Chapter 23

Risk classification of Austrian, Dutch, and German poultry farms with regard to the incursion of the avian influenza virus

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Abstract

Considering the latest outbreaks in Asia, Africa, and Europe, the avian influenza virus (AIV) still represents a global threat for the international poultry industry. As experiences from many AIV outbreaks have already shown, biosecurity is one of the crucial factors to avoid an introduction at farm level. The more birds, people and items enter a poultry farm, the higher is the risk of an AIV introduction at farm level (FAO 2004). To minimise the risk of AIV incursion at poultry farm level, it is important to investigate and assess the risk status of poultry farms and to communicate this to the farmers. However, data on biosecurity practise and contacts at European poultry farms is rare.
The farm data were gathered by using questionnaires and visitor books in 343 farms in Austria, Germany, and The Netherlands. The inquiry covers subjects in the categories farm location, management, farm biosecurity, and disease prevention measures. In addition, the farmers documented private and production related visitors for 30 days in a farm's logbook. To evaluate the results, an international expert panel defined and weighted the most important risk factors for AI introduction at farm level within a three-stage Delphi study. Based on this evaluation, all farms were assigned to three classes of risk. To communicate the results to the farmers as comprehensible as possible, a traffic-light scheme was used. The highest risk class represented poultry farms with a high potential for AIV introduction. Comparing the different prevalent structures of poultry production in the three countries, the results can also be used in regard to the EU zoonosis directive.

1. Introduction

Over the last decades, there has been a significant concentration of poultry production in a limited number of areas in the European member states (Bettio et al. 2003). The ongoing consolidation of poultry meat and hen egg production has led to different organisation patterns in poultry production. On the one hand there are sparsely populated poultry areas (SPPA), where small farms produce for own consumption or local markets. On the other hand there are densely populated poultry areas (DPPAs), where large vertically integrated companies supply national and international markets (Windhorst 2008, this report). Regional concentration of poultry production has many economical advantages, but as a serious side effect an increased risk on the introduction and spread of poultry diseases, for example avian influenza (AI), exists. Experiences from AIV outbreaks revealed that virus introduction is often caused by a complex interaction of different risk factors at farm level. Especially breaches in biosecurity as well as a high number of contacts between farms by poultry transports, people or vehicles may play a crucial role in the introduction and spread of AIV. However, data on biosecurity practise and frequencies of visitor contacts at European poultry farms is rare.

To gain more insight into prevalent farm management structures and hygiene measures applied at poultry farms, three European Union member states, Austria, Germany, and The

Netherlands, were selected to conduct a questionnaire and logbook study on farm level. These countries developed a high concentration of regional poultry production clusters, but they differ in their production and organisation patterns, and are therefore good examples for detailed analyses (see also Veauthier & Windhorst 2008).
Data on farm management and contact structures as collected in this study can be used to distinguish farm differences in regard to their location in a densely or sparsely populated poultry area as used by Bettio et al. (2003). The quantification of contacts on farms gives additionally important data to show how AIV may spread. In this regard, the data can serve to simulate spread patterns of infectious diseases as already used by Sanson (2005) and Nielen et al. (1996) for Foot and Mouth Disease (FMD).
The main objectives of this paper are:

- to describe the prevalent farm management and contact structures,
- to determine the farms' differences in risk factors related to the introduction of AI,
- to develop a method to evaluate the farm's risk status with regard to the introduction of the AI virus,
- to develop a comprehensible tool to communicate the results to the farmers.

2. Material and Methods

2.1. Selection of farms

The study was carried out in Austria, Germany, and The Netherlands. Due to the different organisation patterns of the poultry production sector in these countries and for practical reasons, the farm selection method differed by each country. In Germany, 976 poultry farmers in Lower Saxony and Mecklenburg-Vorpommern received an invitation letter. With the invitation letter, a flyer which was particularly developed for this study and informed the farmers about the aim, procedure, and background of the study was enclosed. The response rate to the invitations was 18.9 %. Reasons for not willing to participate were 1) too busy, and 2) not interested. To reach a broader audience of poultry farmers, articles about the project were published in national poultry journals as well as in the local press. Responding to these announcements, 37 additional farmers registered for participation. In total, 222 German poultry farmers were involved. Next to the questionnaire, the flyer, the logbook, and a stamped and addressed envelope were delivered to every participant to assure a free return of the documents. In case of further questions, contact details of the study supervisor at the Institute for Spatial Analysis and Planning in Areas of Intensive Agriculture (ISPA) were added.
In the Netherlands, the study was conducted by the Dutch project partner within the Healthy Poultry project. Sixty-five broiler and layer farms were selected from the Agricultural Accountancy Data Network (BIN) of the Agricultural Economics Research Institute (http://www.lei.wur.nl/UK/statis tics/Binternet/default.htm). This network collects financial and technical data of a representative sample of farms and holdings of the Dutch Agricultural Census. The administrators of the network made a pre selection of 75 farms; 10 farms were not selected as they had the same owner as other farms in the selection, were very small or because owners were not motivated or were difficult to reach. Of the other 75 farms 65 farms were selected to obtain a reasonable number of farms of each type (broiler and layer) and each housing type (cage, barn, mixed) in the study. Each selected farmer was sent a letter inviting his/her participation in the study, followed by a telephone call a few days later. The response rate was 60% (39/65 farms). Reasons for not willing to participate were 1) too busy, 2) not interested and 3) participating in too many studies already. With farmers that indicated their willingness to take part, a visit was planned. All farm visits were done by the same person,

who interviewed the farmers and filled in a questionnaire. The logbook was filled in by the farmers starting on the day of the visit. Farmers who participated in this study were paid remuneration (Geenen et al. 2008).
In Austria, the study was conducted in cooperation with the Austrian product board („Zentrale Arbeitsgemeinschaft der österreichischen Geflügelwirtschaft“, ZAG). The institution selected a representative sample of 30 broiler, 30 layer, and 30 turkey farms. The response rate was 93.3 %. Reasons to refuse participation were 1) too busy, and 2) not interested. On-site, the supervising branches of the Austrian product board (Geflügelmastgenossenschaft Ges.m.b.H. / GGÖ, EZG Frischei GmbH and Österreichischen Qualitätsgeflügelvereinigung (QGV)) visited the farms and distributed the questionnaires and logbooks. In case of any further questions, the farmer had the possibility to contact their branches as well as the product board itself. After a time period of 4-5 weeks, the documents were collected by the product board and sent back to Germany.

2.2. Characteristics of the participants

In total, 343 poultry farms participated within the study. As can be seen from table 1, data were collected in 84 farms in Austria, in 37 farms in the Netherlands and in 222 poultry farms in Germany. The majority of farms had either layers, broilers or turkeys. Since the importance of poultry other than broilers or layers in the Netherlands is quite low (e.g. turkey represent only 1.3 % of the total poultry stock), only broiler and layer farms were included in the Dutch study. In Germany, twelve pullet farms, three layer breeder farms, one ostrich farm, one geese farm, and nine pedigree poultry farms additionally participated within the German study (Table 1). The poultry stocks analysed represent 3.0 % of all Dutch farms (2.8 mill. birds), 11.2 % (1.5 mill. birds) of the Austrian farms and 12.2 % (13.1 mill. birds) of the poultry stocks in Germany.

Table 1. Overview of participating farms (Q = Questionnaire, LB = Logbook)

Country	**Austria**		**Germany**		**The Netherlands**	
Poultry species	Q	LB	Q	LB	Q	LB
Broilers	29	29 (100%)	76	68 (89.5%)	16	12 (75.0%)
Layers	29	29 (100%)	65	49 (75.4%)	21	11 (52.4%)
Turkeys	26	24 (92.3%)	55	35 (63.6%)	-	-
Pullets	-	-	12	12 (100%)	-	-
Other poultry species*	-	-	14	4 (28.6%)	-	-
Total	**84**	**82 (97.6%)**	**222**	**168 (75.7%)**	**37**	**23 (62.2 %)**

*Three layer breeder farms, one goose and one ostrich farm, and nine pedigree poultry farms

Table 2 shows the different farm size levels of the participating farms. The distribution of the participants to the farm size classes is similar to the poultry production structure of the countries. While the Netherlands and Germany tend to have larger farm units, Austrian farms show a different structure with smaller units. A closer look at table 2 reveals that 41 % of the Dutch and German participants house between 10,000 and 50,000 birds; 59 % respectively 35 % of the farms have units between 50,000 and 100,000 birds or even larger farms. In contrast, 52 % of the Austrian farmers own smaller production units between 1,000 and 10,000 birds. The farm size can also be interpreted with regard to the consequences of AIV outbreaks. The larger the production unit, the higher are the economic losses in case of an AI outbreak.

Table 2. Overview of the farm size levels of the participating farms

	Austria		**Germany**		**Netherlands**	
	Farms	in %	Farms	in %	Farms	in %
<= 1,000	1	1.2	14	6.3	0	0
1,001 - 10,000	44	52.4	38	17.1	0	0
10,001 - 50,000	31	36.9	90	40.5	15	40.5
50,001 - 100,000	7	8.3	44	19.8	8	21.6
>= 100,001	1	1.2	34	15.3	14	37.8
Missing*	0	0.0	2	0.9	0	0.0
Total	**84**	**100.0**	**222**	**100.0**	**37**	**100.0**

* No data stated

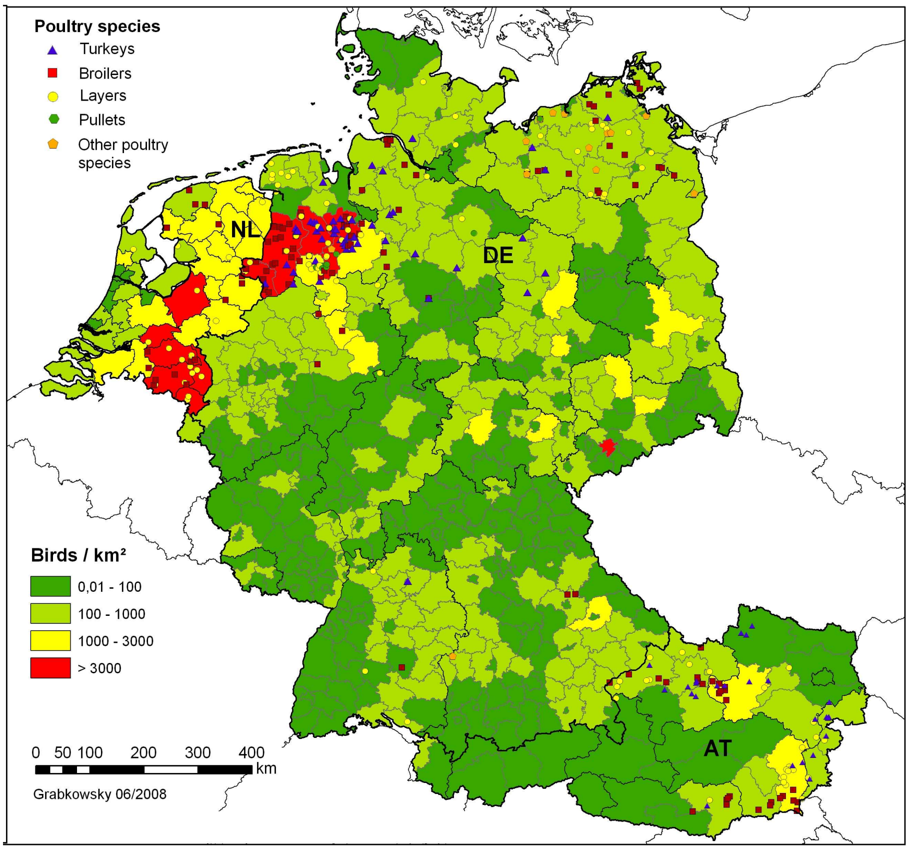

Figure 1. Distribution of participants in Austria, Germany, and the Netherlands in regions with different poultry densities

Figure 1 displays the distribution of participants as well as the poultry density (birds/km²) in the administrative districts of Austria, Germany and The Netherlands. Most of the farms are located in the main poultry production areas of the participating countries, where high densities of poultry with more than 3,000 birds /km² can be found. This is especially true for the regional concentration in the north-western part of Germany and the southern part of the Netherlands which pose an extremely high risk for an uncontrollable spread of AI as it was the case after virus introduction in the Netherlands in 2003. Furthermore, the map shows that the poultry density much higher in Germany and the Netherlands than in Austria. Next to the varying density patterns, the different farm structures led to the selection of the three countries. In these densely populated poultry areas, the 2003 outbreak of AIV impacted the whole production chain within the Dutch poultry industry.

2.3. Study Design

At farm level, risk factors can be differentiated in factors related to location of the farm, farm management, disease prevention and factors that deal with the contact structure of a farm. Qualitative and quantitative data on location, management and disease prevention were collected by means of a questionnaire and data on farm contacts were collected with a logbook. Both tools were pre-tested by submitting them to experts as well as to a sample of farmers. The results were evaluated and used to adjust both survey instruments. In the Netherlands, the documents were adapted to the Dutch situation, and additional questions were added for further purposes.

Questionnaire - The questionnaire consisted of 68 questions with regard to the fields general farm structure and organisation, feed, litter, manure, employees, biosecurity, pest control, rendering, sharing machinery, which can be attributed to the three categories “location of the farm”, “farm management” and “disease prevention”. In Austria and Germany, the questionnaire was filled in by the farmers, whereas the Dutch farmers were interviewed by a student from Wageningen University.

Logbook - For a period of four weeks, the farmers were asked to document all private and production related visitors in a standardised logbook. On site, the following information on contacts were recorded: date and time of visit, reason of visit, access to the poultry houses (yes/no), address and type of business where the visitor was coming from (origin), whether poultry was present at the origin or destination address and if yes, specification of the poultry species and whether the visitor had access to these poultry houses.

2.4. Analysis

The collected data were entered into SPSS 15.0 and assimilated in order to build up a unique database. In a preliminary stage, the dataset was checked on its consistency and if possible missing information was replaced after consultation with the farmers or partners involved. Subsequently, a descriptive analysis was carried out on the whole dataset. Participants, who did not deliver their logbook (Table 1), were excluded from the logbook and the final evaluation since only the questionnaire data could be analysed.

2.4.1 Questionnaire analysis

In total, 38 parameters were used to assess a farm’s risk potential for the three categories “location”, “farm management” and “disease prevention”. Within the evaluation process, the following assumption was applied: the more risk factors present at a farm, the higher the potential for AIV introduction. The assessment consisted of two steps. In the first step, each existing risk factor received one point. To emphasize very important risk factors for AIV introduction, an additional weight was derived in a second step. Based on a literature research, the relative importance of 19 risk factors related to either poultry production (e.g. housing system, number of poultry species housed at the farm) or biosecurity (e.g. pest control, basic hygiene before entering the poultry house, housing a new stock) was rated within a Delphi study (see Geenen et al., this report). The rates obtained from the Delphi study were used to derive weighting factors between 0 and 1, which were added to the score of one point obtained in step 1 (Table 3).

Within the evaluation process, the participants’ answers were checked on the occurrence of risk factors. For each risk factor present, the score specified in table 3 was attributed to the farm's account. Subsequently, for each farm the total score of each category (location, management, disease prevention and contact structure) was calculated. The distribution of scores per category was plotted and based on equal intervals (equal intervals on the mean of the maximum scores reached by the countries), three risk classes (1-3) were determined. Accordingly, each farm was assigned to one of the three risk classes per category. To communicate the results as much transparent and comprehensible as possible, the risk classes were visualised using a traffic-light scheme, where the red light represents the highest risk and the green light indicates a lower risk for AIV introduction. To gain more insight in the results of each category, the traffic light schemes were produced for every category as well as for the final scores of the questionnaire assessment.

Table 3. Risk factors used within the evaluation procedure

	Risk factor	Risk characteristics	Weighting factor
Location	***1.*** *Near (<= 1km) to surface water?*	Ocean, Lakes, rivers <= 1 km	1
	2. *Classified as wild bird resting place?*	Yes	1
	3. *Classified as wild bird feeding place?*	Yes	1
	4. *Distance to next poultry farm <= 1km*	<= 1 km	1
Farm management	***5.*** *Free running cat at the farm?*	Yes	1
	6. *Direct sale at the farm?*	Yes	1
	7. *Farm is not part of a vertically integrated production system*	No	1.8
	8. *Number of birds per farm*	>= 18.000	1
	9. *Number of poultry houses at the farm*	> 3	1
	10*. Are different species of poultry kept on the farm*	Yes	1
	11*. Additional keeping of ducks and/or geese*	Yes	1
	12. *Additional keeping of pigs*	Yes (pigs)	1.4
	13. *Birds of multiple ages at the farm*	pre-harvesting	1.5
	14. *Housing system: Freerange or freerange in combination with other systems*	Outdoor or In- and Outdoor	1.8
	15. *Feed storage with access for wild birds/cats/rodents*	open, without roof cover / barn	1.7
	16. *Litter storage with access for wild birds/cats/rodents*	open, without roof cover / barn	1.7
	17. *External employees working at the farm*	Yes	1.4
	18. *Egg trays are used more than once*	Yes (only for layers)	1.7
Disease prevention	***19.*** *Information of the staff about AI and the associated caution and care required while working at the farm*	No	1.6
	20 - 25. *No rules for protective clothing for external employees*	Housing, collection, vaccination, loading crews, tradesmen, transport firms	1
	26. *Machinery sharing (e.g. loaders, conveyor systems)*	Yes	1.7
	27. *No cleaning and disinfection of the machinery before return*	At own premises after return Not regulated	1.5
	28. *No disinfection of vehicles, that drive onto the premises*	No	1.6
	29. *No hand washing before entering the poultry house*	Not in advance	1.6
	30. *No disinfection of the footwear before entering the poultry house*	Not in advance	1.7
	31. *No changing of clothes before entering the*	Not in advance	1.7

poultry house		
32. *No disinfection of housing equipment*	No	1.6
33 - 34. *No pest control*	No rodent control	1.5
	No insect control	1.4
35. *Irregular pest control*	If required	1
36. *No carcass container at the premises*	No	1
37. *Rendering truck drives onto the premises*	Yes	1
38. *No disease prevention concept*	No	1

2.4.2 Logbook analysis

For the assessment of the logbook data, seven statements on characteristics of contact patterns at a poultry farm were phrased. As can be seen from table 4, the statements deal with the frequency and type of the contact patterns on a poultry farm in the considered time period of 30 days. Within the Delphi study, the experts indicated their agreement or disagreement on the statements. In case of agreement, the expert panel rated the likelihood of AIV introduction for each contact pattern characteristic using a scale from "very important" to "negligible".

Table 4. Contact pattern characteristics used for the logbook assessment

		The likelihood of AI introduction increases, …
Contact pattern characteristics	***I***	*… the more visitors*[1)] *come to a farm per day*
	II	*… the more visitors*[1)] with access to the poultry house *come to a farm per day.*
	III	*… the more* poultry professionals[2)] *come to a farm per day.*
	IV	*… the more poultry professionals* with access to the poultry house *come to a farm per day.*
	V	*… the longer a visitor*[1)] *stays in the poultry house.*
	VI	*… the later the visitor*[1)] *arrives at the farm on that day*[3)].
	VII	*… the more contacts with poultry farms the visitor has had already on that day*

[1)] Visitors = All persons, who visit a farm (Poultry professionals, officials, private visitors etc.)
[2)] Poultry professionals = Poultry services, veterinarians, feed suppliers, quality controllers, management advisers etc.
[3)] Assumption: With proceeding daytime, the visitor could have visited more farms.
[4)] ++ Very important, + Important, ○ Medium, − Low, −− Negligible

Since 36.8 % of the experts did not agree with the statements V and VI, these records were excluded from the analysis. For the assessment of the data, the rating keys were transformed into school marks (very important = 1, negligible = 5). Accordingly, the mean mark was calculated and a weighting factor between 0 and 1 was derived as can be seen from table 5.

Table 5. Derived weighting factors from the Delphi study

The likelihood of AI introduction increases, …	***No, I disagree.*** *(number of votes)*	***Yes, I agree.*** *Number of votes by mark*					***Mean mark***	***Weighting factor***
		1	***2***	***3***	***4***	***5***		
*Statement **I***	*3*	*1*	*6*	*5*	*3*	*1*	*2,8*	***0,4***
*Statement **II***	*1*	*8*	*7*	*1*	*2*	*0*	*1,8*	***0,6***
*Statement **III***	*0*	*4*	*5*	*7*	*2*	*1*	*2,5*	***0,5***
*Statement **IV***	*0*	*9*	*6*	*2*	*2*	*0*	*1,8*	***0,6***
*Statement **V***	***7***	*0*	*3*	*3*	*1*	*5*	***3,7***	-*
*Statement **VI***	***7***	*0*	*2*	*4*	*3*	*3*	***3,6***	-*
*Statement **VII***	*0*	*12*	*6*	*0*	*1*	*0*	*1,5*	***0,7***

* Not considered in the evaluation.

In a next step, the frequency scores for each of the five contact characteristics of every farm were classified on the base of four quartiles; outliers (scores, that are twice higher than the fourth' class limit) were stored in a fifth class as can be seen from figure 2. Considering the various amounts of contacts which vary by poultry species and by production type, the farms were assessed separately within their species category and by country. The weight calculated for each contact statement (Table 5) was added to the frequency class a farm was assigned to. For example: a layer farm registered 12 visitors (class 4, Fig. 2), which had access to the poultry house (statement II, weighting factor 0.6), hence the result for this statement is 4 + 0.6 = 4.6. In the next step, for each farm the weights for each of the five statements were added and the distribution of final scores was plotted. Based on equal intervals, three risk classes (1-3) were determined, and each farm was assigned to one of the three risk classes. Again, the results were displayed using a traffic light scheme as described in chapter 2.4.1.

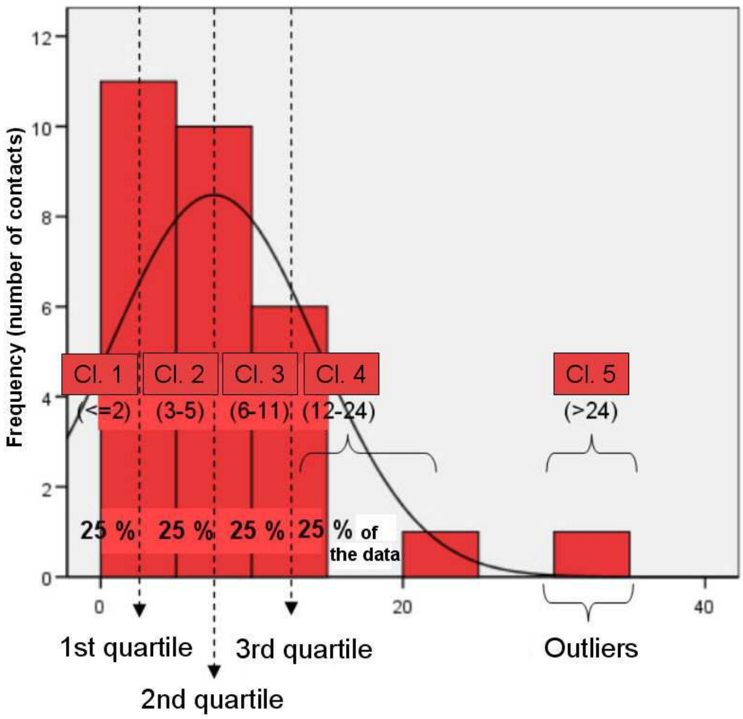

Figure 2. Quartile based method to classify the contact frequencies

<u>2.4.3 Final assessment</u>
For the final assessment, only farms that handed in both the questionnaire and logbook were considered. For these farms, the scores of each category were added and subsequently, each farm was classified based on this final score (equal intervals) to one of the three risk classes. To communicate the results in a comprehensible way, a traffic light scheme visualises the three risk classes. At the end of the study, all participants in Austria and Germany got a complete report of their results, where all parts of the survey were described and explained.

3. Results

3.1. Questionnaire

Tables 4 to 6 show the results of the selected questions from the questionnaire survey in Austria, Germany and the Netherlands. For all yes/no variables, the percentage of farms at which the risk factor is either present or absent is mentioned, for other nominal variables the percentage of farms is given for all values. In the case of continuous variables, the mean (min-max) values are given.

<u>3.1.1 Category "location"</u>
A closer look at the category "location" reveals that 51 % of the German farms and 70 % of the Austrian farms are located to surface water within a radius of 1 km. Due to the high density of waterways and wetlands in the Netherlands, almost all Dutch participants are situated next to surface water (97.3 %). Considering the distance to the next poultry, it is worth mentioning, that all of the Austrian and Dutch poultry farms as well as 93.7 % of the German farms were adjacent to another poultry farm within a radius of 10 km. This is

especially important in case of an AIV outbreak, when the EU Council directive 2005/94/EC has to be followed. To prevent further spread, a surveillance zone with a radius of at least 10 kilometres around the holding is established, in which different disease control measures (e.g. restrictions on live bird transports, implementation of preventive eradication programmes) have to be applied.

Table 4. Results of the category „Location“

Risk factors	**Value**	**Austria** N = 84	**Germany** N = 222	**Netherlands** N = 37
Near (<= 1km) to surface water?	Yes [%]	70.2	50.9	97.3
Distance to surface water in km?	Mean (min/ max)	2.1 (0.1 /18.0)	1.8 (0.0 / 18.0)	1.7 (0.0 / 5.0)
Classified as wild bird resting place?	Yes [%]	13.1	5.9	13.5
Classified as wild bird feeding place?	Yes [%]	7.1	3.6	n.d.
Distance to next poultry farm in km	Mean (min / max)	2.1 (0.05 /10.0)	3.5 (0.3 /27.0)	1.7 (0.2 /8.0)

n.d. = no data

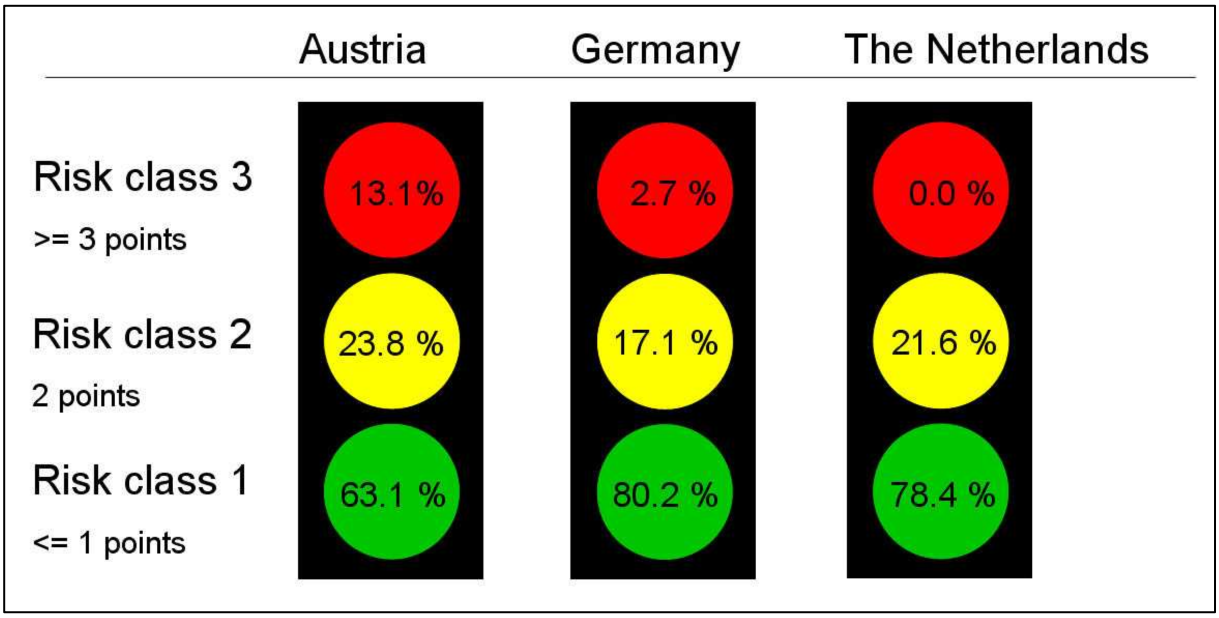

Figure 3. Attribution of the participating farms to risk classes in the category “farm location”

To assess the farms within the category “location”, five risk factors were used (Table 3). The first three factors are related to the farms’ distance to wetlands, which can be frequented by wild and migratory birds carrying the AI virus. The fourth variable is related to the poultry farm density, which is important to consider in a high risk period. If a farm is infected, the distance to other poultry farms can be a crucial factor whether the virus is introduced to the adjacent farm. The maximum number of points for a farm to reach was four points. Accordingly, the farms were assigned to three risk classes. As it can be seen from figure 3, more than 60 % of the farms from all countries reached the lowest class. 23.8 % of all Austrian, 17.1 % of the German, and 21.6 % of the Dutch participants were assigned to class 2. None of the Dutch farms and only 2.7 % of the German participants were attributed to the highest risk class, whereas 13.1 % of the Austrian farms got three or more points in this category and were allocated to risk class 3.

3.1.2 Category "poultry farm management"

Table 5 gives an overview about the collected data in the category "poultry farm management". A comparison of the results for the three countries shows that 41 % of the Austrian and Dutch farmers offer poultry and/or poultry products (mainly eggs, poultry meat and vegetables/fruits) in a farm shop on their premises, whereas this is only the case in 14 % of the German farms. Since a direct sale is accompanied with a higher amount of visitors, it can increase the risk of the incursion of infectious agents (EFSA 2006). Further important risk factors to be considered are the additional keeping of ducks and geese and the usage of an outdoor housing system (freerange). Ducks, geese, and other poultry kept in freerange are attractive for wild birds to mingle with the farmed birds and possibly deposit droppings on the ground which may represent a source of infection (Westbury et al. 1998, Tumpey et al. 2004, EFSA 2005). A closer look at table 5 shows that 8.3 % of the Austrian farms and 11.3 % of the German farms additionally keep ducks or geese. Since the Dutch system of Integrated Quality Control (IKB) provides strict requirements, the Dutch farms do not have mixed farming. A freerange housing system is used in 13.1 % of the Austrian and in 17.6 % of the German farms, whereas 6 % of the Austrian, 7.2 % of the German, and 8.1 % of the Dutch farmers even combine in- and outdoor housing systems (e.g. barn and freerange housing). Furthermore, the storage of litter used in the poultry houses was investigated. Litter may be contaminated by the droppings of wild birds, cats, or vermin, which may present another cause for infection. Table 5 reveals that between 20 % of the Dutch farms, 57 % of the Austrian, 60 % of the German farmers store the litter with access for rodents, cats, and wild birds.

Table 5. Results of the category „Farm management“

Risk factors	**Value**	**Austria** N = 84	**Germany** N = 222	**Netherlands** N = 37
Direct sale of poultry and/or poultry products	Yes [%]	40.5	14.0	40.5
Free running cats at the farm?	Yes [%]	36.9	36.8	24.3
Is the farm part of a vertically integrated production system?	No [%]	54.8	18.5	89.2
Additional keeping of ducks/geese at the farm?	Yes [%]	8.3	11.3	0.0
Additional keeping of pigs?	Yes [%]	43.8	63.6	5.3
Usage of a multiple age system?	Yes [%]	36.3	47.9	43.2
Type of housing	Indoor: Cage [%]	6.0	9.5	10.8
	Indoor: Barn [%]	75.0	59.0	64.9
	Outdoor: Freerange [%]	13.1	17.6	0.0
	In- and Outdoor [%]	6.0	7.2	8.1
Storage of food	Access for wild birds / cats rodents [%]	3.6	7.4	0.0
Storage of litter	Access for wild birds / cats rodents [%]	57.2	60.3	20.0
External employees at the farm?	Yes [%]	28.6	61.3	32.4
Only for layer farms:		N= 29	N= 65	N=21
Are egg trays used more than once?	Yes [%]	65.5	55.4	95.2

For the assessment of the participant’s results in this category, 14 risk factors were evaluated. The theoretical maximum score was 19 points. The maximum score accomplished by the participants were 13 points in Austria, 15.4 points in Germany and 8.3 points in the Netherlands. Accordingly, the farms were assigned to three risk classes (fig. 4). 31 % of the Austrian and 28.8 % of the German farms reached the lowest risk class, whereas only 8.1 % of the Dutch farms got less than 4 points. In risk class two, 86.5 % of the Dutch participants, 62.6 % of the German and 51.2% of the Austrian farms can be found. While only a small proportion of German and Dutch farms were assigned to risk class 3, the share of the Austrian farms in this class amounts to 18 %.

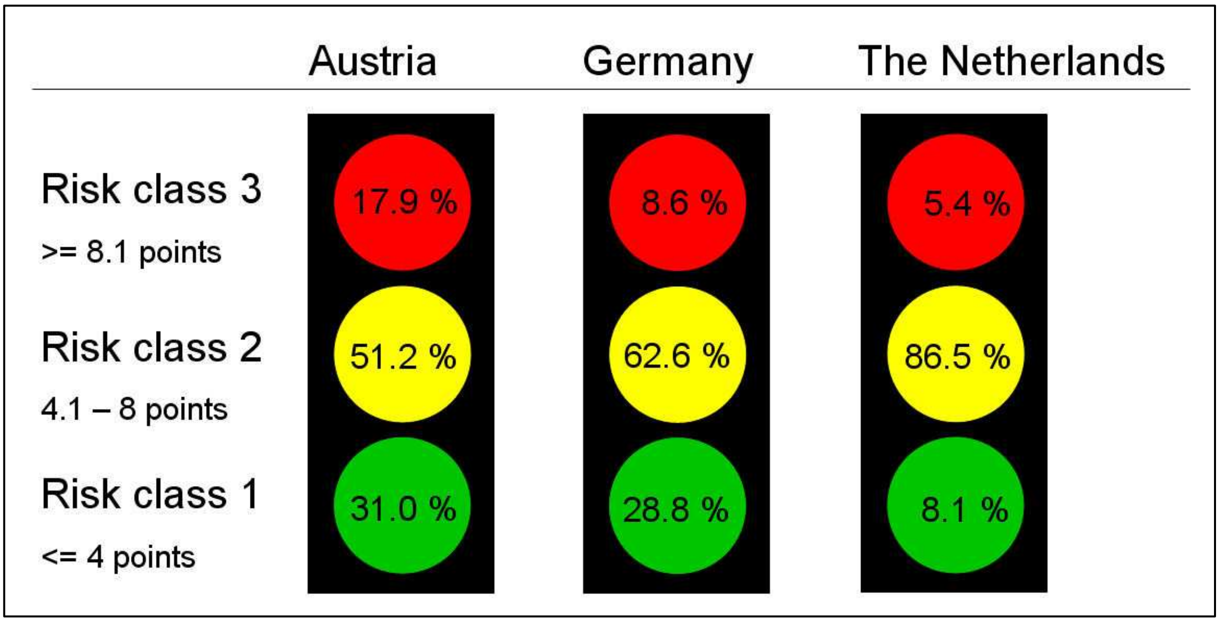

Figure 4. Attribution of the participating farms to risk classes in the category "farm management"

3.1.3 Category „Hygiene/disease prevention"

Next to farm management, biosecurity measures are widely accepted as the first line of defence against AI at farm level. The enquiry of prevalent hygiene measures undertaken in the participating farms covered measures applied for visitors as well as for employees of the poultry farm. A selection of variables investigated within the study can be found in table 6.
In Austria and Germany, more than 80 % of the farmers inform their staff about avian influenza and the associated special caution and care, which is required while working at the poultry farm. In contrast, almost 40 % of the Dutch farmers stated not to inform their employees. A closer look at table 6 reveals that regulations on protective clothing for crews that work temporarily at the farms are not common in all farms. This is especially the case in Austria, where 18.8 - 50 % of the farms do not give clear instructions for external workers. In Germany, this is mainly true for tradesmen and people of transport firms, whereas all Dutch farmers instruct their staff to wear protective clothing.
Biosecurity measures such as cleaning and disinfection of clothes, shoes or hand washing before entering the sheds constitute important barriers to the introduction of AIV into poultry holdings. But the efficiency of biosecurity plans greatly depends on the compliance of the farmer and his personnel (EFSA 2008). Therefore, all participants were asked about different hygiene measurements applied before entering the poultry house. Between 23 % (DE) and 32 % (NL) of all farms analysed do not wash their hands before and after leaving the poultry house. 7 % (AT) and 16 % (DE) of the participants do not change their clothes and between 7 % (DE) and 12 % (AT) do not disinfect their footwear before entering the poultry house. Furthermore, the disinfection of housing equipment (drinking systems, feed lines, tools etc.) was another question enquired. 37.8 % of all Dutch farms, 60.4 % of the German, and 70.2 % of all Austrian farmers answered not to clean and disinfect any equipment before implementing it to the poultry house. Furthermore, 19.4 - 28.6 % of all poultry farms investigated responded to share machinery with other poultry farms, but 11.1 - 34.1 % of these farmers do not care about how and if the machinery is cleaned before the return.

Table 6. Results of the category „Hygiene/disease prevention“

Risk factors	Value	Austria N = 84	Germany N = 222	Netherlands N = 37
Information of the staff about AI and the associated special caution and care required?	No [%]	13.1	8.6	37.8
Protective clothing for housing crews	Not regulated [%]	45.5	7.4	0.0
Protective clothing for depopulating crews	Not regulated [%]	17.5	10.0	0.0
Protective clothing for vaccination crews	Not regulated [%]	50.0	0.0	0.0
Protective clothing for tradesmen	Not regulated [%]	41.2	21.3	0.0
Protective clothing for loading crews	Not regulated [%]	18.8	3.5	n.d.
Protective clothing for transport firms	Not regulated [%]	32.4	36.1	n.d.
Hand washing before entering the poultry house?	Not at all [%]	31.0	23.0	32.4
	Not in advance [%]	4.8	2.7	62.2
(Percentages do no sum up to 100%)	Not afterwards [%]	26.2	18.5	0.0
Disinfection of footwear before entering the poultry house?	Not at all [%]	11.9	6.8	n.d.
	Not in advance [%]	15.5	13.1	n.d.
(Percentages do no sum up to 100%)	Not afterwards [%]	0.0	0.0	n.d.
Changing of clothes before entering the poultry house?	Not at all [%]	7.1	15.8	n.d.
	Not in advance[%]	3.6	1.4	n.d.
(Percentages do no sum up to 100%)	Not afterwards [%]	1.2	0.0	n.d.
Disinfection of housing equipment?	No [%]	70.2	60.4	37.8
Disinfection of vehicles, that drive onto the premises	No [%]	97.6	64.0	97.3
Vermin control?	No [%]	2.4	1.4	0.0
Regular vermin control?	If required [%]	32.2	12.3	0.0
Carcass container at the farm?	No [%]	20.2	8.1	0.0
Does the rendering truck drive onto the premises?	Yes [%]	58.3	28.4	18.9
Machinery sharing (e.g. conveyor systems, loaders, straw shoppers)?	Yes [%]	28.6	19.4	24.3
Cleaning and disinfection of the machinery before delivery to owner?	On own premises after delivery [%]	29.6	13.6	0.0
	Not regulated [%]	25.9	34.1	11.1
Disease prevention plan at the farm?	No [%]	82.1	37.4	n.d.

n.d. = no data

For the assessment of this category, 18 risk factors were used. The maximum score reached by the participants were 11.8 points in the Netherlands, 16.1 points in Germany, and 17.1 points in Austria. Accordingly, the farms were attributed to three classes of risk. As can be seen from figure 5, 40 % of the German and 9.4 % of the Austrian farms reached less than 4 points, whereas no Dutch farm can be found in the lowest risk class. Between 36.9 % (DE) and 56.8 % (NL) of the poultry farms were assigned to risk class 2. More than 40 % of the Dutch and Austrian participants can be found in the highest risk class, while only 20 % of the German farmers got more than eight points in this category (figure 5).

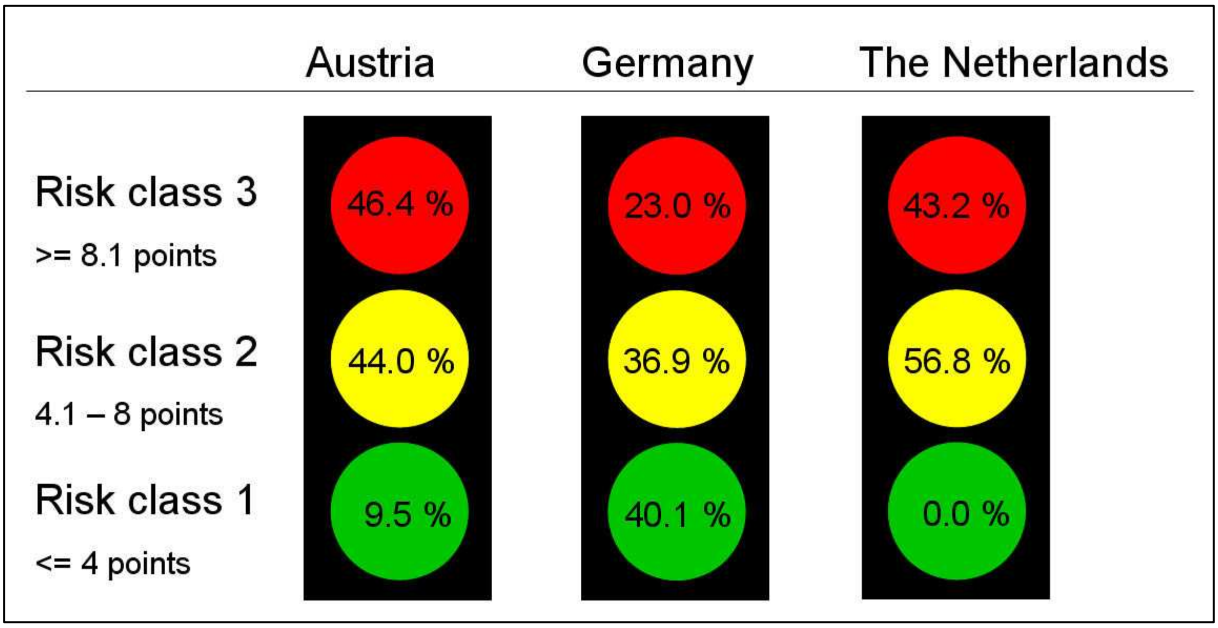

Figure 5. Attribution of the participating farms to risk classes in the category "hygiene/ disease prevention"

3.2. Logbook data

During the poultry production cycle, visitors with different purposes enter the premises. The risk of biosecurity breaches increases with an increasing number of people, birds, and items which enter the poultry farm (Thomas *et al*., 2005). The visitors registered in the logbooks were differentiated by the reason of their visits. The mean frequencies of visitors differentiated by the type of contact as well as the amount and share of the visitors, who additionally had access to the poultry shed, are summarised in table 7.

The number of visitors registered during the investigation period averages between 33 in Austria, 46 in the Netherlands, and 47 visitors in Germany. Related to the larger farm sizes in Germany and the Netherlands, the mean number of contacts is 30 % higher than in the Austrian farms. As can be seen from table 7, the share of visitors who entered the poultry house is two fold higher in Germany (20.3 people on average) than in the Netherlands (9.5 people on average). This is related to the relatively high amount of visitors in the field of "inspections / health care" as well as to the high amount of external workers who come to the farm temporarily to work in the poultry houses (e.g. loading or vaccination teams, poultry professionals).

The majority of all contacts registered can be attributed to deliveries of feed, litter and other materials as well as to private contacts which are considered to be low risk contacts. Transports of live poultry as well as the movement of manure were considered as high risk contacts by the Delphi experts (Geenen et al., this report). Live bird transports usually take place once during a production cycle. Since not all farms conduct an all-in/all-out system, some of the farms registered more livestock trucks at their premises. A closer look at table 7 reveals that the collection of manure contributes 5 % to the total Dutch contacts, whereas this share is lower in Austria (1 %) and in Germany (1.5 %).

Practising a direct sale at the farm or keeping different domestic species, result in more visitors per day. The share of contacts in this category in comparison to the total number of contacts is highest in Austria (26.7 %), where on average 8.8 customers come to the farm per month. In Germany and the Netherlands, between two (NL) and four (DE) visitors can be attributed to farm sale activities.

Table 7. Mean frequencies of visitors (premises and shed) per month by reason of visit

Country	**Austria**				**Germany**				**The Netherlands**			
	Mean freq./ 4 wks		Mean freq. access shed		Mean freq./ 4 wks		Mean freq. access shed		Mean freq./ 4 wks		Mean freq. access shed	
Reason for visit	N	in %	N	in %	N	in %	N	in %	N	in %	N	in %
Control, Inspection, treatment	3.3	9.8	2.6	37.7	7.7	15.6	6.9	34.0	4.8	10.6	3.6	37.9
Live bird transport	1.1	3.4	0.3	4.3	1.4	2.9	0.6	3.0	1.6	3.5	0.5	5.3
Housing	0.3	0.9	0.3	4.3	0.8	1.6	0.7	3.4	0.2	0.4	0.2	2.1
Pre-harvesting / catching work	2.1	6.3	0.2	2.9	5.6	12.0	5.4	26.6	0.6	1.2	0.4	4.2
External staff members	0.0	0.1	0.8	11.6	0.1	0.3	0.1	0.5	2.3	4.9	0.9	9.5
Repair, construction work in the shed	1.2	3.6	0.0	0.0	2.1	4.5	1.0	4.9	0.8	1.8	0.5	5.3
Advisors	1.1	3.3	0.3	4.3	0.5	1.2	0.2	1.0	1.8	4.0	0.8	8.4
Deliveries to the farm	3.1	9.5	0.4	5.8	5.8	12.3	0.2	1.0	6.1	13.4	0.0	0.0
Distribution of poultry products	1.7	5.0	0.0	0.0	4.3	9.2	0.5	2.5	4.5	9.8	0.5	5.3
Direct sale at the farm	8.8	26.7	0.1	1.4	3.6	7.7	0.4	2.0	2.0	4.3	0.0	0.0
Collection of manure / rendering trucks	0.3	1.0	0.8	11.6	0.7	1.5	0.0	0.0	2.3	5.1	0.1	1.1
Cleaning, disinfection, rodent control	0.5	1.4	0.0	0.0	0.5	1.0	0.3	1.5	0.4	0.9	0.4	4.2
Non-poultry related farm contacts	2.8	8.5	0.4	5.8	1.9	4.0	0.2	1.0	1.8	4.0	0.3	3.2
Private / Other contacts	6.8	20.6	0.7	10.1	11.9	25.5	3.8	18.7	16.5	36.1	1.3	13.7
Total	32.9	100.0	6.9	100.0	46.9	100.0	20.3	100.0	45.7	100.0	9.5	100.0

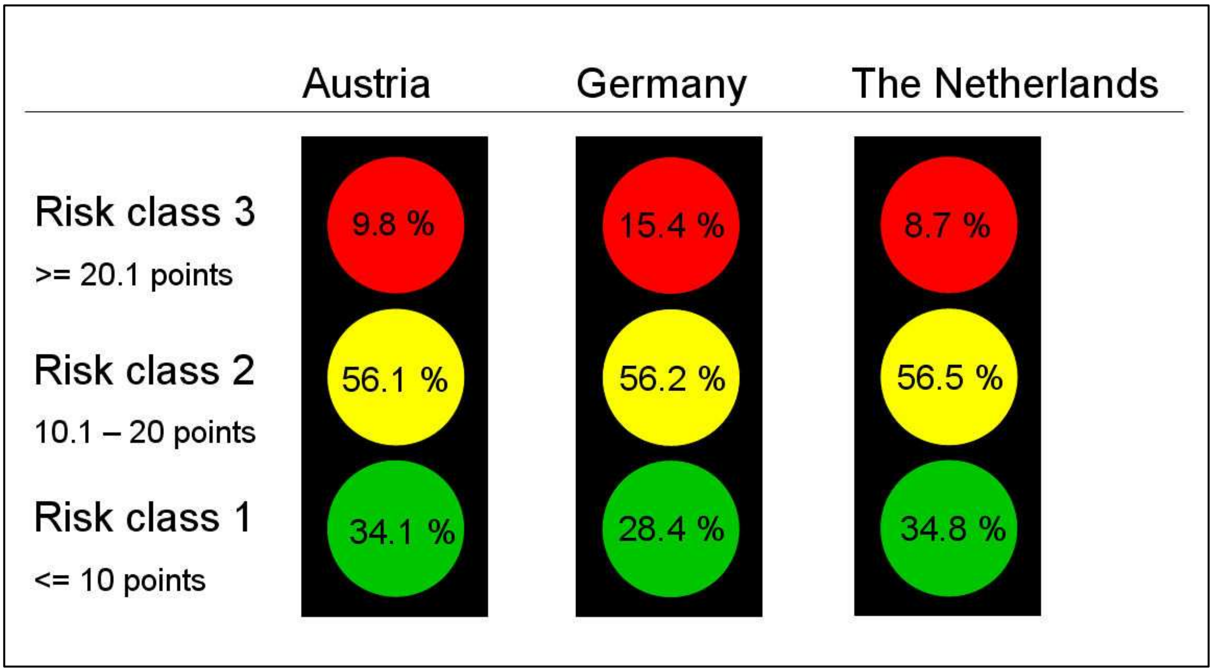

Figure 6. Results of the assessment of the contact structure in Austria, Germany, and the Netherlands

The assessment of the logbooks was conducted with regard to the frequency of visitors during the 30 day period (see chapter 2.4.2). The higher the risk class, the more risk contacts where registered at the poultry farms. As it can be seen from figure 6, the distribution of the participants to the risk classes is similar in all countries. On third of the participants reached the lowest risk class with less than 10 points. 56 % of all participants were assigned to the medium risk class, whereas between 8.7 % (NL) and 15.4 % (DE) of the poultry farms can be found in the highest risk class.

3.3. Final assessment

As described in chapter 2.4.3, the scores derived from the questionnaire and logbook assessment were added for each farm. The final scores range between 11.1 and 49 points. The theoretical maximum to reach was 77 points. Only farms with both documents handed in for analysis were considered (table 1). Figure 7 displays the final assessment of the farms to the risk classes using the traffic light colours.
The highest share of participants in risk class 1 can be found in Germany (13.1 %), followed by Austria, where 4.9 % of all Austrian farms reached less than 16 points. None of the Dutch farms can be found in the lowest risk class, which is influenced by the relatively high scores from the evaluation of the questionnaires. As can be seen from figure 7, more than two third of all participating farms were assigned to the second risk class. The highest risk class 3 contains farms with more than 32 points. Almost one quarter of the Austrian farmers, more than one fifth of the Dutch poultry farms and 17 % of the German farms were attributed to the risk class 3.

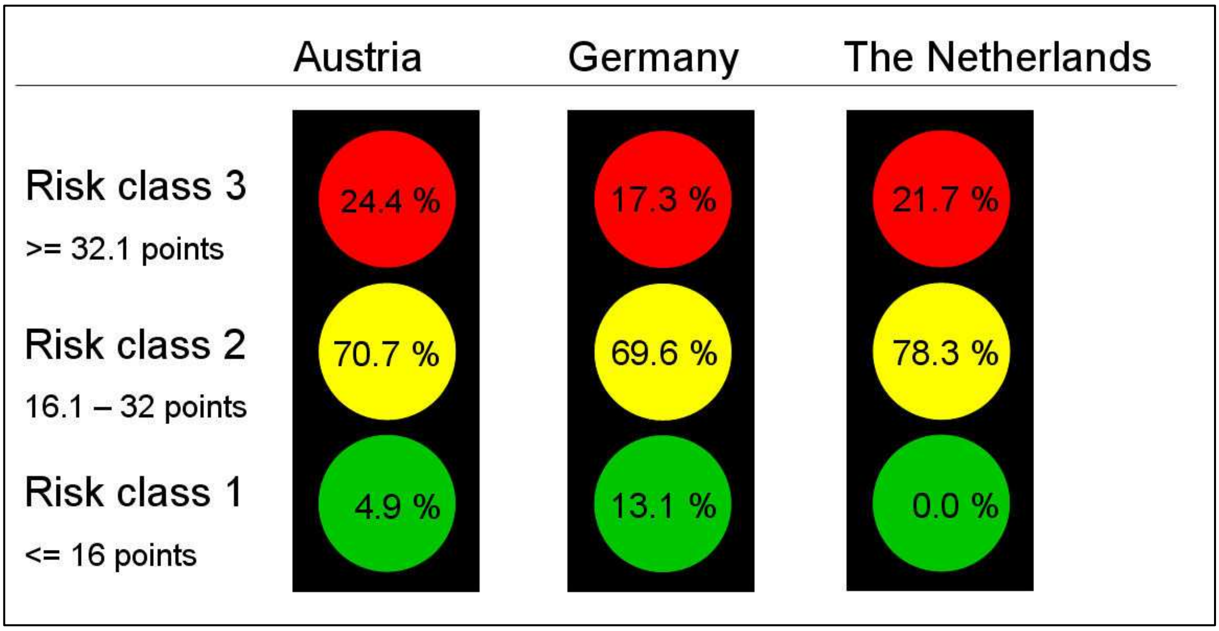

Figure 7. Final attribution of the farms to three risk classes

Table 8 gives an overview about the results by country and poultry species. As can be seen, two third of the participants were attributed to the risk class 2, a quite low share reached the lowest class and between 8.3 % and 36.4 % can be found in the highest risk class. Only a small proportion of the Austrian and German broiler farms and no Dutch farm were attributed to the lowest risk class. 70 % of the Austrian and German as well as 92 % of the Dutch farms were allocated to class 2. The highest share of farms in class 3 shows the groups with broilers and layers. Although only 8.3 % of the Dutch broiler farms can be found here, 21 % of the German and 28 % of the Austrian broiler farms received more than 32 points. A closer look at the results of the layer farms by countries reveals that none of the Austrian and Dutch farms reached the lowest risk class, but more than one third of them was assigned to the highest risk class. More than 20 % of the German layer farms reached class 1 and 14.3 % can be found in class 3.

Table 8. Final assessment of the participating farms by poultry species and country

Poultry species	*Country*	**Austria**		**Germany**		**Netherlands**	
	Risk classes	N	in %	N	in %	N	in %
Broilers	Risk class 1 (<= 16.0)	1	3.4	6	8.8	0	0
	Risk class 2 (16.1 - 32.0)	20	69.0	48	70.6	11	91.7
	Risk class 3 (>= 32.1)	8	27.6	14	20.6	1	8.3
	Total	**29**	**100.0**	**68**	**100.0**	**12**	**100.0**
Layers	Risk class 1 (<= 16.0)	0	0	11	22.4	0	0
	Risk class 2 (16.1 - 32.0)	18	66.7	31	63.3	7	63.6
	Risk class 3 (>= 32.1)	9	33.3	7	14.3	4	36.4
	Total	**27**	**100.0**	**49**	**100.0**	**11**	**100.0**
Turkeys	Risk class 1 (<= 16.0)	3	11.5	3	8.6	n.d.	n.d.
	Risk class 2 (16.1 - 32.0)	20	76.9	27	77.1	n.d.	n.d.
	Risk class 3 (>= 32.1)	3	11.5	5	14.3	n.d.	n.d.
	Total	**26**	**100.0**	**35**	**100.0**	**n.d.**	**n.d.**
Pullets	Risk class 1 (<= 16.0)	n.d.	n.d.	2	16.7	n.d.	n.d.
	Risk class 2 (16.1 - 32.0)	n.d.	n.d.	8	66.7	n.d.	n.d.
	Risk class 3 (>= 32.1)	n.d.	n.d.	2	16.7	n.d.	n.d.
	Total	**n.d.**	**n.d.**	12	100.0	**n.d.**	**n.d.**
Other poultry species (ostriches, ducks, pedigree poultry)	Risk class 2 (16.1 - 32.0)	n.d.	n.d.	3	75.0	n.d.	n.d.
	Risk class 3 (>= 32.1)	n.d.	n.d.	1	25.0	n.d.	n.d.
	Total	**n.d.**	**n.d.**	**4**	**100.0**	**n.d.**	**n.d.**

n.d. = no data

4. Discussion

In this study, poultry farms were analysed with regard of their location, farm management, hygiene/disease prevention practises, and contact structure. Within the evaluation process, the participants' answers were checked on the occurrence of risk factors and the frequency of high risk contacts respectively. For each risk factor present, a specific score was attributed to the farm's account. Subsequently, for each farm the total score of each category (location, management, disease prevention and contact structure) was attributed to one of three risk classes by assuming that more risk factors apparent at a farm lead to a higher risk on AIV introduction. To communicate the results in a comprehensible way, a traffic-light-scheme was proposed to assess the farms' risk status for a possible incursion of the virus. However, the highest risk class is not intended to forecast an AIV incursion in the near future. As experiences of precedent outbreaks show, even farms with a good hygiene standard can be affected by an AIV outbreak (Korbel 2005).

The efficacy of biosecurity plans depends greatly on the compliance of the farmer and his personnel. Compliance will be enhanced when they have a basic understanding of the purpose of the measures (WHO 2008). Therefore, one focus of the study was especially laid on the implementation of disease prevention measures. One result was that the farms perform worst in this category "hygiene/disease prevention". As described in chapter 3.1.3, the investigation revealed a set of biosecurity gaps, which are related to basic hygiene measures such as hand washing or the disinfection of poultry house equipment. On the one hand, this means that more education of the farmers is necessary and on the other hand it means that most of these security breaches are easy to bridge. To communicate the results, each of the Austrian and German farmers got individual information about the results including an explanatory text by mail. In addition, check lists for the premises, the service rooms as well as for the poultry houses were provided. In these lists, daily suggestions how to maintain a high level of biosecurity and how to prevent the incursion of pathogens were made. Furthermore, the participants were invited to a conference on disease prevention in poultry farms, which was held in each country. During these conventions the results were presented and additional veterinarian information was given. Besides, the farmers had the possibility to ask questions and to discuss their results. Most of the participants were grateful for the advice and astonished, that easy steps can help to improve their farm's risk status. From these reactions it can be stated that indeed the traffic light system seemed to have been understood by the farmers. For further investigations it is advisable to evaluate the transparency and the use of the traffic-light-system and to investigate if the guidelines and suggestions are applied by the farmers. Based on these experiences it can be concluded that education and communication are still essential tools within farm management and disease prevention, even in the western part of the European Union, where an invariable high degree of professionalism could be assumed.

Comparing the evaluation results between the countries, it is striking that the Austrian participants received the worst results, followed by the Dutch and the German farmers. An explanation could be the different organisation structures of poultry production in these countries, which could give reasons for variations in farm management and contact structures. With regard to disease prevention, the Austrian and Dutch participants showed a high potential to improve their basic hygiene measurements. This is especially astonishing for the Netherlands since the country already faced a severe AIV outbreak in 2003 and therefore the farmers were expected to provide a high degree of hygiene standard. This is true for four participants (broiler farms), who stated to implement the Dutch system of Integrated Quality Control (IKB) and reached risk class 2. The holistic IKB-concept includes the safety and quality of the product, and the production method and it is implemented in 70 % of the broiler farms in the Netherlands (Bekman 2007). However, also farms working without the IKB-system reached lower risk classes. For further research it is recommended to evaluate the implementation of farm management, hygiene, and disease prevention measures in both types of farms with and without the IKB-system.

Since biosecurity is a farm's first line of defence, the results are not only relevant for the introduction of AIV, but also for the introduction of any poultry pathogens. Especially with regard to the EU zoonosis directive 2003/99/EC[1] and for example the realisation of the commission regulation No 1168/2006[2], most of the farms investigated need to adjust their hygiene management in order to achieve the defined prevalence level by each country. Nevertheless, despite the limitations of this study and the relatively small data set used in relation to the size of the countries, the system developed can provide an outline for the prevalent AI introduction risk status of livestock and poultry farms. For future research and use within disease prevention it is recommended to investigate a representative sample of farms in different European regions. Accordingly the data could be interpolated using multivariate statistical methods (e.g. kriging) to produce regional risk maps. As suggested by the expert panel within the Delphi study (Geenen et al., this report), these maps could inform about the different share of farms posing a low, medium or high introduction risk. In combination with the regional risk maps developed within the project (Grabkowsky et al., this report), this information could be of use for decision makers in terms of disease prevention.

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[1] Decision No 2119/89/EC of the European Parliament and of the Council setting up a network for the epidemiological surveillance and control of communicable diseases in the Community (OJ L 268, 3.10.1998, p.1)
[2] Commission regulation (EC) No 1168/2006 of 31 July 2006 implementing Regulation (EC) No 2160/2003 as regards a Community target for the reduction of the prevalence of certain salmonella serotypes in laying hens of *Gallus gallus* and amending Regulation (EC) No 1003/2005

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