-toxam (sum)	Iprodione
991054	-	-
991055	0.1	-
991060	-	-
991068	-	0.07
991116	-	-

There are no maximum limits for pesticides residue for animal feeds. Only 2 pesticide residues were found in 2 of the 5 samples with relatively low amounts just above the limit of quantification (LOQ). Therefore it seems that pesticide residues is not a major problem in the 5 cottonseed meals that were selected for analysis.

5.3 Sunflower seed cake/meal

Five sunflower seed meals were randomly selected and analysed for pesticides (Table 21). None of the pesticides listed in Table 21 were detected in the five selected sunflower seed meals. Therefore it seems that pesticide residues is not a major problem in the 5 sunflower seed meals that were selected for analysis.

6. HEAVY METALS IN DAIRY FEEDS AND INGREDIENTS

Although some heavy metals are needed in minute amounts by animals and humans (such as: copper, zinc, chromium and nickel), most of the heavy metals are toxic and dangerous to animal/human health and/or the environment. Heavy metals are persistent (heavy metals do not decay) and one of the largest problems associated with heavy metals is the potential for bioaccumulation in animals and/or humans which can cause serious illness.
Several dairy feed ingredients were randomly selected for analyses of heavy metals. The analysis was carried out by BLGG Deutschland (Parchim, Germany) using ICP and the heavy metals that were analysed are: lead, cadmium, mercury, arsenic, chromium, nickel, zinc and copper.

6.1 Limestone

Ten limestone samples were randomly selected and analysed for heavy metals. The results are presented in Table 24.

Table 24. Levels of heavy metals (mg/kg = ppm) in the 10 selected limestone samples.

Sample no	Lead	Cadmium	Mercury	Arsenic	Chromium	Nickel	Zinc	Copper
991128	1.0	0.06	< 0.01	< 0.50	10.0	5.8	9	2.6
991129	2.5	0.06	< 0.01	0.57	23.7	12.0	15	8.2
991130	3.4	0.17	< 0.01	1.20	3.0	3.3	18	4.4
991131	2.0	0.09	< 0.01	< 0.50	4.0	2.8	10	4.5
991132	143.0	1.50	< 0.01	4.30	11.9	7.5	502	4.2
991133	2.9	0.14	< 0.01	1.90	11.1	1.2	9	1.8
991134	2.5	< 0.02	< 0.01	< 0.50	18.1	13.0	41	41.3
991135	1.9	0.04	< 0.01	< 0.50	17.5	7.9	9	2.5
991136	1.9	0.06	< 0.01	< 0.50	4.0	2.2	8	2.4
991137	2.0	0.09	< 0.01	0.62	4.6	1.1	8	6.5
EU max (ppm)	10.0	2.00	0.10	2.00	-	-	-	-

For 4 heavy metals the EU stipulates a maximum limit in animal feeds and feedstuffs, 10 ppm for lead, 2 ppm for cadmium, 0.1 ppm for mercury and 2 ppm for arsenic. One of the analysed limestone samples is above the EU limit for lead (143 ppm) and arsenic (4.3 ppm).

6.2 Fish and bone meal

Seven fish meal and 2 bone meal samples were selected and analysed for heavy metals. The results are presented in Table 25.

Table 25. Levels of heavy metals (mg/kg = ppm) in the 7 fish meal and 2 bone meal samples.

Sample no	Sample	Lead	Cadmium	Mercury	Arsenic	Chromium	Nickel	Zinc	Copper
991119	Fish meal	19.00	< 0.04	< 0.05	< 0.30	140.5	53.0	90	11.5
991120	Bone meal	< 0.50	< 0.04	< 0.05	< 0.30	14.2	8.2	21	1.2
991121	Fish meal	2.80	0.25	< 0.05	< 0.30	155.5	87.0	37	26.6
991122	Fish meal	17.00	< 0.04	< 0.05	< 0.30	124.5	73.0	115	19.1
991123	Fish meal	< 0.50	< 0.04	< 0.05	< 0.30	100.8	74.0	12	4.9
991124	Fish meal	< 0.50	< 0.04	< 0.05	< 0.30	142.3	65.0	13	51.9
991125	Fish meal	< 0.50	< 0.04	< 0.05	< 0.30	249.2	143.0	33	8.5
991126	Fish meal	12.00	< 0.04	< 0.05	< 0.30	25.4	12.0	36	5.4
991127	Bone meal	3.90	< 0.04	< 0.05	< 0.30	18.2	9.4	45	20.8
EU max (ppm)		10	2	0.1	2	-	-	-	-

For 4 heavy metals the EU stipulates a maximum limit in animal feeds and feedstuffs, 10 ppm for lead, 2 ppm for cadmium, 0.1 ppm for mercury and 2 ppm for arsenic. Three of the analysed fish meal samples are above the EU limit for lead (19, 17 and 12 ppm).

7. SALMONELLA IN FISH AND BONE MEAL

Salmonella is a genus of enterobacteria which can cause serious illness amongst animals and humans. Salmonella infections are zoonotic and many infections are due to ingestion of contaminated food.
Seven fish meals and 2 bone meals were selected for testing on the presence of salmonella. The analysis was carried out by CCL Nutricontrol (Veghel, the Netherlands).
In none of the analysed fish and bone meal samples salmonella was detected.

8. PRICE/QUALITY RATIO OF DAIRY MEALS

8.1 Price of Kenyan dairy meals

In addition to the quality analysis of dairy meals, also the price of dairy meals was recorded. The prices of 19 high yield dairy meals are presented in Table 26, including the protein content when available.

Table 26. Protein content and price of 19 high yield dairy meals.

Type of dairy meal	CP (%)	Price (KES/70kg)
High yield dairy meal	21.1	2750
High yield dairy meal	17.2	1950
High yield dairy meal	18.3	2250
High yield dairy meal	19.1	2300
High yield dairy meal	16.5	2400
High yield dairy meal	15.6	1850
High yield dairy meal	15.2	1750
High yield dairy meal	-	2000
High yield dairy meal	17.7	1800
High yield dairy meal	18.0	1850
High yield dairy meal	13.3	1850
High yield dairy meal	-	1850
High yield dairy meal	14.0	1750
High yield dairy meal	16.7	1600
High yield dairy meal	14.8	1920
High yield dairy meal	17.9	1850
High yield dairy meal	14.9	2200
High yield dairy meal	-	1950
High yield dairy meal	-	1800
	Min	1600
	Max	2750
	Average	**1983**
	Standard dev.	278.7
	CV (%)	**14.1**

The average price of the "high yield" dairy meals is KES 1983,- with a standard deviation of KES 278,7. Figure 11 shows the relationship between the protein content and the price of the high yield dairy meals. It shows a weak positive relationship (R^2 = 0.34)

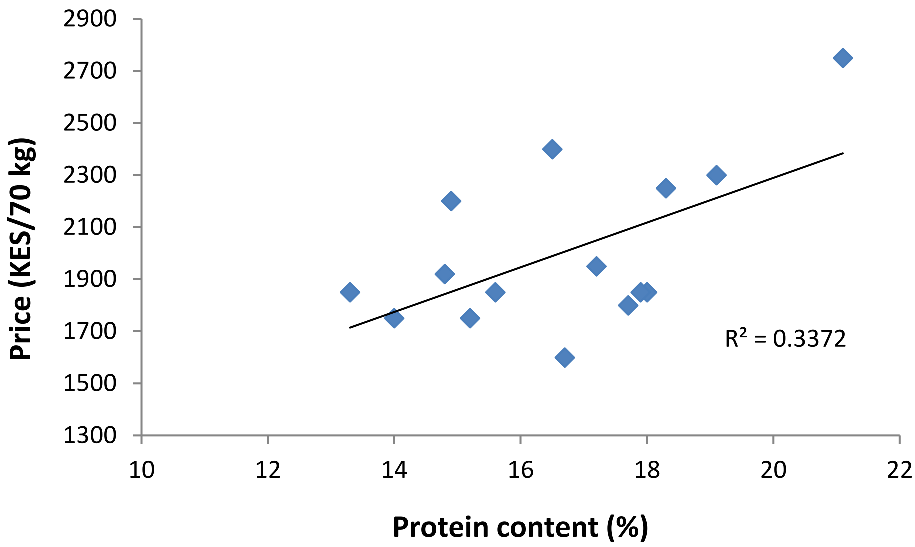

Figure 11. Relationship between the protein content and the price of the high yield dairy meals.

The price of 17 "ordinary" dairy meals are presented in Table 27, including the protein content when available.

Table 27. Protein content and price of 17 ordinary dairy meals.

Type of dairy meal	**CP (%)**	**Price (KES/70kg)**
Ordinary dairy meal	17.8	1400
Ordinary dairy meal	-	1650
Ordinary dairy meal	17.9	1650
Ordinary dairy meal	16.8	1700
Ordinary dairy meal	13.0	1950
Ordinary dairy meal	15.7	1550
Ordinary dairy meal	13.3	1450
Ordinary dairy meal	-	1800
Ordinary dairy meal	16.7	1600
Ordinary dairy meal	16.8	1700
Ordinary dairy meal	17.5	1750
Ordinary dairy meal	14.3	1700
Ordinary dairy meal	15.3	1750
Ordinary dairy meal	18.4	1655
Ordinary dairy meal	-	1700
Ordinary dairy meal	-	1700
Ordinary dairy meal	-	1600
	Min	1400
	Max	1950
	Average	**1665**
	Standard dev.	127.2
	CV (%)	**7.6**

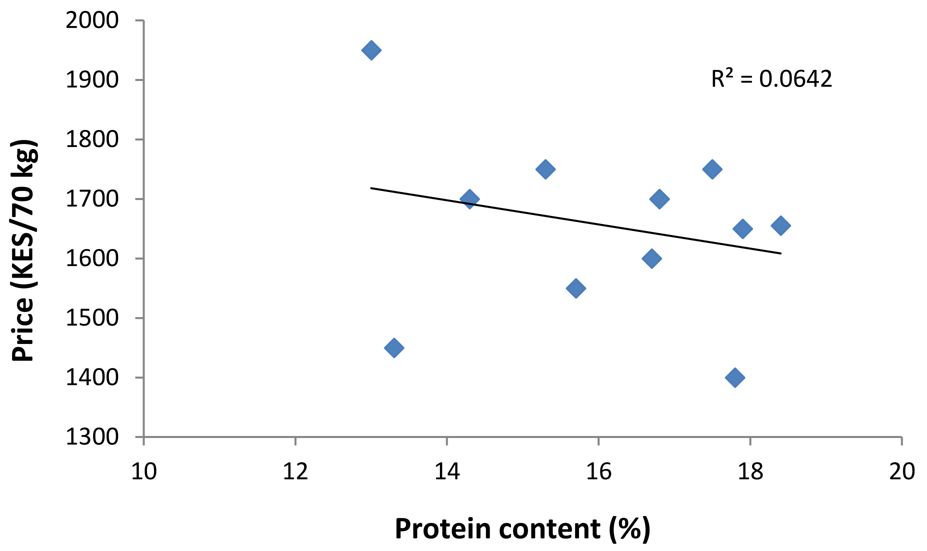

Figure 12. Relationship between the protein content and the price of the ordinary dairy meals.

The average price of the "ordinary" dairy meals is KES 1665,- with a standard deviation of KES 127,2. Figure 12 shows the relationship between the protein content and the price of the ordinary dairy meals. Contrary to the high yield dairy meals, no relationship was found (R^2 = 0.06) between protein content and price of the ordinary dairy meals. It should be noted that 12 observation might have been too low to find a relationship between protein content and price of ordinary dairy meals.

8.2 Prices of dairy meals in other countries

Figure 13 and 14 show the price trends of standard compound feed (or dairy meal) with 14-15% protein and protein rich compound feed with 17-18% protein in the Netherlands, respectively.

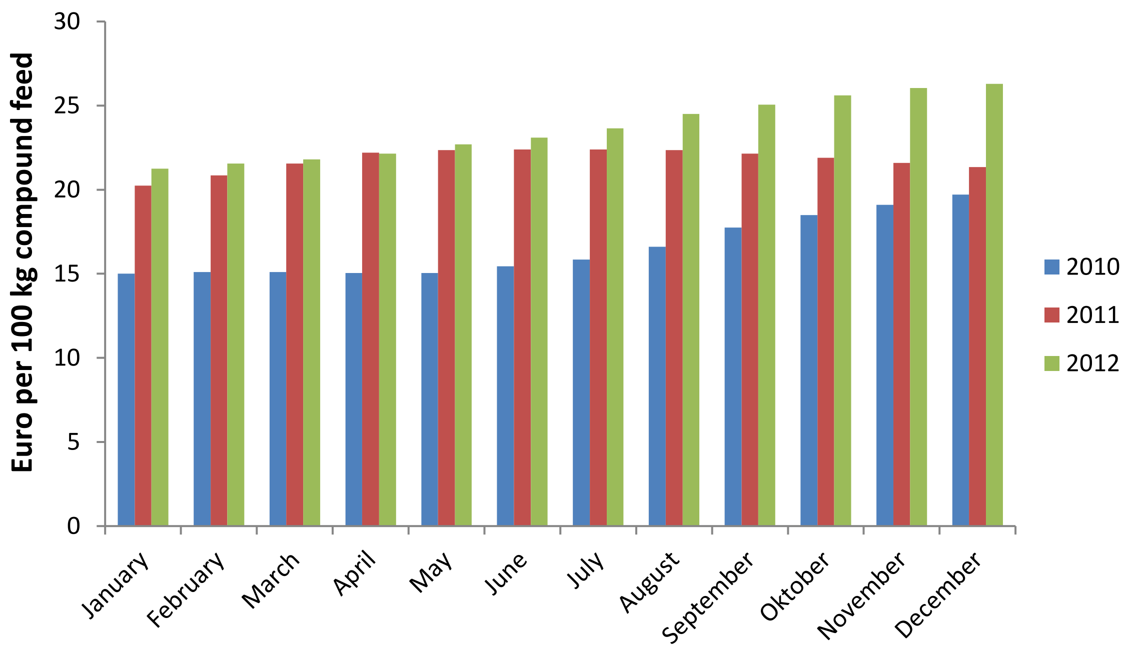

Figure 13. Price trend of standard compound feed (14-15% protein) in the Netherlands. Source: Prijs-Informatie Desk LEI Wageningen UR, the Netherlands.

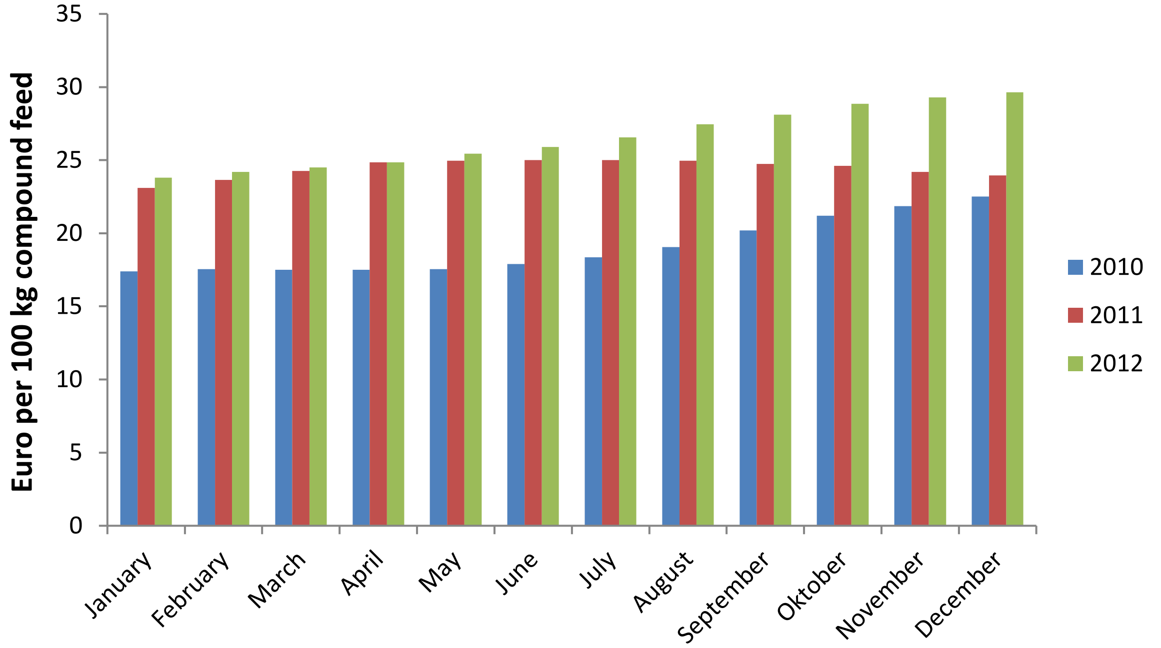

Figure 14. Price trend of protein-rich compound feed (17-18% protein) in the Netherlands (Source: Prijs-Informatie Desk LEI Wageningen UR, the Netherlands).

Figure 15 below shows the price trend of standard compound feed (or dairy meal) with ± 15% protein in the Kansas City area (United States of America).

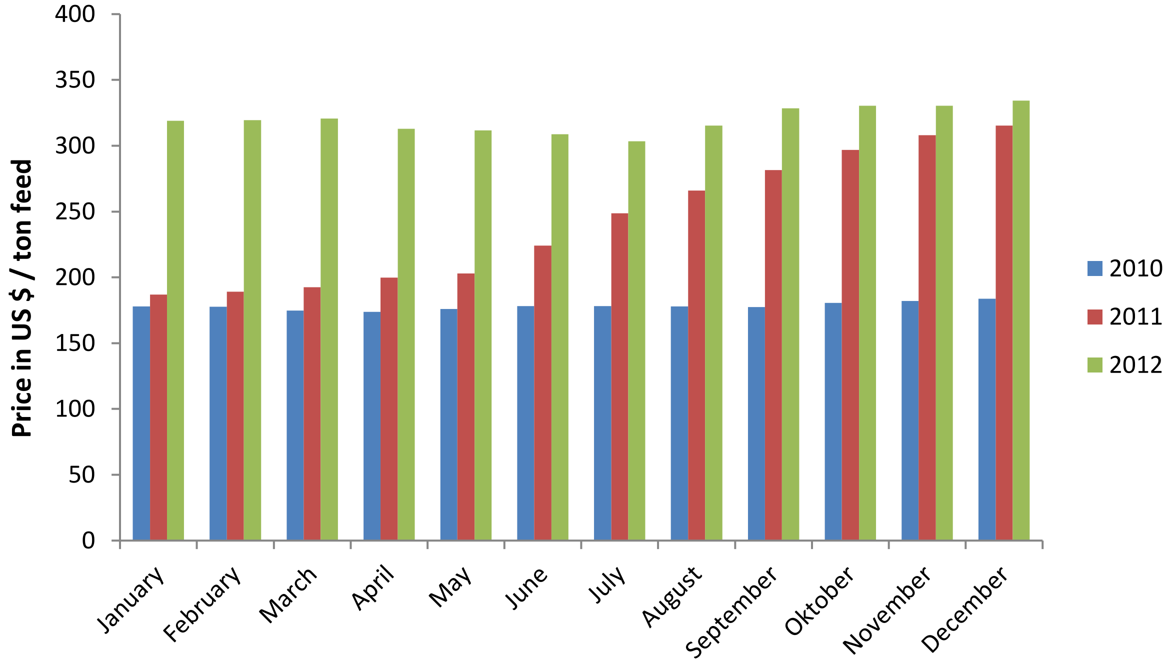

Figure 15: Price trend of compound feed (15% protein) in the Kansas City area, USA (Source: Prof. Brian W. Gould, Agricultural and Applied Economics, University of Wisconcin, Madison).

Figure 16 below shows the price trend of standard compound feed (or dairy meal) in the United Kingdom (UK).

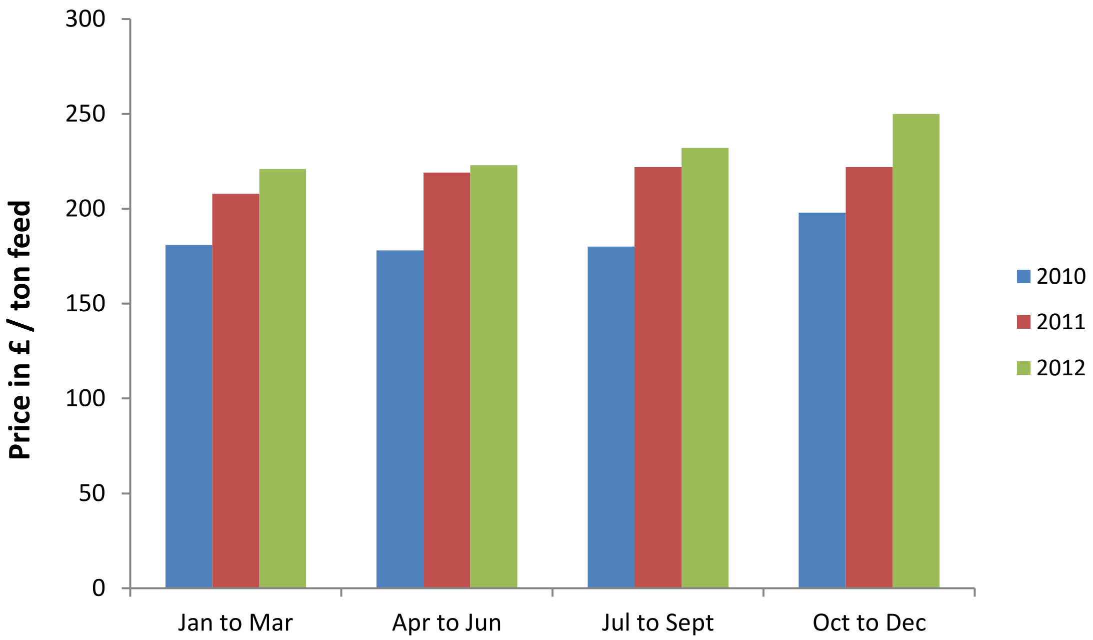

Figure 16: Price trend of standard compound feed in the UK (Source: Tom Johnson, national statistics of Department for Environment, Food and Rural Affairs (DEFRA).

8.3 Comparison of price/quality ratio between Kenya and other countries

Figure 17 on the next page shows the prices we recorded in the Kenyan dairy meals (both ordinary and high yield) with the prices of dairy meals (compound feeds) in other countries. The prices of the dairy meals from the different countries date from December 2012. The dairy meal prices of each country were converted to euro's by using the appropriate exchange rate of the currency in December 2012.

From this comparison it seems that the price of Kenyan dairy meals is somewhat lower compared to the other countries investigated (the Netherlands, United States of America and the United Kingdom). This is the case for both ordinary as well as high yield dairy meals, although for high yield dairy meals only the Netherlands was used for comparison. It should also be noted that this is just a comparison of one time point (snapshot) and it could be that the differences in prices vary across time. In addition, the exchange rate of the different currencies and the amount of dairy meal which is used to express (e.g. per 70kg, per 100kg or per ton) can have a large influence on the price of dairy meals. For example, in the Netherlands the price per kg compound feed is much lower when 5 tons of feed are bought compared to when 10 kg of feed is bought.

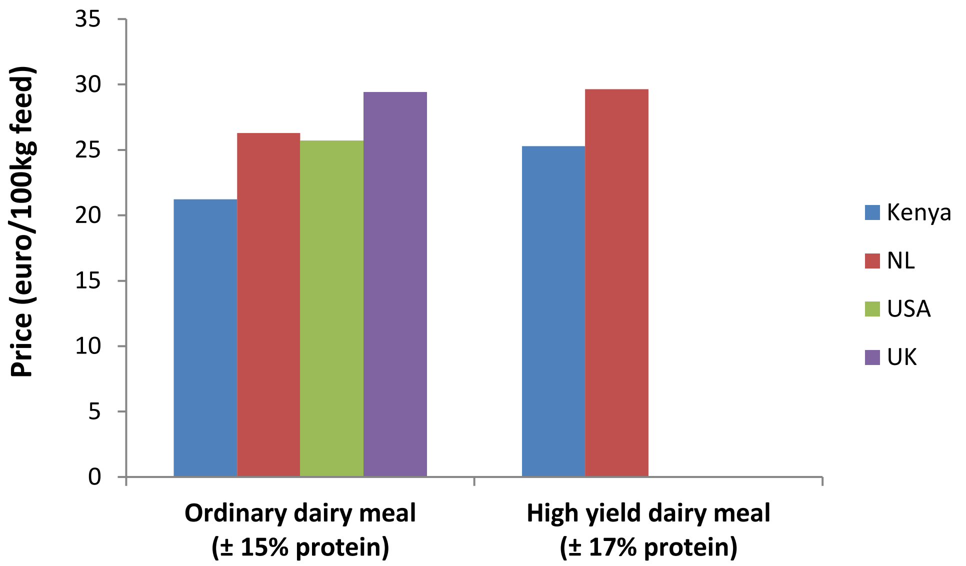

Figure 17: Price comparison of dairy meals (both ordinary and high yield) between Kenya and other countries. Prices are from December 2012.

9. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

9.1 Nutritional value of dairy meals

The results of the analysis of the dairy meal database provided by Dr. Makoni (ABS TCM ltd) and the results of the nutritional analysis by BLGG of the dairy meals collected as part of this study, are comparable, indicating that our results are reasonably representative for Kenyan dairy meals (both ordinary and high yield). However, it should be noted that although averages were quite similar, in both cases there was substantial variation in the nutritional composition.

In both cases it is shown that the main issues with dairy meals are the ash and crude protein content. In general, approximately 50% of the dairy meals that were analysed did not meet the KEBS standard for ash content (ABS: 50% and 43%, BLGG: 65% and 56% for high yield and ordinary dairy meals, respectively).

Similarly, approximately 1/3 of the dairy meals that were analysed did not meet the KEBS standard for crude protein content (ABS: 28% and 30%, BLGG: 39% and 25% for high yield and ordinary dairy meals, respectively).

Protein is one of the main and most valuable components of a dairy meal (together with metabolizable energy) to promote adequate milk production in dairy cows. It is therefore important that dairy meals contain the minimum amount of crude protein which is required by the KEBS standard. It is therefore recommended that regular testing of dairy meals, to examine if dairy meals comply with the KEBS standard, is implemented to ensure their nutritional quality. In addition, a label containing the nutritional composition of the dairy meal should be mandatory in order for the users to know what they are feeding their dairy cows.

9.2 Nutritional value of raw materials

In addition to dairy meals, also several raw materials were analysed for their nutritional value, since these are used to produce dairy meals.

The nutritional analysis of wheat bran shows that most nutrients meet the KEBS standard, although variation is relatively high. One exception was dry matter, since 70% of the wheat bran samples that were analysed did not meet the KEBS standard. This can create a problem with spoilage (moulds, mycotoxins etc) if this wheat bran is storage for a relatively long period.

The nutritional analysis of wheat pollard shows the same trend as for wheat bran. This means that the relative low dry matter content can create a problem with spoilage (moulds, mycotoxins etc) if stored for a relatively long period.

For maize germ meal the nutritional analysis shows that a high number of samples did not meet the KEBS standard for dry matter (90%), ash (90%) and crude protein (70%). This means that a high percentage of the analysed maize germ meals are of sub-standard quality and this could explain the fact that a high number of dairy meals did not meet the KEBS standard for ash and crude protein.

The results for cottonseed cake show that most nutrients meet the KEBS standard. Only the crude fat content is an issue since 60% of the samples did not meet the KEBS standard. This indicates that the fat extraction method used is not always efficient enough and a relative high amount of fat remains in the cottonseed cake. Feeding a high amount of fat (> 8% of total diet) to dairy cows can lead to a decreased fibre digestion in the rumen and therefore a decreased milk production. The same issue with high fat content also applies to the sunflower seed cake samples that were analysed.

In addition, 90% of the analysed sunflower seed cake samples did not meet the KEBS standard for crude fibre, indicating that the extent of dehulling is too low.
The analysis results of the fish meal samples show that none of the examined fish meal samples meet the KEBS standards for ash and crude protein. The average ash content of the fish meal samples was almost 50% where the KEBS standard stipulates a maximum ash content of 20%. In addition, the average protein content is 40% where the KEBS standard stipulates a minimum crude protein content of 60%. This shows that the fish meal samples that were analysed are of very poor nutritional quality which could be caused by: the use of cannery offal or contamination with other substances.

9.3 Nutritional value of fodders

On average the nutritional quality of the maize silages is quite good. One of the remarkable aspects of the maize silages is the low starch content, which in turn results in relative high fibre contents. This low starch content indicates that these maize silages were most likely harvested relative early, before the cob (and kernels which contain starch) are fully developed. This also leads to a relative low OM digestibility and consequently net energy. It has to be noted that other factors also influence the starch content of maize silage including: genetic variety, fertilization and/or climate/weather.
The results of nutritional analysis of the Boma Rhodes hay samples show a relative high fibre content combined with a relative low protein content. In addition, the OM digestibility and therefore net energy are relatively low. These result could indicate that fertilization was not optimal (not enough nitrogen) or that the grass was cut too late (high stem to leaf ratio). It has to be noted that the recommended values of BLGG and the average NL values used for comparison are mainly based on hay which are made from perennial ryegrass (*Lolium perenne*), which in general contain more protein and less crude fibre.
The nutritional analysis of the lucerne hay samples show that the fibre content is relatively low and the protein content is relatively high. In addition, the OM digestibility and therefore the net energy is relatively high compared to the average values in NL. This indicates that the Lucerne hay samples that were analysed are high quality fodders in terms of their nutritional composition. It has to be noted however that only 3 samples were analysed, which might not be representative for Lucerne hay in general.

9.4 Mycotoxins in animal feeds

In both dairy meals and maize germ cake/meals, 3 out of the 5 examined samples contained aflatoxins above the maximum level (KEBS; 10ppb) for dairy feedstuffs. On the contrary, none of the 10 examined maize silages contained mycotoxins above the maximum levels.
This indicates that care should be taken with dairy meals and maize germ meal, to reduce to risk of aflatoxin contamination.

9.5 Pesticides in animal feeds

The presence of pesticides was examined in 10 dairy meals, 5 cottonseed meals and 5 sunflower seed meals which were randomly selected as part of this study. In the dairy meals that were investigated only a low amount of pesticides (just above the detection limit) were found.

In the cottonseed meals only 2 very low pesticide residues were found in the sunflower seed meal no pesticide residue at all was found. These results indicate that pesticide residues are not a major issue in the animal feeds that were analysed as part of this study.

9.6 Heavy metals

The presence of heavy metals was tested in 10 limestone, 7 fish meal and 2 bone meal samples which were randomly selected as part of this study. Out of the 10 limestone samples, 1 sample exceeded the maximum limit for lead and arsenic stipulated by the EU.

9.7 Salmonella

Seven fish meals and 2 bone meals were selected for testing on the presence of salmonella. In none of the analysed fish and bone meal samples salmonella was detected.

10. APPENDIX SAMPLING PROTOCOLS

10.1 Sampling protocol of animal feeds (raw materials, end products, concentrates)

Preparation:

1. Determine what can be considered as one lot (animal feedstuff produced under similar conditions).
2. Work hygienically.

Tools:

1. Sampling apparatus: cylindrical sampler, shovel or hand-scoop (shall be clean and dry).
2. Sampling bag or container (shall be clean and dry).

Sampling:

1. Samples shall be fully representative of the lot from which they are drawn (use the whole lot).
2. A sufficient number of primary samples shall be drawn and carefully mixed, giving a representative bulk sample (minimum number of primary samples is 9).
3. When the material is in cakes or large lumps, single cakes or large lumps may be taken as primary samples of the lot
4. The minimum weight of the bulk sample (mix of primary samples) shall be 1 kilogram.

Packaging and labeling:

1. Sampling bag or container shall be closed/sealed properly with as little air as possible (fill bag or container as much as possible).
2. The label of the sample shall at least contain the following:
   - Type of product/material: mixture or not, additives, maturity, storage.
   - Date and place of sampling.
   - Name and address manufacturer.
   - Name of the sampler.
   - Any other particulars of the lot.

Storage:

Samples shall be stored dry, dark and cool (as cool as possible) and transported to the laboratory as soon as possible.

10.2 Sampling protocol of fodders (silage pit, silo, loose, bulk or loosely deposited)

Preparation:

1. Determine what can be considered as one lot (samples shall not be mixed across different lots).
2. Work hygienically.

Tools:

1. Sampling apparatus: cylindrical sampler, shovel or hand-scoop (shall be clean and dry).
2. Sampling bag or container (shall be clean and dry).

Sampling:

1. Samples shall be fully representative of the lot from which they are drawn (use the whole lot).
2. A sufficient number of primary samples shall be drawn and carefully mixed, giving a representative bulk sample (minimum number of primary samples is 9).
3. Make sure that samples are not taken from the surface of the lot, but on a depth of 50 to 100 centimeter.
4. If samples are taken from silage, make sure that cover is closed again.
5. Create 2 bulk samples (mix of primary samples) with a minimum weight of 1 kilogram each.

Packaging and labeling:

1. Sampling bag or container shall be closed/sealed properly with as little air as possible (fill bag or container as much as possible).
2. The label of the sample shall at least contain the following:
   - Type of product/material: mixture or not, additives, maturity, storage.
   - Date and place of sampling.
   - Name and address manufacturer.
   - Name of the sampler.
   - Any other particulars of the lot.

Storage:

1. Samples shall be stored dry, dark and cool (as cool as possible) and transported to the laboratory as soon as possible.