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Performance of commercial laying hen genotypes on free range and organic farms in Switzerland, France and The Netherlands

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Abstract 1. A total of 257 farmers with free ranging laying hens (organic and conventional) in Switzerland, France and The Netherlands with 273 flocks were interviewed to determine the relationships between the genotype of the hens, management conditions and performance.
2. Almost 20 different genotypes (brands) were present on the farms. In France, all birds were brown feathered hens laying brown eggs. In Switzerland and The Netherlands, there were brown, white (white feathered hens laying white eggs) and silver (white feathered hens laying brown eggs) hens. In Switzerland, mixed flocks were also present.
3. The overall effect of system (organic vs. conventional free range) on egg production and mortality was significant, with higher mortality and lower egg production among organic hens. In pair wise comparisons within country, the difference was highly significant in The Netherlands, and showed a non-significant tendency in the same direction in Switzerland and France.
4. White hens tended to perform better than brown hens. Silver hens appeared to have a higher mortality and lower production per hen housed at 60 weeks of age.
5. There were no significant relationships between production, mortality, feather condition and use of outside run or with flock size.
6. There was more variation in mortality and egg production among farms with a small flock size than among farms with a large flock size.

INTRODUCTION

In Europe and the United States, alternatives for cage housing of laying hens have become more common. The implementation of EU Council Directive 1999/74 has meant that from January 2012 onwards, housing of hens in non-enriched cages is prohibited. Alternative systems that conform to the EU directive are enriched or 'colony' cages and non-cage housing, the latter with or without an outside range. In the EU as a whole, the colony cage (Kleingruppenhaltung in Germany) is the baseline. This system, in which some environmental enrichment (e.g. perches, nest boxes, dust bath) is provided, has been designed for groups of up to about 80 hens. In Switzerland, a non-EU country, enriched cages are also prohibited, and free range is most common: almost 70% of layers are kept according to free range (RAUS) standards (Bundesamt für Landwirtschaft, 2010).

The EU recognises several categories for housing systems of laying hens:

Code 0: Organic production, with at least $4\,m^2$ outdoor range for each laying hen, and inside housing in a barn (floor) or aviary (multi level) system with no more than $6\,hens/m^2$ accessible surface. In addition, beak trimming is not allowed, and the diet must be composed of at least 95% organic ingredients (a move

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to 100% from 2012 has been deferred for the present).

Code 1: Free range production, with outside access as above, inside with a maximum of 9 hens/m^2 accessible area, but no requirement for organic feed ingredients, and beak treatment is allowed.

Code 2: Housing in barns or aviaries without outside access, with a maximum of 9 hens/m^2.

Code 3: Housing in enriched cages.

The number of farms with free range hens (organic and conventional) is increasing. In general, production efficiency in free range systems is lower than in closed housing systems and mortality is more variable and on average higher (Sparks *et al*., 2008; Thiele and Pottgüter, 2008; Anderson, 2010).

Worldwide, three breeding companies provide almost all the hens for commercial egg production. In general these hens are the result of a cross between 4 grandparent lines. The companies each provide a variety of genetic groups, and within these groups several specific 'brands'. The main groups of commercial laying hens are white layers, brown layers and more recently silver layers. White layers have white feathers, lay white eggs, lay slightly more eggs, consume slightly less food and generally have a body weight below 1900 g. Brown layers have brown top feathers, white down feathers, lay brown eggs and have a bodyweight between 1900 and 2000 g. Silver layers have mainly white feathers and some of them may be partly brown. They lay brown eggs and have bodyweights up to 2100 g. As the world market predominantly is focussed on cage housing, selection emphasis has been mainly on good performance in cages. Up to 1999, results were published of European random sample testing of layers of different brands housed in cages (Heil and Hartmann, 1999). In the early days of random sample testing, layers were tested in floor pens. Later, almost all testing stations shifted to cage housing. From 2000 onwards, no international representative summary of random sample testing was possible, due to closure of most of the testing stations and the increasing variability in type of housing/environment, which makes random sample testing less reliable (Heil and Hartmann, 1999). The few stations that still function (e.g. North Carolina, USA and Ustrasice, Czech Republic) test hens in different systems, but no published results were found for comparisons of genotypes in free range systems. Glawatz *et al*. (2007) indicated that, for organic production, results obtained in test stations differ from those on farm, and that genotypes of hens specialised for best performance in cages are not necessarily best suited for free range systems.

The main aim of the present study was to get more information on how different brands or groups of laying hens perform under organic and free range conditions. Furthermore, it was considered useful to know if certain brands or groups of brands were more suitable for these systems. Therefore the study explored which genotypes are actually used in free range and organic systems in Switzerland, France and The Netherlands and how farmers perceive the suitability of the hens for those systems.

MATERIALS AND METHODS

Farms and flocks

Switzerland, France and The Netherlands were selected as being representative for different European situations, because these countries were expected to differ with regard to general climate, farm size, preference for specific strains and housing systems. In Switzerland and The Netherlands, variability in genotypes and housing systems was expected to be higher compared with France, where brown egg laying strains and barn housing are used almost exclusively (Galea, personal communication). In Switzerland and The Netherlands, white egg layers and silver genotypes are also used and barn housing and aviaries are both present. Therefore the aim in Switzerland and The Netherlands was for 50 organic and 50 free range layer farms, and in France for 20 organic and 20 free range farms to be sampled. Farm and flock sizes in Switzerland were expected to be smaller than in France, while farm and flock sizes were expected to be larger in The Netherlands.

In each country, farms were sampled from a national data base available to respectively FiBL for Switzerland, WUR-LR and Louis Bolk Institute for The Netherlands, and ISA for France. An identical questionnaire was sent to all the farmers in their native language (German for Switzerland, Dutch for The Netherlands and French for France). Questions were formulated as yes/no or multiple choice, or actual numbers had to be filled in. The Appendix gives an overview of the items covered in the questionnaire in English, the language in which the project team communicated.

Participation in the enquiry was voluntary, but the number of farmers who refused to cooperate was low (less than 10%). A limited number of farmers completed the questionnaire entirely themselves. In Switzerland, part of the data were provided through egg traders, but most questionnaires were completed by telephone interviews. In Switzerland and The Netherlands more complete data sets were obtained compared with France. Some farms had more than one

flock, where a flock was defined as a single age group kept separately with separate registration of egg production and mortality. The questionnaire contained questions at farm and at flock level. At farm level, the farm size, number of houses, farmer's experience with laying hens, layout of the house(s) and outside area, as well as the method of data recording were requested. Only flocks where performance was recorded either on paper or in an electronic database were included in the analysis of performance data. Data collected at flock level comprised the genotype, rearing system, specific treatments (e.g. beak treatment, vaccination, medication), feeding regimes (e.g. roughage, additional grain), and performance data (egg production per hen housed and mortality at 60 weeks of age). Flock data were recorded for the most recent flock(s) available. All data are based on information from the farmers.

The genotype was classified according to 'brand' i.e. specific cross. These crosses were later summarised in genetic groups: 'white' i.e. white hens laying white eggs; 'brown' i.e. brown hens laying brown eggs; 'silver' i.e. white hens laying brown eggs; or 'mixed' i.e. birds of different brands and/or genetic groups in one house.

Additional questions covered causes of mortality, feathering condition of the hens and estimates of the use of the outside run. Feather condition was recorded on a relative basis: no birds with poor feather cover, less than 25% birds with poor feather cover, more than 25% birds with poor feather cover. Finally, the farmers were asked to estimate the average percentage of hens outside to determine the use of the outside run.

Statistical analysis

Production, mortality and feathering score were analysed with a multiple regression analysis (GenStat release 13·2) for main effects of country (CH, NL or F), system (organic or free range) and genetic group or 'brand', and their interactions. For egg production, the actual figures (number per hen housed) were used. On percentage mortality a $\log + 0{\cdot}1$ transformation was performed before analysis. Feather cover was analysed with the score (0, 1 or 2) assumed to be continuous. Differences between countries, systems and 'brands' or genetic groups were tested with a two-sided t-test, with the procedures RPAIR (gives t-test for all pairwise differences of means) and PPAIR (displays results of t-test for pairwise differences). The relationships between egg production and mortality or flock size were tested with multiple regression analysis, correcting for country and/or system and/or genotype.

RESULTS

Only farms (flocks) where performance data were recorded systematically were included in the analysis. Almost all farmers kept records of the performance of their stock. The proportion of farmers that did so with a data management program was over 50% in The Netherlands and about 50% in France and Switzerland. Farmers that did not use a data management program, but kept records on paper and were able to provide data on egg production and mortality at 60 weeks of age, were also included in the analysis.

Table 1 gives an overview of the number of farms and flocks by country and by farm type, together with flock size, age of transfer to the layer house, beak treatment and housing equipment. In Switzerland, more organic than conventional free range farms were sampled, while in France there were more free range than organic farms. In The Netherlands, the distribution was almost 50/50. The number of hens per flock was lower in Switzerland than in France and lower in France than in The Netherlands.

Age of transfer of the pullets to the layer house was slightly older for free range flocks than for organic flocks; and in Switzerland transfer took place later than in France and The Netherlands. Only a limited number of farms (<10%) reared the birds themselves.

In Switzerland no beaks were treated, whereas the French farmers indicated that both organic and free range flocks had treated beaks. In The Netherlands, almost all free range farms had flocks with treated beaks, and all organic flocks had intact beaks; two free range farmers and 6 organic farmers did not provide data on beak treatment. However, beak treatment has been prohibited for many years in organic poultry in The Netherlands and was not likely to be present. The two free range farmers probably had flocks with treated beaks.

In Switzerland, all but two flocks were housed in aviaries. Aviaries are defined here as housing systems where hens can freely move between tiers in the house on several levels, thus having more usable area than the ground surface of the house. In France, only two flocks were housed in aviaries, with all others in barn housing. In The Netherlands, slightly more of the conventional free range flocks were in aviaries than in barn systems; while for organic flocks it was 50/50 for both housing systems. These descriptive variables were not analysed statistically.

Table 2 provides data on the number of flocks per genotype and country. There were almost 20 different genotypes present in the three countries. In Switzerland a large number

Table 1. *Number of farms, number of flocks, flock size, average age at transfer of pullets to the layer house, beak treatment and housing system per country and system*

Country	Switzerland		France		The Netherlands	
System	Free range	Organic	Free range	Organic	Free range	Organic
Number of farms	35	91	31	11	48	57
Number of flocks[1]	52	102	26	10	71	57
Flock size						
Mean	3093[a]	1635[a]	7577[b]	4682[ab]	17 625[c]	8077[b]
Minimum	500	500	1700	2298	1500	330
Maximum[2]	8014	2000	18 000	9000	45 050	18 350
Age at transfer of pullets (weeks)[3]	18·3	18·0	17·7	17·6	17·6	17·2
Flocks with intact beaks, N[3]	52	102	0	0	0	51
Flocks with touched beaks, N[3]	0	0	13	2	0	0
Flocks with trimmed beaks, N[3]	0	0	13	8	69	0
Flocks in aviaries, N[3]	52	100	1	1	40	28
Flocks in floor housing, N[3]	0	2	24	9	31	27

[a,b,c]Figures with different letters within lines differ significantly ($P < 0{\cdot}05$).
[1]Some farms had more than one flock. Not all farmers provided data on beak treatment or housing equipment.
[2]Minimum and maximum flock size per country and system.
[3]Data not subjected to statistical analysis

Table 2. *Distribution of genetic groups and genotypes on organic and free range systems across countries; number of flocks per genetic group or genotype*

Genotype \ Country	Switzerland	France	The Netherlands	Total
Brown hens	*38*	*37*	*81*	*156*
Lohmann Brown Lite	0	0	51	51
ISA Brown	0	11	15	26
Hy-Line Brown	22	0	2	24
ISA Warren	1	15	3	19
Lohmann Brown Classic	9	2	5	16
Bovans Brown/GL	3	6	1	10
H&N Brown Nick	2	0	4	7
Shaver 579	0	2	0	2
Hisex Brown	0	1	0	1
Lohmann Brown M	1	0	0	1
White hens	*35*	*0*	*7*	*42*
LSL Classic	25	0	3	28
H&N Super Nick	10	0	0	10
Dekalb White	0	0	4	4
Silver hens	*5*	*0*	*36*	*41*
Hy-Line Silver	0	0	15	15
H&N Silver Nick	2	0	12	14
Dekalb Amberlink	0	0	9	9
Lohmann Silver	3	0	0	3
Mixed flocks	*72*	*0*	*1*	*73*
Brown + white	56	0	0	56
Silver + white	10	0	0	10
Brown + silver	6	0	1	7
Other genotypes	*4*	*0*	*2*	*6*

of farms had mixed flocks. In the analysis of data, mixed flocks were considered as a separate genetic group. Only a limited number of genotypes were present in all three countries, which makes analysis of data by genotype less reliable.

Table 3 presents data on egg production, mortality, feather score and use of outside run by country and system (organic or free range). Table 4 gives data on egg production, mortality, feather cover and run use by genetic group and housing system. Table 5 gives the level of significance of main effects (country, system and genotype) and their interactions.

Egg production per hen housed is partly dependent on mortality, and tended to be lower on organic farms than on conventional free range farms in all three countries. For all countries taken together, the difference between organic and free range was significant. Egg production was significantly higher in France than in The Netherlands, while egg production in Switzerland was not different from that in France or The Netherlands. Mortality was similar (France, Switzerland) or significantly higher (The Netherlands) on organic farms than on free range farms. Overall, differences were caused by the low egg production per hen housed in The Netherlands, which is related to high mortality at the organic farms in The Netherlands. Mortality showed large variation, with 50% as highest incidence in an organic flock in The Netherlands. Due to the large variation (several farms with mortality of over 25%), this was not a clear outlier and omitting this farm from the dataset did not change rank orders, or the significance of differences between groups.

For most genetic groups, production up to 60 weeks of age tended to be higher and mortality lower in conventional free range compared with organic systems, but not always significantly so.

The scores as reported by the farmers for feather cover by country and housing system are given in Table 3, and by genotype and housing system in Table 4. A lower score implies more hens with intact feather cover and fewer hens

Table 3. *Egg production per hen housed and mortality to 60 weeks of age, estimates of feather cover and percentage of hens outside, per country and system (mean ± standard deviation)*

	Switzerland		France		The Netherlands	
	Free range	Organic	Free range	Organic	Free range	Organic
Egg production (N)	$244{\cdot}1^{a} \pm 14{\cdot}8$	$241{\cdot}9^{a} \pm 13{\cdot}7$	$247{\cdot}0^{a} \pm 11{\cdot}8$	$245{\cdot}4^{a} \pm 8{\cdot}1$	$244{\cdot}9^{a} \pm 11{\cdot}2$	$231{\cdot}0^{b} \pm 17{\cdot}8$
Mortality (%)	$5{\cdot}9^{a} \pm 3{\cdot}3$	$6{\cdot}6^{a} \pm 4{\cdot}8$	$4{\cdot}9^{a} \pm 1{\cdot}9$	$4{\cdot}7^{a} \pm 1{\cdot}5$	$6{\cdot}6^{a} \pm 3{\cdot}8$	$12{\cdot}0^{b} \pm 8{\cdot}3$
Feather cover (score)[1]	$0{\cdot}71^{ab} \pm 0{\cdot}82$	$1{\cdot}11^{abc} \pm 0{\cdot}84$	$0{\cdot}35^{a} \pm 0{\cdot}49$	$0{\cdot}90^{abc} \pm 0{\cdot}88$	$0{\cdot}96^{bc} \pm 0{\cdot}81$	$1{\cdot}35^{c} \pm 0{\cdot}74$
Hens outside (%)	ND	$69^{c} \pm 15$	$29^{a} \pm 14$	$35^{a} \pm 17$	$25^{a} \pm 16$	$54^{b} \pm 23$

[a,b,c] Figures with different letters within lines differ significantly ($P < 0{\cdot}05$) Statistical analysis of flock size, egg production, mortality, feather score and % hens outside is done on a flock basis; ND: No data available.
[1]Scores: 0: no birds with poor feather cover, 1: < 25% birds with poor feather cover, 2: > 25% birds with poor feather cover.

Table 4. *Egg production and mortality to 60 weeks of age, feather cover and percentage of hens outside, by genetic group and system of production (mean ± standard deviation)*

	White	Brown	Silver	Brown + Silver	Brown + White	White + Silver
Eggs/hen housed (N)						
Free range	$248{\cdot}7^{c} \pm 11{\cdot}7$	$246{\cdot}2^{c} \pm 11{\cdot}1$	$237{\cdot}8^{bc} \pm 10{\cdot}1$	$248{\cdot}0^{c} \pm 4{\cdot}2$	$200{\cdot}0^{a1}$	–[2]
Organic	$243{\cdot}5^{c} \pm 13{\cdot}4$	$239{\cdot}1^{bc} \pm 15{\cdot}3$	$227{\cdot}2^{b} \pm 15{\cdot}3$	$254{\cdot}3^{c} \pm 7{\cdot}5$	$240{\cdot}8^{c} \pm 16{\cdot}6$	$243 \pm 7{\cdot}1$
Mortality (%)						
Free range	$5{\cdot}2^{bc} \pm 2{\cdot}4$	$5{\cdot}8^{bc} \pm 3{\cdot}2$	$9{\cdot}8^{bcd} \pm 4{\cdot}2$	$5{\cdot}5^{abc} \pm 5{\cdot}0$	$1{\cdot}0^{a1}$	–[2]
Organic	$3{\cdot}5^{ab} \pm 1{\cdot}9$	$8{\cdot}0^{bc} \pm 5{\cdot}3$	$13{\cdot}4^{d} \pm 10{\cdot}0$	$9{\cdot}6^{bcd} \pm 4{\cdot}0$	$7{\cdot}1^{bc} \pm 5{\cdot}2$	$10{\cdot}4 \pm 7{\cdot}5$
Feather cover (score)						
Free range	$0{\cdot}58^{a} \pm 0{\cdot}72$	$0{\cdot}85^{a} \pm 0{\cdot}82$	$1{\cdot}00^{ab} \pm 0{\cdot}68$	$1{\cdot}00^{a} \pm 1{\cdot}41$	$0{\cdot}22^{ab} \pm 0{\cdot}67$	–[2]
Organic	$0{\cdot}30^{a} \pm 0{\cdot}48$	$1{\cdot}00^{ab} \pm 0{\cdot}83$	$1{\cdot}46^{b} \pm 0{\cdot}76$	$1{\cdot}60^{b} \pm 0{\cdot}55$	$1{\cdot}47^{b} \pm 0{\cdot}69$	$1{\cdot}1 \pm 0{\cdot}88$
% hens outside						
Free range	35 ± 9	25 ± 15	29 ± 19	–[3]	–[3]	–[2]
Organic	48 ± 35	52 ± 23	62 ± 21	74 ± 15	70 ± 12	72 ± 19

[a,b,c]Figures with different letters between rows and within lines 1–2 and 3–4 respectively differ significantly ($P < 0{\cdot}05$).
[1]One flock.
[2]Not represented in the data set.
[3]No data in responses.

Table 5. *Significance (P-levels) of the effects of country, system and genetic group and their interactions[1] on eggs production, mortality, feather cover and percentage of hens outside at 60 weeks of age*

Effect	Eggs/hen housed, N	Mortality, %	Feather cover	% hens outside
Country	0·018	<0·001	<0·001	<0·001
System	<0·001	<0·001	<0·001	<0·001
Genetic group	0·004	<0·001	<0·001	0·002
Country × system	0·013	0·004	0·028	0·033
Country × genetic group	0·621	0·686	0·425	0·020
System × genetic group	0·033	0·003	<0·001	0·142

[1]The 3-way interaction could not be tested, because in France there were only data on brown hens.

with naked skin areas. For all strains taken together, there was a tendency for organic hens to have worse feather cover than conventional hens. When both systems were taken together, white hens tended to have better feather cover than silver hens, with the brown hens intermediate.

Whereas all farmers were also asked to estimate the percentage of hens that used the outside run, this question was seldom answered by the Swiss farmers, which restricted statistical analysis. In organic systems, more hens tended to be outside than in conventional systems, while in Switzerland the percentage of hens outside was estimated to be higher than in France or The Netherlands.

The relationships between flock size and production, mortality and feather score were examined by simple correlations, as well as by more complicated models involving genotype

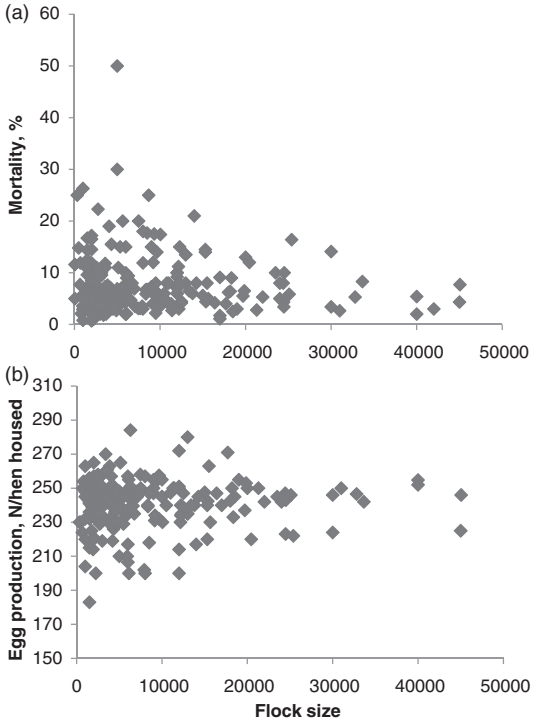

Figure 1. *The relationships between flock size and mortality (upper panel) and egg production (lower panel) at 60 weeks of age. (Note that there were slightly more flocks with mortality than egg production data.)*

and/or country. The analyses did not yield significant correlations: Figure 1 shows the relationships between flock size with egg production and mortality. There was no indication of a correlation between flock size and mortality or egg production regardless of whether genotype was included or excluded in the model. However, variation in egg production and mortality appeared to be larger for small flocks than for large flocks, with extreme values in both directions present in relatively small flocks.

DISCUSSION

Because the study aimed for a 50/50 distribution between conventional free range and organic farms, organic farms are overrepresented compared with the general situation in the three countries. In Switzerland around 50% of all layer farms are free range (Bundesamt für Landwirtschaft, 2010) and around 20% organic (Bio Suisse, 2010, personal communication). In The Netherlands there are slightly more free range layer farms than organic layer farms (PVE, 2010), while in France there are more free range than organic farms (Fermet-Quinet and Bussière, 2010). Reference data on average flock size and housing system in the three countries are not available.

The distribution of genotypes across countries and systems in the survey mirrors the general picture in the three countries: in France only brown hens, while in Switzerland and The Netherlands more variation in types. In Switzerland the number of mixed flocks was high compared to the other countries. Based on discussions with farmers in The Netherlands, their interest in mixed flocks is increasing, although in the survey there was only one mixed flock present in The Netherlands.

There remain a very limited number of primary breeding companies worldwide. They all provide different genetic groups (white, brown, silver) and within the genetic group often different brands. These genotypes are offered for cage, inside floor/loose housing and free range systems. All commercial genotypes are the result of crosses between pure lines, which are all heavily selected for high egg production. Consequently, they are genetically rather similar when compared to genetic variation in the ancestors of domestic chicken and/or standard breeds of fancy fowl (Muir *et al.,* 2008).

From the large number of different genotypes present on free range and organic farms, we conclude that there is no preferred genotype for free range systems and that no genotype is best suited for those conditions. White hens are rather scarce in organic and free range systems, although less so in Switzerland than in The Netherlands. This might be due to the preference for brown eggs in the northwestern part of Europe (Arthur and O'Sullivan, 2005), the main market for The Netherlands, and/or the association among consumers between brown egg shells and free range systems and/or healthier eggs (Johnston *et al.*, 2011). This association is also promoted by retailers: advertisements and Google searches for 'free range eggs' provide almost exclusively pictures of brown eggs. Silver hens were introduced some years ago as more suitable genotypes for non-cage housing systems, as they were expected to combine the advantages of the good feathering of a white hen with the desired brown egg shells. Currently, they are mainly present in The Netherlands. The introduction of silver hens and the increase in free range and organic systems occurred more or less together. However, the results here do not indicate that silver hens are specifically suitable genotypes for free range and organic systems.

The finding that mortality is, on average, higher in organic than in free range systems supports the findings of Hovi *et al.* (2003), Zeltner and Maurer (2009), Lambton *et al.* (2010), and Anderson (2010). From the present enquiry among farmers, no clear indications on causes of mortality could be obtained. However, from another study among 30 Dutch organic laying hen farmers it seems that 50% of the dead hens had *E. coli* or chronic gut infections, 10–15%

died because of smothering and other 'accidents', and in 25% of the cases the cause of death was not clear or was other than mentioned above (J. Wagenaar, 2011; personal information). There was no relation between mortality and flock size, except that variation in mortality was higher among small flocks than among large flocks.

Egg production per hen housed at 60 weeks of age is related to mortality. Differences in production between countries, systems and genotypes reflect almost entirely the differences in mortality.

While the number of flocks of white hens is rather low, their performance in organic and free range systems is high compared to the other genotypes. Silver hens, in contrast, show relatively high mortality and consequently low production per hen housed. Genotype is confounded to some extent between country and flock size (more white hens and small flocks occur in Switzerland and more silver hens and large flocks in The Netherlands). Nevertheless no relationship between flock size and production or mortality could be established in the current data set.

In this study, white hens had a better feather cover than brown hens, while feather scores for silver hens were lowest. Lücke *et al.* (2004) and Damme (2004) found among some brown genotypes a high predisposition to feather pecking. Anecdotal information from commercial farmers in Sweden and fancy fowl breeders in The Netherlands indicates that a Rhode Island Red background (present in most/all brown genotypes) might increase the tendency for feather pecking and cannibalism. However, Elwinger *et al.* (2008) comparing an experimental cross of Rhode Island Red and White Leghorn with two different commercial white layer genotypes in an organic system, did not find differences in performance or feather pecking between genotypes. Hens with a Rhode Island Red background thus are not in all cases prone to feather pecking. Silver hens originate from the same (grand)parent lines as brown hens and have many characteristics in common with brown layers (body weight, calm behaviour, egg shell colour). In spite of the difference in combination of the grandparent lines, silvers apparently do not differ from brown hens in pecking behaviour. Free range systems provide different conditions for laying hens than closed houses or cages, conditions under which most hens have been selected. Due to increased mobility and reduced temperature control in free range systems compared with cages and closed houses, free ranging hens probably have a higher energy requirement (Ketelaars *et al*., 1985; Anderson, 2010). Testing of genotypes of hens that have to perform in free range conditions is preferably done under free range conditions.

With increasing numbers of farms with hens in free range systems, a follow-up of the random sample testing system that was in place for cage housing in the previous century (Heil and Hartmann, 1999) might be helpful. At present, central testing stations for genotypes do not seem to be feasible. Glawatz *et al*. (2007) considered that the development of test systems under field conditions was necessary for organic egg production.

A large number of farmers used a computerised management package, increasingly on an internet basis. Collecting data from such packages systematically could be valuable to gain information on performance of genotypes in free range systems. This is most effective if data are collected across countries. This requires a level of cooperation that could be arranged by distributors/hatcheries and/or the breeding companies involved. Organising such a testing system through farmers' organisations is possible, but not likely.

In conclusion, organic and free range farms housed a wide variety of genotypes in Switzerland and The Netherlands. In France only brown hens were housed; in Switzerland and The Netherlands there were brown, white and silver hens. In Switzerland mixed flocks were also present. There was a tendency for slightly higher mortality and lower egg production per hen housed at 60 weeks of age in organic flocks compared with conventional free range flocks in Switzerland and France, and a significant difference in the same direction in The Netherlands.

White hens tended to perform better than brown hens, while silver hens had a higher mortality and lower production per hen housed at 60 weeks of age. There were no significant relationships between production, mortality, feather condition and use of the outside run or flock. There was more variation in mortality and egg production among farms with a small flock size than among farms with a large flock size. There was no indication for either a positive or negative trend in production or mortality in relation to flock size.

In a next step, data on feeding regimes, performance, management, health status, and use of the outdoor run will be systematically recorded during farm visits on approximately 40 farms per country. These farms have been selected based on the data presented in this paper in order to represent 'typical' farms for each country.

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APPENDIX

Overview of the records/questions in the enquiry. Data are on the last flock finished, or on the current flock if >60 week of age. A farm can have more than one flock and data are recorded by flock.

Farm
Farm name.
Quality system implemented? Which?
Type of contract.
Mixed farm, or specialized on egg production, % income from egg production.
Years of experience with poultry.
Years of experience with free range layers.
Number of caretakers.
Recording of performance data, no, paper, database (which).
Egg grading data available.
Farm size, number of hens, cockerels.
Number of houses.
Size of houses.
Flock size, number of hens, number of cockerels.
Date and age placed in layer house.
Number of sections in the house.
Genotype, colour: white, brown, silver, mixed, other.
Commercial name, distributor.
Number of genotypes on farm and per flock.
Same or other genotypes in past flocks; if other which?
Next flock same or different genotype? Why?

Rearing
Housing system: floor, aviary, other.
Beak trimming: no, cut, touched.
Size of rearing flock.
Age started on litter.
Density, N pullets/m^2.
Additional grains.
Additional roughage.
Free range access, from which age.

Health management (rearing and laying period)
Vaccinations, which?
Anthelmintic treatments, which?
Other medication, which?
Causes of mortality.

Flock performance, 60 weeks
Egg production, N/hen housed.
Mortality, % hen housed.
Feather score, impression of farmer.
Hens with wounds, impression of farmer.
% hens outside, impression of farmer.

Laying period
All in, all out.
Housing system: floor, aviary, other.
Overall usable area, m^2.
Littered area, % of usable area.
Type of litter.
Litter added or replaced during flock.
Free range, daily access?
Veranda available, daily access?
Space requirements independently checked?
Perch material and length/hen (cm).
Number of nest boxes/hen or m^2/hen for group nests.
Daylight, artificial light?
Light intensity in house (lux).
Type of feeder: chain, round feeder, other; feeder space/hen.
Type of drinker: nipple, cup, round drinker; drinker space/hen.
Type of feed: pellets, crumbs, mash.
Additional grains, where and when?
Additional roughage, what, where and when?
Ventilation: mechanical, natural?
Moulting, if yes: how?