

## Annex 1 Tables of results

Table 1 Flock age at start of monitoring (weeks)

Site		Period 1	Period 2	Period 3
1	Age at start (weeks)	46	26	35
2	Age at start (weeks)	49	24	33
3	Age at start (weeks)	22	56	66

Table 2 Feed dry matter contents (g/kg), estimated metabolisable energy values (MJ/kg dry matter) and feed metabolisable energy intake (MJ/hen.day)

Site (s)	Variable	Period 1	Period 2	Period 3
1	Dry matter (g/kg fresh basis)	886	880	878
2	Dry matter (g/kg fresh basis)	876	884	872
3	Dry matter (g/kg fresh basis)	900	869	872
1	Estimated metabolisable energy (MJ/kg dry matter)	12.4	12.6	12.2
2	Estimated metabolisable energy (MJ/kg dry matter)	12.5	11.9	12.6
3	Estimated metabolisable energy (MJ/kg dry matter)	11.2	11.3	10.1
1	Feed metabolisable energy intake (MJ/hen.day)	1.37	1.38	1.36
2	Feed metabolisable energy intake (MJ/hen.day)	1.43	1.30	1.19
3	Feed metabolisable energy intake (MJ/hen.day)	1.19	1.24	0.97

Table 3 Manure nutrient contents (%dw)

Site (s)	Variable	Period 1	Period 2	Period 3
1	Dry matter (%)	43.8	30.7	34.9
1	Total nitrogen (%dw)	3.9	5.8	4.8
1	Ammonium-nitrogen (%dw)	1.7	2.3	1.6
1	Uric acid-nitrogen (%dw)	1.1	0.1	0.9
2	Dry matter (%)	65.4	33.0	34.2
2	Total nitrogen (%dw)	4.3	5.0	4.3
2	Ammonium-nitrogen (%dw)	3.8	2.4	1.5
2	Uric acid-nitrogen (%dw)	1.1	0.6	0.3
3	Dry matter (%)	32.7	35.0	35.1
3	Total nitrogen (%dw)	1.5	4.6	4.0
3	Ammonium-nitrogen (%dw)	2.7	1.9	6.1
3	Uric acid-nitrogen (%dw)	0.9	0.5	0.5

Table 4 Mean gradient for linear regression ( $p < 0.001$ ) of (internal temperatures) T1.T2 and T2.T1, and improved estimate of the regression coefficient (MnT1T2) (Munson and Rodbard, 1981; Rodbard *et al.*, 1977), their standard errors, and approximate errors calculated by the propagation of errors (Wilson, 1981; Melissinos, 1966)

s	p	T1T2	%VAR T1T2	T2T1 grad	1/T2T1 grad	MNT1T2 grad	SE_T1T 2	SE_T2T 1	SE_1/ T2T1	SE_MN T1T2
1	1	0.8620	65	0.77000	1.29870	1.08035	0.1140	0.10200	0.17204	0.20638
1	2	0.9770	77	0.79460	1.25849	1.11775	0.1120	0.09090	0.14397	0.18240
1	3	0.9378	87	0.93520	1.06929	1.00354	0.0732	0.07300	0.08347	0.11102
2	1	1.2260	95	0.77500	1.29032	1.25816	0.0551	0.03480	0.05794	0.07996
2	2	0.2420	81	3.39100	0.29490	0.26845	0.0222	0.31100	0.02705	0.03499
2	3	3.4630	50	0.15220	6.57030	5.01665	0.7330	0.03220	1.39004	1.57146
3	1	1.1843	92	0.77780	1.28568	1.23499	0.0756	0.04970	0.08215	0.11164
3	2	1.0800	68	0.64100	1.56006	1.32003	0.1440	0.08550	0.20809	0.25306
3	3	1.0040	100	0.99523	1.00479	1.00440	0.0067	0.00664	0.00670	0.00948

**Note:**

The purpose of Table 4, *inter alia*, was to provide credible information that the temperatures near the nest boxes (T1, INT1 in the report) were substantially mirrored by those above the slats (T2, INT2 in the report) and that they were not some unrelated abnormal idiosyncrasy of the measurement or place of measurement, data for which, if unrelated, could not be accommodated within the hen model. We consider the first numerical line only in Table 4. Linear regression, without recourse to special software, assumes e.g. a response variable T1 and an independent variable (with no error) T2. Column 3 shows the slope from such an analysis and the percentage variation explained is shown in column 4. However, both these variables have uncertainties and neither can be said to be independent. Thus if we now carry out the regression the other way around *i.e.* T2 (response variable) and T1 the independent variable we get the slope in column 5. However, the inverse of this latter slope (column 6) gives another estimate of the slope T1, versus T2 which we can now average (column 7) to get a representative value of the slope of T1, versus T2 when consideration has been given to uncertainty in both variables. We use the propagation of errors, utilising the uncertainty of each calculated intermediate component (columns 8 to 10) that led to column 7, and this is given in the last column (column 11). In summary column 7 shows a representative value for the slope of T1, versus T2 with its standard error (column 11).

Table 5 Regression analysis of feed metabolisable energy intake (MJ/hen.day) versus OUT1, OUT2 (when measured), INT1 and INT2 (°C)

Site	Period	Independent variable	P-value	%Variance explained
1	1	OUT1	NS	2
1	1	INT1	NS	0
1	1	INT2	NS	0
1	2	OUT1	NS	0
1	2	INT1	NS	0
1	2	INT2	NS	0
1	3	OUT1	0.018	19
1	3	INT1	NS	10
1	3	INT2	NS	0
2	1	OUT1	NS	0
2	1	INT1	NS	0
2	1	INT2	NS	0
2	2	OUT1	NS	0
2	2	INT1	NS	0
2	2	INT2	NS	0
2	3	OUT1	NS	0
2	3	OUT2	NS	0
2	3	INT1	NS	0
2	3	INT2	NS	0
3	1	OUT1	NS	0
3	1	INT1	NS	0
3	1	INT2	NS	1
3	2	OUT1 (missing data)	-	-
3	2	INT1	0.014	19
3	2	INT2	NS	6
3	3	OUT1	NS	0
3	3	OUT2	NS	0
3	3	INT1	NS	0
3	3	INT2	NS	0

Table 6 Calculated nutrient content of layer ration (2) for non-organic free-range hens and organic hens (as fed basis, g/kg)

Nutrient	Non-organic ration Concentration (g/kg)	Organic ration Concentration (g/kg)	Target specification (g/kg)
Dry matter	878.0	879.2	-
Crude protein	179.5	199.3	170.0 – 220.0
Lysine	8.6	<b>7.9</b>	8.6 – 9.1
Methionine	4.1	<b>3.7</b>	4.1 – 4.3
Methionine + cystine	7.0	7.4	-
Tryptophan	2.2	2.2	2.1 – 2.3
Crude fibre	27.8	43.5	-
Oil (acid)	53.9	50.4	20.0 – 60.0
Linoleic acid	28.1	26.8	>17.5
Total ash	139.8	137.3	-
Calcium	43.0	41.0	41.0 – 43.0
Total phosphorus	5.5	<b>6.0</b>	<5.5
Available phosphorus	3.4	3.5	3.4 – 3.6
Sodium	1.7	1.7	1.7 – 1.9
Potassium	7.8	7.0	>2.0
Chloride	2.3	2.2	1.8 – 2.3
metabolisable energy (MJ/kg)	11.70	<b>11.67</b>	11.70 – 11.90

Notes: the target nutrient specifications used for laying hens were marginally higher than those given by the NRC (1994). However, it is important to note that the recommendations given by the NRC are estimates derived from requirements for smaller white-egg layers. The target nutrient specifications given in Table 8 are typical of those recommended by the breeder company for brown egg-layer hybrids in UK outdoor production systems. Values given in bold italic fall outside the target range for a nutrient or energy value.

Table 7 Calculated nutrient content of 'chick' ration for non-organic pullets and organic pullets (as fed basis, g/kg)

Nutrient	Non-organic chick ration Concentration (g/kg)	Organic chick ration Concentration (g/kg)	Target specification (g/kg)
Dry matter	877.9	876.6	-
Crude protein	<b>193.7</b>	<b>209.7</b>	180.0
Lysine	9.2	<b>9.0</b>	9.2
Methionine	4.0	<b>3.9</b>	4.0
Methionine + cystine	7.0	7.6	6.8
Tryptophan	2.3	<b>2.3</b>	2.1
Crude fibre	40.0	41.1	-
Oil (acid)	56.2	56.3	-
Linoleic acid	27.5	<b>28.3</b>	10.0
Total ash	65.6	64.3	-
Calcium	10.5	10.1	10.0-10.5
Total phosphorus	7.4	7.2	-
Available phosphorus	4.5	4.5	4.5
Sodium	1.7	1.7	1.6 – 1.8
Potassium	<b>8.9</b>	<b>8.1</b>	<7.0
Chloride	2.3	2.3	1.8-2.3
ME (MJ/kg)	11.80	<b>12.20</b>	11.80

Values given in bold italic fall outside the target range for a nutrient or energy value.

Table 8 Calculated nutrient content of grower ration for non-organic traditional free-range table chickens, organic table chickens (not including fishmeal) and organic table chickens (including fishmeal) (as fed basis)

Nutrient	Non-organic traditional free-range table chickens Concentration (g/kg)	Organic table chickens (not including fishmeal) Concentration (g/kg)	Organic table chickens (including fishmeal) Concentration (g/kg)	Target specification (g/kg)
Dry matter	864.0	867.2	866.5	-
Crude protein	179.9	180.7	184.2	161.0 – 210.0
Lysine	8.6	<b>7.6</b>	<b>8.2</b>	8.6 – 9.1
Methionine	3.3	<b>3.0</b>	3.2	3.1 – 3.3
Methionine + cystine	6.3	6.3	6.3	6.3 – 6.5
Tryptophan	2.1	2.1	2.1	2.1 – 2.3
Crude fibre	23.5	<b>41.9</b>	32.9	<40.0
Oil (acid)	34.2	<b>51.2</b>	<b>51.6</b>	<50.0
Linoleic acid	17.5	<b>27.3</b>	<b>26.9</b>	17.5 – 20.0
Total ash	55.0	55.1	54.6	-
Calcium	8.7	8.4	8.6	8.2 - 8.7
Total phosphorus	6.1	6.5	6.3	<6.5
Available phosphorus	4.1	4.1	4.3	4.1 – 4.3
Sodium	1.6	1.6	1.7	1.6 – 1.8
Potassium	7.0	<b>7.3</b>	<b>7.1</b>	<7.0
Chloride	2.3	2.3	2.3	1.8 – 2.3
ME (MJ/kg)	12.59	12.75	<b>12.95</b>	12.20 – 12.80

Values given in bold italic fall outside the target range for a nutrient or energy value.

Table 9 Calculated nutrient content of breeder 'layer 1' ration for non-organic breeders (as fed basis, g/kg)

Nutrient	Non-organic breeder 'layer 1' ration Concentration (g/kg)	Organic breeder 'layer 1' ration Concentration (g/kg)	Target specification (g/kg)
Dry matter	873.0	872.5	-
Crude protein	165.1	174.4	150.0 – 200.0
Lysine	7.4	<b>7.1</b>	7.4 – 7.9
Methionine	3.5	<b>3.3</b>	3.5 – 3.7
Methionine + cystine	6.3	6.3	6.3 – 7.0
Tryptophan	2.0	1.9	1.8 – 2.0
Crude fibre	40.0	35.7	<40.0
Oil (acid)	38.6	38.7	<60.0
Linoleic acid	20.0	19.7	14.0 – 20.0
Total ash	110.2	106.6	-
Calcium	31.0	29.5	29.0 – 31.0
Total phosphorus	6.5	6.3	-
Available phosphorus	4.0	4.1	4.0 – 4.2
Sodium	1.5	1.6	1.5 – 1.7
Potassium	7.1	6.3	2.0 – 9.0
Chloride	2.3	2.3	1.8 – 2.3
ME (MJ/kg)	11.50	<b>11.78</b>	11.50 – 11.70

Values given in bold italic fall outside the target range for a nutrient or energy value.

Table 10 Composition of layer ration (2) for non-organic free-range hens (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	598.9
Soya extracted de-hulled	209.6
Sunflower meal	30.4
Vegetable oil	37.7
Synthetic methionine	1.4
Dicalcium phosphate	9.2
Limestone	98.1
Sodium bicarbonate	1.9
Salt	2.8
Mineral and vitamin supplement	10.0

Table 11 Composition of layer ration (2) for organic hens (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	533.0
Soya full-fat supa soy	200.0
Maize gluten 60/2	70.0
Sunflower meal	80.0
Dicalcium phosphate	10.0
Limestone	92.0
Sodium bicarbonate	2.75
Salt	2.25
Mineral and vitamin supplement	10.0

Table 12 Composition of 'chick' ration for non-organic pullets (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	501.8
Wheatfeed	150.0
Soya ex de-hulled	149.3
Maize gluten feed (200 g/kg crude protein)	54.2
Sunflower meal	32.1
Fishmeal (660 g/kg crude protein)	25.0
Peas	23.0
Vegetable oil	32.2
Synthetic methionine	0.847
Dicalcium phosphate	9.0
Limestone	9.5
Sodium bicarbonate	1.1
Salt	2.1
Mineral and vitamin supplement	10.0

Table 13 Composition of 'chick' ration for organic pullets (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	509.0
Wheatfeed	150.0
Soya full-fat supa soy	200.0
Maize gluten 60/2	60.0
Sunflower meal	25.0
Fishmeal (660 g/kg crude protein)	25.0
Dicalcium phosphate	9.5
Limestone	8.0
Sodium bicarbonate	1.5
Salt	2.0
Mineral and vitamin supplement	10.0

Table 14 Composition of grower ration for non-organic traditional free-range table chickens (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	750.0
Barley	8.8
Soya ex de-hulled	160.7
Maize gluten 60/2	25.4
Fishmeal (660 g/kg crude protein)	4.2
Vegetable oil	16.8
Synthetic lysine	1.1
Synthetic methionine	0.38
Dicalcium phosphate	12.5
Limestone	5.8
Sodium bicarbonate	2.2
Salt	2.2
Mineral and vitamin supplement	10.0

Table 15 Composition of grower ration for organic table chickens (not including fishmeal) (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	688.0
Soya full-fat supa-soy	200.0
Maize gluten 60/2	20.0
Sunflower meal	60.0
Dicalcium phosphate	12.5
Limestone	5.0
Sodium bicarbonate	2.3
Salt	2.3
Mineral and vitamin supplement	10.0

Table 16 Composition of grower ration for organic table chickens (including fishmeal) (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	707.5
Soya full-fat supa soy	200.0
Maize gluten 60/2	20.0
Sunflower meal	20.0
Fishmeal 66	25.0
Dicalcium phosphate	10.0
Limestone	4.0
Sodium bicarbonate	1.5
Salt	2.0
Mineral and vitamin supplement	10.0

Table 17 Composition of breeder 'layer 1' ration for non-organic breeders (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	650.3
Soya ex de-hulled	122.3
Sunflower meal	76.0
Wheatfeed	38.1
Vegetable oil	20.8
Synthetic lysine	0.532
Synthetic methionine	0.827
Dicalcium phosphate	12.2
Limestone	64.8
Sodium bicarbonate	1.7
Salt	2.4
Mineral and vitamin supplement	10.0

Table 18 Composition of breeder 'layer 1' for organic breeders (g/kg)

Ingredient	Concentration (g/kg)
Wheat (110 g/kg crude protein)	642.5
Soya full-fat supa-soy	120.0
Sunflower meal	40.0
Wheatfeed	50.0
Maize gluten 60/2	40.0
Fishmeal 66	25.0
Dicalcium phosphate	9.0
Limestone	60.0
Sodium bicarbonate	1.5
Salt	2.0
Mineral and vitamin supplement	10.0

Table 19 Summary of the effects of temperature on % change in maintenance requirement per °C

Source	Temperature range, °C	% change in maintenance metabolisable energy requirement per °C
Romijn and Lokhorst, 1966	5 to 10	0.69
Van Kampen, 1974	10 to 20	2.85
Emmans, 1974	7 to 35	1.54
Byerly <i>et al.</i> , 1978	Probably wide	1.05
Van Kampen, 1981	10 to 35	0.89; 1.49
Ozeki <i>et al.</i> , 1988	-5 to 20	1.31
Basaglia <i>et al.</i> , 1999	12 to 31	2.55

## Annex 2 References

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### Annex 3 Details of acronyms used

Acronym	Meaning
s	Site
p	Period
INT	Internal (house) temperature
INT1	Internal temperature measured adjacent to the nest boxes
INT2	Internal temperature measured over the slats
OUT	Outside temperature
OUT1	Outside temperature measured at position 1
OUT2	Outside temperature measured at position 2
Tw	Weighted mean temperature
Tw10%	Weighted mean temperature when 10% of the flock ranged outdoors
Tw50%	Weighted mean temperature when 50% of the flock ranged outdoors
TotOUT	Total degrees outdoors during ranging
TotINT ACC	Total degrees indoors during range access
TotINT NO ACC	Total degrees indoors during no range access
TotINT DARK	Total degrees indoors during darkness
Tot FLOCK	Total degrees experienced by the flock
%dw	% dry weight
LCT	Lower critical temperature
UCT	Upper critical temperature