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Final Report

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Final Report

PROJECT FINAL REPORT

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Final Report

Please note that the contents of the Final Report can be found in the attachment.

4.1 Final publishable summary report

Executive Summary

By establishing an increased understanding of Campylobacter epidemiology and control measures in geographically distinct regions of the EU as well as semi-continuous monitoring methods, we are now able to provide broiler producers and retailers with a research-based certification programme that includes educational material, guidelines and standards on how to produce broilers with low-risk of Campylobacter contamination.

The research within CamCon has identified several interventions that are predicted to effectively improve the biosecurity, thereby offering methods to control this important public health problem. Given the EU-wide nature of broiler production and marketing and the prevalence of human infections across the community, we have identified control measures that are applicable across Europe.

CamCon has, in addition to the educational material for producers and the poultry industry, produced several scientific publications, abstracts, posters and presentations at scientific meetings, several presentations for the poultry industry internationally and nationally in the participating countries.

The project CamCon (Campylobacter control – novel approaches in primary poultry production) started 1 May 2010 and ended 30 April 2015. The consortium consisted of 10 participating institutions from seven countries representing various parts of Europe. The participating institutions included national diagnostic laboratories, institutions providing research and advisory services and universities.

The goal of CamCon was to improve the control of Campylobacter in primary poultry production in various parts of Europe and thereby enable the production of fresh, Campylobacter-free chickens (or with a very low contamination level). The project placed great emphasis on ensuring rapid and effective dissemination of scientific achievements to end-users, in particular the EU poultry industry.

Five scientific Work Packages dealt with a wide aspect of questions related to Campylobacter in primary poultry production; epidemiology of Campylobacter, three different pre harvest interventions (biosecurity and fly screens, bacteriophages and vaccines), development of rapid methods for detection of Campylobacter, risk assessment and economical aspects of different interventions and finally, how to transfer the knowledge regarding Campylobacter and how to prevent this from being a problem in the primary poultry production to the poultry industry themselves.

In addition to several scientific publications, CamCon and the results has been presented more than 50 times at several meetings and in various media to inform the industry (nationally and internationally), the authorities (nationally and internationally) and the scientific community about the project and the results. Several publications and presentations are also expected after the project ends.

Summary description of project context and objectives

CamCon aimed to improve the control of Campylobacter in primary poultry production in various parts of Europe and thereby enable the production of fresh, Campylobacter-free chickens or chickens with a very low contamination level. The project placed great emphasis on ensuring rapid and effective dissemination of scientific achievements to end-users, in particular the EU poultry industry.

The consortium consisted of 10 participants from seven countries representing various parts of Europe. The participating institutions included national diagnostic laboratories, institutions providing research and advisory services and universities.

The activities in CamCon was organised into five interdependent Work Packages described below.

Work package 1 - Epidemiology
This WP aimed to improve our understanding of the epidemiology of Campylobacter, considered the role of different subtypes of Campylobacter, seasonal and geographical variation as well as within and between farm house transmission of the bacteria. The work used a combined field, laboratory and modelling approach, with large-scale studies that encompassed geographical variation and longitudinal studies that quantify the dynamics of infection at the flock level.

Work Package 2 – Pre-harvest interventions
This WP focused on three different intervention strategies; the effect of comprehensive biosecurity in two very different geographical areas, phage therapy (which was partly developed and tested in a semi-field setting), and vaccination.

Work Package 3 – Diagnostic tools for monitoring and control
This WP aimed to implement efficient, inexpensive and rapid methods for semi-continuous detection, strain identification and quantification of Campylobacter at farm level.

Work Package 4 – Risk assessment and economics
This WP aimed to evaluate the effectiveness and efficiency of the interventions studied in WP2, combining data from the epidemiological studies in WP1 and data from the intervention studies in WP2 with quantitative microbiological risk assessment and economic analysis. The implications of regional differences were evaluated.

Work Package 5 – From science to industry
This WP aimed to facilitate rapid transfer of new science-generated knowledge to practical solutions for the poultry industry, with the ultimate aim of reducing the growing burden of Campylobacter-associated illness on the population. To accomplish this, we developed novel web-based and tailor-made education and E-learning programmes targeted to poultry farmers and farm personnel in close cooperation with poultry farmers and poultry operators in order to constantly apply feedback and user requirements into the education programmes.

Conclusion
CamCon has provided novel approaches for the control of Campylobacter in poultry to significantly enhance the ability of the European food industry to produce and sell Campylobacter-free broilers (or broilers with a very low contamination level of Campylobacter). Intervention during primary production is likely to be the most effective way to bring about control of this important public health problem. Given the EU-wide nature of broiler production and marketing and the prevalence of human infections across the community, we have identified control measures that are applicable across Europe.

By establishing an increased understanding of Campylobacter epidemiology and control measures in geographically distinct regions of the EU as well as semi-continuous monitoring methods, we are now able to provide broiler producers and retailers with a research-based certification programme that includes educational material, guidelines and standards on how to produce these low-risk broilers.

Description of main S & T results/foregrounds

CamCon focussed on five different areas to learn more about Campylobacter and poultry;
- the epidemiology of Campylobacter in poultry in Europe,
- how to prevent/reduce Campylobacter at farm level,
- how to detect Campylobacter,
- the most efficient ways to combat Campylobacter at farm level, and what the costs for this would be,
- and last, but not least, how to communicate the findings and the general knowledge about Campylobacter in primary poultry production to the industry.

The main results for each of the five research areas are presented below. In addition, CamCon as such – its main ideas and layout - has been presented at several meetings and in various media to inform the industry (nationally and internationally), the authorities (nationally and internationally) and the scientific community about the project, its web site and expected outcome.

Epidemiology of Campylobacter

This Work Package was divided in five tasks;
• a study of risk factors for Campylobacter colonization,
• a longitudinal study looking into details of Campylobacter colonization,
• assessment of the importance of flies in transmission of Campylobacter,
• a study on MLST subtypes of Campylobacter across Europe,
• modelling the in- house Campylobacter colonization of broilers

Risk factors for colonization
Data on Campylobacter in broilers were obtained through national surveillance programmes in Denmark and Norway, as well as Campylobacter data collected from a longitudinal study on 20 farms in the Netherlands, Poland, Spain and the UK. These data were combined with questionnaire data obtained through a survey in the six countries.

The results of the questionnaires survey provided new and detailed insight into a number of variables associated with management and biosecurity practices in the broiler production within the participating countries. With the exception of a baseline study carried out by the European Commission, describing a limited number of potential risk-factors, this is the first comprehensive standardized questionnaire survey carried out simultaneously in several European countries.

The surveillance data from Norway (173 farms) and Denmark (107 farms), including Campylobacter status from more than 5200 flocks were analysed separately. An increased risk for Campylobacter colonization was associated with country; i.e. Danish broiler flocks were more frequently colonized than Norwegian flocks. Furthermore, the age of the broiler house, density of birds, level of biosecurity (anteroom and barrier at entrance), length of downtime (reducing downtime to up to 10 days being protective) and type of drinkers were all found to be associated with the risk of the broiler flocks becoming colonized by with Campylobacter.
The analyses were then extended to include data from the prospective 20-farm study. The data on flocks were combined with climate data to further investigate differences among climatic regions of the EU.

When analysing these data, an increased risk was associated with country; in descending order, broiler flocks were more frequently colonized in Poland, Spain, UK, the Netherlands, Denmark and Norway. There was an association between climate and colonization of flocks, i.e. the number of positive flock increased with increasing ambient temperatures. Furthermore, the conclusions from the study on data from Norway and Denmark were supported by this expanded study. Factors associated with biosecurity on the farm were again identified as risk factors; age of house, anterooms and barriers in each house, designated tools for each house, as well as length of downtime and the types of drinkers were found to be associated with the risk of the broiler flocks becoming colonized by with Campylobacter.

In conclusion, CamCon has provided the first risk factor analyses of comparable data from six European countries and has provided an insight into the risk factors across countries. There is a clear effect of country and temperature. Furthermore, a number of specific biosecurity measures have been identified across countries as important risk factors for Campylobacter colonization of broiler flocks.

Longitudinal study in UK and Spain
Based on the list of farms included in the questionnaire survey described earlier, a subset of UK farms (8) and Spanish farms (5) were selected for a more in-depth longitudinal study. At the start of the project, there were frequent meetings with poultry producers in both the UK and Spain to agree farm access, sampling protocols and data collection.

In both countries, extensive sampling of selected flocks (109 in UK and 63 in Spain) and the farm environments took place over a two year period. Data relating to geographical location, local climate, on-farm management practices and welfare indicators was also collected to be included in the modelling of the in-house Campylobacter colonization described below.

In UK, a total of 54% of flocks were positive for Campylobacter before slaughter. The average age at which flocks become positive was 23 days, with the earliest detection of Campylobacter being at 9 days of age. No farm remained consistently negative throughout, with some seasonality evident.

In Spain, 60% of flocks were positive for Campylobacter before slaughter, with none of the farms remaining consistently negative throughout. The earliest detection of Campylobacter was at 7days of age. In both countries, the time at which flocks first became Campylobacter-positive is significantly earlier than has been previously reported in the literature and may reflect the highly sensitive boot sock detection method used in this study.

Role of flies in transmission of Campylobacter
The farms included in the longitudinal study described above were also included in studies on flies.

Campylobacter carriage by flies
In both countries there was a low carriage rate of Campylobacter in flies, however somewhat higher in Spain where also a clear seasonal peak was found. Similar for both countries were, that the Campylobacter risk flies were found within a diminutive part of the Diptera order, commonly called ‘filth flies’.

Flies were captured one by one in the close broiler house surroundings. Musca domestica (house fly) was the most frequent (89.8%) fly species captured in Spain and the only fly species positive by culture (1.7%), however with a peak of 31.8% positive flies in September. In UK, very few Musca domestica were caught and none were found to be Campylobacter positive. In UK, flies were cultured in pools of ≈10 and the individual carriage rate calculated to 0.3%. The positive pools comprised mainly of the families Calliphoridae (blow flies), Fanniidae (lesser house flies), Muscidae (including the common house fly) and Scatophagidae (dung flies). In accordance with the species distribution found in UK, additional PCR detection in Spain found very similar fly families positive i.e. Calliphora sp. (blow fly), Fannia canicularis (lesser house fly), M. domestica, and Ophyra sp. (= Scatophagidae) (black garbage fly). The prevalence by PCR in Spain was 10.5%, with a peak of 32.2% positive flies in August.

Genotyping of the Campylobacter isolates
The MLST and PFGE typing showed that flies may likely be an integrated part of the entire Campylobacter ‘farm to fork’ chain between environment – broiler – chicken meat – humans. In UK the positive flies were found to carry both cattle and broiler associated MLST types of Campylobacter, types also reported in relation to human disease. In Spain, PFGE profiles were found identical among Campylobacter isolates from flies in the surroundings and broilers in the houses during concurrent rearing cycles. Most of the broiler flocks became Campylobacter positive around the same time or just after detecting Campylobacter in the sampled flies, with evidence of the same strains being found in both flies and broilers during the same rearing cycle.

The proportion of risk flies out of the total insect population
The results in the two countries were quite similar. The majority, ~75% of the total insect population, belonged to Diptera. A higher diversity was seen in the material from UK with 31 families of Diptera of which 2.3% were filth flies, compared to 17 Dipteran families in Spain of which 0.14% was filth flies.

More than 10,000 insects were captured by traps to evaluate the composition and abundance of the insect population in the close surroundings of the houses. This whole population is likely to be embedded in the ventilation inlet air with the possibility to contaminate the in-house environment or transmit Campylobacter directly when eaten by the chickens. A large number of insects were found to be associated with broiler house ventilation inlets; the 10,000 insects were captured at short sampling episodes and represent only the very top of the iceberg concerning the number of insects actually ingressed.

Flies' ability for transmission between farms
Concerning flies' ability to transmit Campylobacter between farms, flies may easily spread Campylobacter to other farms within a periphery of a few kilometers.

A behavioral laboratory study conducted in cooperation with two other national Danish projects observed a flight range of around 10,000 meters within 24 hours. This range is likely somewhat less under outdoor environmental conditions,

In conclusion: The overall prevalence of Campylobacter positive flies was found to be low ~1% of flies in broiler house surroundings, but the ingress of flies in ventilation air was high. Campylobacter types found in flies were associated both to concurrent broiler flocks as well as to Campylobacter types already known in both livestock and humans. So, flies were found to be a risk for transmission of Campylobacter to and between broiler flocks. Secondly, a role in other parts of the Campylobacter epidemiology is suggested.

Typing of Campylobacter strains
A total of 457 isolates from Spain, Poland and Norway were typed using MLST. These comprised Campylobacter isolates collected prospectively from Spain (n=160) and Poland (n=172) as part of task 1.1, of which full allelic profiles were obtained from 132 and 157 isolates respectively. Isolates were also obtained from retrospective collections of Campylobacter species from surveillance in poultry in Norway (n=174), with full allelic profiles obtained from 168 isolates.

The resulting sequence data were combined with retrospective MLST data provided by the UK, the Netherlands and Denmark, giving a total of 1011 isolates. All retrospective isolates had been selected from studies which took place between 2003 and 2011. All isolates selected were from broiler chickens, with one isolate selected per crop and equally distributed over the year to allow any seasonal effects on sequence type (ST) to be explored.

The dataset was analysed to give sequence types, and clonal complexes where available. The frequency of occurrence of each ST was determined and Principal Component Analysis (PCA) applied, showing a large degree of diversity amongst the STs from different countries, with isolates from the UK being most divergent from the other countries, and Spain and Poland being most similar to each other.

Modelling the in-house Campylobacter colonization of broilers
Data from the longitudinal study was used in complex models to examine the direct and indirect pathways to colonization by Campylobacter.

We found that the likelihood of colonization of the study building significantly increased if adjacent production buildings on a farm first became colonized. In addition, the likelihood of colonization was also significantly greater for standard welfare systems (higher stocking density) in comparison to higher welfare systems (lower stocking density). The type of drinking water provider also affected the underlying risk of colonization by Campylobacter, where the risk of colonization associated with drinking cups and nipples was significantly greater than drinking water providers that did not provide cups. Longer duration of down-time between flock-cycles significantly reduced the likelihood of colonization. External air temperature was also found to increase the probability that a flock-cycle would become colonized. The infection status of the previous flock-cycle within a farm, the hours of sunshine and rainfall in the month of depopulation did not significantly alter the risk of colonization and were removed from the final model.

Main outcomes from WP1
To date, one peer reviewed paper has been published and a further nine papers have been/will be published about various topics in this WP.

The results have been/will be presented as more than 15 abstracts/posters/oral presentations at more than eight international and national meetings, including meetings with the industry and other stakeholders.

Lessons learned
To produce a questionnaire in several different languages to be used in several different countries, and to be filled in both by farmers and veterinarians/consultants faced some challenges. In hindsight we would have benefitted from having done a small pilot study, to be able to pick out the most “troublesome” questions and improve these.

The basic understanding of proper biosecurity was not always present, and this made it difficult when comparing farms or production companies where farmers may have had different levels of training on biosecurity. However, we think that the teaching material developed in CamCon (WP5) can be a basis for establishing a common platform in future research regarding various aspects of biosecurity, not only regarding Campylobacter.

To identify farms willing to participate in the studies also proved to be difficult. For example, in the UK companies were reluctant to give out address information for farms for the questionnaire survey, therefore they posted out the questionnaires and without follow up by researchers, the compliance rates were relatively low. In future, one could probably also recruit farms via poultry and farming organisations to increase access to farms, including those who are contracted to the big integrated poultry companies and those which are independent growers. It also took to negotiate access to farms and subsequently the farm and factory data which requires an input of staff time from the producers, with further difficulties encountered in that not all companies collect the same data, or record it in the same way. In future for similar work, one should develop a data collection plan and format with the company at the beginning of the project to ensure that all data is collected and stored in a comparable manner and can be accessed throughout the project, rather than extracted at the end.

Before CamCon, it was already known from studies in Denmark and Sweden, that flies living in the close outside environment of broiler farms could carry Campylobacter during the warmer months April to October, although with a very low prevalence, ~1% as an average. In Denmark, a significant peak in Campylobacter positive flies had been observed in July and August. By including two countries with warmer climates than Scandinavia, ie UK with moderately higher average ambient temperatures and Spain with much higher temperatures, we could investigate how the carriage rate of flies differed from Scandinavia, and if flies should be considered of higher importance as a risk factor due to the higher ambient temperatures. It was also a question if the peak would be much broader in these warmer climates. The results in CamCon showed that the prevalence of Campylobacter positive flies was quite similar to the Scandinavian data and that the peak also just covered a 2 months period in the much warmer climate in Spain. This suggests that the previous results from Scandinavia can be transferred to countries with warmer climates, both a milder Northern European as well as a hotter Southern European climate.

Intervention strategies

Three different intervention strategies to be used in a farm setting were included in the project; Fly screens as an add-on to good biosecurity, bacteriophages and vaccination. The first intervention could, if implemented successful, be able to produce Campylobacter free broilers, while the two other strategies could lead to a reduced amount of Campylobacter in intestines of broilers being colonized by Campylobacter, thereby reducing the risk for humans becoming infected by handling broiler meat.

Fly screens and biosecurity
The objective was to investigate if fly screens would prove useful under different geographical, climatic and production conditions. The precondition for success was acknowledged to be that the farms already would have to have a high level of biosecurity.

Studies were performed in two countries UK and Spain, in close collaboration with the poultry industry. In UK CamCon collaborated with a Defra funded project to optimize the amount and use of data to be included in the study. The Defra study was set up to test the reductive effect of an implemented basic biosecurity regime in a first phase followed by a second phase with addition of fly screens. In Spain, where we soon realized that no farms were adequate in biosecurity initially, an amended study ‘the 18-farm study’ was designed with more focus on advice to and training of farmers in biosecurity practice. For this training, draft educational material developed in WP5 was applied.

Results from the UK Defra study showed no reductive effect on the flock Campylobacter prevalence of the implemented basic biosecurity protocol during the 1st phase and fly screen were not able to improve that during the 2nd phase. This merely confirmed the anticipation, already set in the original application, that high level biosecurity practice is crucial to achieve a benefit of fly screens. However, a slight delay in the introduction of Campylobacter in flocks during the peak insect season was observed after the implementation of fly screens.

In Spain, a study including 18 farms was conducted. Given the experience gained in UK with the lack of effective biosecurity, much effort was instituted in upgrading and training the biosecurity practice on the Spanish farms. Fly screens were not added until preliminary results indicated some effect of the instituted biosecurity practice. The effect of biosecurity + fly screens seems so far promising by April 2015 (the end of the CamCon project), but the full effect cannot be evaluated until ultimo 2015. The project will be carried further on under the responsibility of the CamCon partner in Spain.

The functionality of the ventilation systems was tested during the study, and found fully effective on the study farms with fly screens in both UK and Spain.

Based on the results so far, we expect that the outcome of the 18-farm study will confirm our hypothesis, that the implemented biosecurity practice can reduce the yearly flock prevalence of Campylobacter in Spanish broiler houses, and that fly screens may add further to the effect of basic good biosecurity.

Bacteriophages
The main goal of this task was to study if phage therapy by oral administration of lytic phages to broilers is feasible for the control of Campylobacter in a field setting.

Several bacteriophages have been collected through the project period to produce “phage cocktails” to be used in further studies. With the end of the project this task was finished recognizing that the established phage cocktail for trials had a very broad, but not complete, host-range for Campylobacter.

A bacteriophage production protocol was established by using T-flasks with high surface area. It was noticed that the period that the plaques were left shaking at 4 °C with SM buffer was an important factor. When the plaques stayed shaking for three days the titre was 1E+10 PFU/mL. This last system was chosen to produce phages for the in vivo trials.

Phage production was optimized and the highest yield of production was obtained in solid cultures. It is harder to scale-up solid cultures than liquid cultures, 500 cm2 tissue culture plates were used to produce high amounts of phages to be used in the large field trials.

Different experimental conditions for phage therapy of naturally infected broilers were tested (treatment group n=10), varying inoculum size (10^5-10^9 PFU/animal) and daily vs. one time (day 35) phage application. Results were highly variable but never showed a statistical significant reduction of Campylobacter more than a temporary reduction of 1 log, similar in pattern to the temporary 2-3 log reduction demonstrated previously in experimental infected broilers with one susceptible Campylobacter strain and lytic phage.

Two in vivo chicken pen trials (small scale) with phage therapy both found that no significant reduction was observed in Campylobacter excretion of chickens, and that the measured values were highly variable within treatment groups.

Three field experiments in farms with around 10 000 animals were performed with phage cocktail application either by food or by drinking water. There was a strong biological variation, with standard deviations greater than 100% of the average. In order to reduce the variability among samples the final field trial was performed with a larger number of samples than in the previous trials. In addition to that, 2 administrations of the phage cocktail in 2 consecutive days were performed. The results, although with a lower standard deviation, showed no decrease of Campylobacter loads after phage application.

To be able to find out more about why lytic phage therapy has such little effect in field settings, new studies into possible underlying causes for phage inactivation or phage resistance was performed trying to investigate three hypotheses;

• Phage inactivation due to emergence of resistance
• Phage inactivation due to GI tract environmental conditions (namely pH)
• Phage inactivation by the presence of other microorganisms ruled by quorum sensing

Phage inactivation by physical causes such as low pH and bile salts as present in the intestine was found to have no effect. Other factors as interactions with intestinal microbes (E. coli, Salmonella) or Quorum Sensing also became part of the research but still lack sufficient scientific support; this investigation is still ongoing. Also DNA sequence analyses of phages and resistant Campylobacter strains have not yet led to clear insights into the nature of the effectiveness of phage therapy.

So far, it has to be concluded that although lytic Campylobacter phages could be found and in vitro broad spectrum phage cocktails was produced, there was no statistical significant reduction of Campylobacter by oral administration in broilers in a field setting. However, CamCon has provided useful knowledge also on the more basic mechanisms of inactivation or resistance of bacteriophages.

Vaccination
The main goal of this task was to further develop preliminary work into a vaccine candidate which could be used in a field setting.

All vaccination trials were based upon the principle of in ovo vaccination which means that chicken embryo's at 18-days are vaccinated in the egg. For vaccination against viral diseases this approach has been useful. There are not yet in ovo vaccines against bacterial diseases.

A previously designed candidate Campylobacter subunit vaccine with intrinsic adjuvant activity for use in poultry had demonstrated that embryonated eggs express the TLR receptor that is the target of the adjuvant. In this project, a purified candidate vaccine was successfully produced and used to immunize 18-day embryonated chicken eggs with the engineered flagellin subunit vaccine. The generated antibody response was analysed using a newly developed ELISA.
In ovo experiments with glycosylated, a non-glycosylated flagellin and a whole cell vaccine were performed and the results showed that immune responses (IgG and to a lesser extend IgM and IgA) was induced. However, these responses were not protective against a challenge and there was a dose dependent immune response.

Administration of a higher vaccine dose required optimal production of the antigen, and during the production of the vaccine components, it was noted that the production of the glycosylated product was repeatedly unstable: only in rare cases batches produced a reasonable amount of antigen but most batches failed to produce any glycosylated protein. Until now the antigen was present on a plasmid and this was most probably the reason that the production was instable.

To improve the stability of the production of the engineered flagellin and its degree of glycosylation, the flagellin gene was moved from the thus far used expression plasmid onto the bacterial chromosome. This so-called "next generation" vaccine strain was expected to result in a more stable and homogenous production for glycosylation of the flagellin. Despite the successful insertion of the vaccine-encoding gene into the bacterial chromosome, the yield of glycosylated vaccine was not improved.

For the secretion of flagellin, Campylobacter uses additional proteins (so called chaperones proteins). Currently, chaperones for Campylobacter flagellin are used to optimize the production, secretion, and purification of the glycosylated vaccine antigen. The immunizations are foreseen in the second half of 2015 and therefore after the finalization of the project.

In conclusion, in ovo vaccination of embryonated chicken eggs with a novel subunit vaccine and whole cell vaccine has been demonstrated to generate antibodies against C. jejuni that can be detected to up to 23 day after hatching. For a protective immune response higher dose of antigens are required and, more important, the efficacy of the antigen is supposed to improve considerably when the protein is glycosylated. The (stable) production of glycosylated antigens is a challenge and construction of a Campylobacter strain is still ongoing.

A series of in ovo experiments during the project have provided more insight in the immune response of the possibilities of vaccination with a Campylobacter antigen with intrinsic adjuvant activity. The need for glycosylation of the subunit-vaccine was confirmed during the project and essential fundamental knowledge of the immune response of chickens against Campylobacter was obtained; this is/will be published and is available for the scientific community.

Main outcomes from WP2
A total of at least ten papers have been/will be published about various topics in this WP.

The results have been/will be presented in more than eight abstracts/posters/oral presentations at more than six international and national meetings, including meetings with the industry.

Lessons learned
In relation to biosecurity, flies pose a problem, as they easily move right through many biosecurity barriers by their own force and therefore don't require transport by a person, garment, footwear or a fomite like smaller tools or big machinery. Flies are therefore difficult to prevent from accessing the broiler houses. Flies also have another 'advantage' concerning transmission: chickens actively chase and eat the flies, so even one single fly let into the chicken room, has a great chance of success in transmission of Campylobacter if they carry any.

In the planning of the project, the work load to select farms for the fly screen intervention, had been estimated to be quite similar to previous experience from Denmark, where the previous fly screen intervention studies was conducted in open cooperation with the only two broiler companies in the country and farmer participants could be directly approached. We learned in CamCon, that the situation in countries with several competing broiler companies is much more challenging and time consuming. Recruitment of farms was difficult due to factors such as strong company competition and the wish for a 'closed forum' for each company or even anonymity. We therefore have learned that for the recruitment of farms, it would have been an advantage if one broiler company from each country had joined the project as an SME and agreed to provide the required intervention farms.

The recruitment of study farms which already had implemented high level basic biosecurity was necessary before starting to add the fly screen intervention. Despite of comprehensive biosecurity protocols being published by the European broiler business (i.e. the EPIG guide), it became clear by visiting the actual farms at usual working days, that the implementation of the recommendations were either completely missing or inadequate compared to the necessary level estimated in the CamCon application. Two very different approaches were then launched in the two participating countries, UK and Spain. In UK fly screens were installed despite the lack of recommended biosecurity procedures in place in the farms. This resulted in the conclusion 'no effect of fly screens' in the study, a result confirming the validity of the presumption set in the application, that basic biosecurity have to be in place before fly screens are installed on broiler houses. In Spain, a demanding work was launched to bring the basic biosecurity to a sufficient level at 12 farms and CamCon WP5 provided extensive learning tools and activities which were used for this purpose. So far the biosecurity upgrade has proven effective, but the effect of fly screens is not possible to estimate at the end of CamCon, as the whole upgrade of the biosecurity was so time consuming that the results will not be available until after CamCon has ended.

In summary, we learned that basic biosecurity must be in place before fly screens are implemented. We also learned that an upgrade of biosecurity within a broiler company in general will require at least a couple of years. The teaching material developed in CamCon (WP5) can be a basis for establishing a common platform in future research regarding various aspects of biosecurity, not only regarding Campylobacter.

Regarding bacteriophages, although the concept of pathogen control with lytic bacteriophages seems attractive, and in some cases has proven to be successful, phage therapy under realistic conditions still requires unhampered targeting of the bacteria, followed by a non-inhibited lytic cycle of phage amplification and subsequent killing by lyis. In a realistic context these requirements are not always met as is the case for phage therapy to control Campylobacter in broilers. Under laboratory conditions, with a clear combination of Campylobacter strains and lytic bacteriophages, and even in an animal model with experimentally infected chickens and a priori proven lytic phages, the concept of phage therapy is confirmed. However, an expansion to a real chicken farm introduces many new variables such as limited controlled administration of phages, effect of host microflora on lytic effectiveness of phages, and heterogeneity of Campylobacter. This latter feature of Campylobacter is reflected in the diversity of the phage-resistant Campylobacter strains that even with several phages in a therapeutic cocktail, is difficult to combat.

Due to the large variability the measurement of efficacy of phage therapy for the control of Campylobacter under in field/on farm conditions requires very large numbers of samples (animals) in order to make a statistically significant observation. Still having met these requirements it was shown that the reducing effect on Campylobacter colonization by phage therapy was very small to absent and therefore not relevant.

Especially with regard to phage therapy for control of Campylobacter it seems imperative to do more research on phage inactivation and resistance to be able to make progress as intervention tool.

The work on vaccination improved the insight into the host-Campylobacter interaction and identified more precisely the antigens at the flagellum needed for a activation of the TLR in the chicken. It showed that a Campylobacter antigen with intrinsic adjuvant activity was able to induce an immune response in chickens. However, this immune response was not protective against a challenge with Campylobacter with the currently used dose of the vaccine antigen. It has been shown for the first time that a bacterial recombinant antigen used in in ovo vaccination was able to induce an immune response. The vaccination approach was seen at the start of CamCon as a long-term investment as within the relatively short term of the project it was not realistic to develop a vaccine. From that point of view the vaccine studies have been successful as they improved the knowledge needed for the further development of a future vaccine.

Diagnostic tools

The aim of the Work Package was to develop efficient, inexpensive and rapid methods for enumeration of Campylobacter at farm level.

Four consecutive flocks of broilers on one farm were followed semi-continuously by monitoring with two different methods of air sampling (ILOC based "sniffer" and Sartorius Airport MD8), particle size profiling and boot sock sampling. The four flocks showed highly diverging colonization dynamics. One was positive before the first sampling (10 days of age), one became infected by Salmonella and was slaughtered for destruction, and one did not become positive. In all cases, detection was possible in air at the same time or prior to detection in boot sock samples and we can conclude that air in broiler houses is a most suited target for the sampling and detection of Campylobacter.

Methods to sample and quantify Campylobacter in air were developed, and studies were carried out in conventional broiler houses in Poland in addition to preliminary samplings in Denmark. The size distribution in airborne particles (0.3-10 μm) in the broiler houses in relation to bacterial distribution was analysed. No correlation between airborne Campylobacter and a specific particle size was found.

In conclusion, air sampling on filters, coupled with qPCR, was able to detect Campylobacter colonization before it could be detected in boot swabs and was found to be a promising future technique for monitoring of Campylobacter.

In addition to this experimental work, a report in the form of a review was written on sampling, sample treatment and detection technologies. The review discusses the current and upcoming methods in the poultry production line from farm to fork, and focusses on the applicability of the different methods for various purposes.

Main outcomes from WP3
Two papers have been published about the work done in this WP. The results have been presented as abstracts/posters/oral presentations at two international meetings, including meetings with the industry.

Lessons learned
The future need for diagnostic tools have been summarized in the paper: Monitoring Campylobacter in the poultry production chain — From culture to genes and beyond (2015). Josefsen, M.H., Bhunia, A.K., Olsson Engvall, E., Fachmann, M.S.R., & Hoorfar, J. Journal of Microbiological Methods 112, 118-125. In short, improved monitoring tools are important for the control of Campylobacter bacteria in poultry production. Standardized reference culture methods issued by national and international standardization organisations are time-consuming, cumbersome and not amenable to automation for screening of large numbers of samples. The ultimate goal for rapid monitoring of Campylobacter is to prevent contaminated meat from entering the food market. Currently, real-time PCR is fulfilling abovementioned criteria to a certain extent. Further development of real-time PCR, microarray PCR, miniaturized biosensors, chromatographic techniques and DNA sequencing can improve our monitoring capacity at a lower cost. Combined with innovative sampling and sample treatment, these techniques could become realistic options for on-farm and liquid-sample monitoring at slaughterhouses.

The air sampling technique developed in this WP offers a very cost-efficient, sensitive and noncomplex way of sampling for Campylobacter in poultry production facilities. Transport of the gelatin air filters can be done by ordinary mail, since the detection method does not require live or culturable bacteria. A rapid sample treatment in combination with a real-time PCR detection step reduces both the cost and time of analysis significantly. This technique could be applied simultaneously for monitoring of other important pathogens as well, and will be worth developing further in the future.

Risk assessment and economics

Risk assessments have been performed by two activities:
The first activity relates to interventions at the farm that result in a reduction in flock prevalence. This study was primarily based on the risk factor study performed in WP1. The risk factor study has identified which farm related risk factors do have a significant impact on the Campylobacter flock prevalence in the different countries involved in CamCon. These risk factors have been translated into practical control measures (interventions). Based on the collected data and the risk factor study, the effect of implementation of these interventions in the six different countries has been analysed. The interventions that are predicted to have a significant effect are “building an anteroom and barrier in all houses”; “reduction of the downtime to less than ten days between flocks, together with rodent control and disinfection”; “building new houses if houses are > 15 years of age (houses with anteroom and barrier, using nipples without cups and with designated tools per house)”; “apply drinkers with nipples without cups”; “have designated tools in all houses < 15 years old”.

Three additional interventions were included in the analysis. The results of WP1 did not allow an analysis of these interventions due to data limitations in the 20 farms study of WP1. Still, they are considered effective in the literature. Their effects have been analysed on the basis of previous research done by EFSA (a ban on thinning and reduction of the slaughter age to < 35 days) and by Bahrndorff et al. (2013) (fly screens applied to new houses in Denmark). The results of the studies on fly nets performed in WP2 were not available on time to be included in the analyses.

The percentage of farms involved in the intervention reflects the farms that are amenable for the intervention: in those farms the intervention is not implemented already and it is possible to do it. If this percentage is large, a larger effect of the intervention may be expected.

The change in prevalence is calculated on the basis of the flock prevalence reported by EFSA on the baseline study 2008. From these results both the relative reduction in prevalence and the absolute reduction in prevalence can be derived. From previous risk assessment activities (e.g. Nauta et al 2009) it is assumed that the human health risk of campylobacteriosis from (domestically produced) broiler meat is proportional to the flock prevalence.

It can be seen that none of the interventions sticks out as the single solution. The highest effect is achieved for building new houses in Spain. The general insight that biosecurity is crucial stands, all effective intervention somehow imply an improvement of biosecurity and should preferably be applied in combination.

The second activity relates to interventions that impact the Campylobacter concentration in the intestinal content of live chickens. The plan was to apply results of WP2 on the effectivity of vaccines and bacteriophages, but no quantifiable results were obtained in CamCon. Therefore this study more generally considers the question whether a reduction of Campylobacter concentration in the chicken caeca or chicken faeces at the entrance of the chicken processing plant can be translated to a reduction in human health risk of campylobacteriosis, by the use of a risk assessment model. Two approaches are compared: one where a linear regression of log transformed data on concentrations in the birds' caeca and on concentrations on skin samples of the same flocks are analysed, and one where a previously published risk assessment model is applied.

Roughly the results are similar (with a 45% to 80% reduction in risk predicted with a 1 log reduction of the mean Campylobacter concentration in intestinal contents, depending on the assumptions and the country). However, in general it is not possible to derive a valid "rule of thumb" that allows one to simply translate a reduction in concentration in the intestinal content to a risk reduction. Reasons for this complexity are that different data sets may predict very different relations between concentrations in the faeces and in chicken skin, which is also predicted by the risk assessment model. Also, some assumptions in the risk assessment model (like the relation between concentrations in the faeces and on the carcass exterior) have an impact on the predicted effect, whereas there are no data available to analyse these assumptions. Possibly the variation in performance between slaughterhouses is too large to allow the derivation of a rule of thumb anyway.

The costs for interventions have been studied. Most expensive interventions are the building of new houses, slaughter at 35 days and discontinuation of thinning, cheapest are having designated tools for each house, building an anteroom and barrier and application of fly screens. The costs differ considerably between countries, in general the costs are highest in Denmark and Norway.

Cost effectiveness has been studied on the basis of the risk assessment and the cost study. By including published campylobacteriosis incidences in the different countries involved in CamCon, and published values for the attributable fraction of chicken meat, a factor to translate incidence to DALY (disability adjusted life years) and trade data between countries, costs and cost effectiveness of interventions could be analysed.

It is found that the differences between different countries are large, which makes it hard to draw general conclusions on the cost effectiveness of control measures. Still, some conclusions can be drawn.

- The control measures "building an anteroom + barrier" and "designated tools for each house" are cheap and result in a considerable risk reduction.
- In those countries where the costs are highest (especially Denmark and Norway), the Campylobacter prevalences are relatively low. Therefore, the differences between countries get even larger in terms of cost effectiveness.

For methodological reasons it is difficult to compare the cost effectiveness of on farm interventions as assessed in this project with the cost utility of interventions post farm, as studied elsewhere. Generally speaking, the cost effectiveness of on farm interventions shows a larger variation (between countries and interventions) than interventions during processing.

A report has been written describing the data included in the risk assessment and some basic analyses of the data.

In conclusion:

- Significant risk factors at the farm have been identified and translated to practical control measures. They have been analysed for their effectivity in reducing the flock prevalence in the six countries

involved in CamCon. The differences between countries are considerable and none of the interventions is much better than the others.
• It is not possible to derive a simple rule of thumb to relate reduction in Campylobacter concentration in the intestinal content of chickens to reduction in concentration on the skin of human health risk. The reason for this is a combination of the existing variability in concentrations and processes, and the uncertainty of their impact.
• Costs of control measures vary between countries, which is caused by differences in general cost levels between countries and by differences in average technical farm performance.
• The cost effectiveness study, again, shows large variation between countries. Results were obtained and presented. Cheap interventions that results in significant risk reduction at population level are (1) the use of separate designated tools per farmhouse and (2) building an anteroom and barrier. They are assessed to give risk reductions between (1) 0.6 and 16.1% and (2) 2.8 and 13.2% respectively in the six countries.

Main outcomes from WP4
A total of four papers will be published about various topics in this WP. Also, three reports have been written, about the collected data, the major outcomes of the Work Package and the future data needs. The results have been and will be presented as abstracts/posters/oral presentations at more than four international and national meetings, including meetings with the industry.

Lessons learned
The results confirm the complexity of the Campylobacter problem and show the diversity between countries. Still, the cost effectiveness of interventions could be evaluated and compared for different countries, which gives valuable insights for risk management.
Future data needs are identified and summarized. The report on this topic clarifies the specific needs for high quality data to be used for on-farm risk factor analysis, based on the experience in CamCon.

Also, the specific needs for food chain risk assessment, economic studies and cost effectiveness analysis are indicated. Here it is stressed that these activities may require new data that is not commonly collected in a project like CamCon. Without the availability of data identified by CamCon, it is expected that it will be difficult to improve risk assessment and cost effectiveness studies in Europe.

From science to industry

The specific objective of this work package was to achieve effective dissemination and communication of up-to-date scientific knowledge on Campylobacter control and prevention to stakeholders in the poultry industry.

This has been achieved through the production of educational material and learning tools. These comprise a Best Practice Manual, a Draft Certification Program and a web-based E-learning Program on Campylobacter and biosecurity as a high level of biosecurity at house level is essential for successful reduction of Campylobacter in primary poultry production.

Creating a draft version of the Best Practice Manual was done in close collaboration with WP2 and their work on biosecurity and fly screens in Spain where farms needed an upgrading of biosecurity practices. This initial work included the production of illustrated biosecurity folders and posters as well as the design of an essential biosecurity check list for use on broiler farms. Slide presentations, one with step-by-step instructions for correct entry and exit from poultry houses and one covering biosecurity control points included in the check list have also been produced.

This material was then further developed and integrated with new science-based knowledge generated in the CamCon project to form the backbone of the final Best Practice Manual, Draft Certification Program and the E-learning Program.

The Best Practice Manual aims at highlighting and explaining how these procedures can be implemented directly by the poultry industry. This manual is specifically targeted veterinarians and technical advisors of poultry integrations and cooperatives working with poultry farmers.

The Draft Certification Program provides poultry companies and independent auditing bodies with a complete list of measures that should be implemented and checked regularly in order to ensure and document a uniform quality production of broilers with a reduced risk of Campylobacter. This program is specifically targeted quality managers of poultry companies dedicated to improving the food safety of fresh poultry meat.

The comprehensive E-learning program on Campylobacter and biosecurity may be used by poultry producers and poultry advisors to train and educate farm staff. It goes systematically through the risk factors for Campylobacter introduction at farm and house level in primary poultry production, and underlines the importance of biosecurity procedures in the control and prevention of Campylobacter. The E-learning program also includes a test to ensure that the content of the program has been apprehended, and the results of the test may be used to document farm staff education level as part of a company quality or certification program.

The educational material was presented at the CamCon stakeholder Seminar on April 14th 2015 and is now available at www.camcon-eu.net. In addition to this, the Best Practice Manual and Draft Certification Program have been distributed as hard copies to all major European poultry companies as well as poultry producer organisations and EU and national competent authorities.

Main outcomes from WP5
The main outcome of WP5 is the educational tools and a draft voluntary certification program that have been produced in this WP.

The material has been presented at a number of international and national meetings, including meetings with the industry, and has been received with great interest. At the time of writing several requests have been received from both national Competent Authorities and leading European poultry companies both for possibilities of national language versions of the educational material, and for discussions on how this material may be utilised under the specific poultry company conditions.

Lessons learned
Due to the public concerns on Campylobacter and food safety within the EU there is no doubt that there is a need for effective measures at company and authority levels to be instituted to reduce this problem.

The educational material produced in CamCon has been well received by the stakeholders, and underlines the importance of including a strong element of end-user dissemination activities in future research projects, in order to gain the full societal benefit from scientific advances in academia.

The way forward
During the project, CamCon has identified knowledge gaps and possibilities for future research. We suggest that future projects on Campylobacter (and probably also studies on other topics) should include
• well-designed data collection, based on the specific needs of risk assessment and cost effectiveness studies (see future data needs report WP4). It may be advisable to perform and extensive risk assessment study to design the data collection studies prior to the project.
• intervention studies like for the fly nets, for other interventions as well
• looking at how we can improve adherence to biosecurity on farm, so exploring farmer behaviour and indeed farmer understanding of what biosecurity means

Potential impact and main dissemination activities and exploitation results

Potential impact
A scientific opinion published by EFSA in 2010 concludes that 50 – 80% of the cases of campylobacteriosis in humans may be attributed to the chicken reservoir as a whole. Therefore, reducing Campylobacter in the poultry sector, both by preventing flocks from becoming positive, but also – by doing so – preventing the environment around the poultry houses becoming massively contaminated by contamination from the inside to the outside of the house after a broiler flock has

been positive and by used litter from the flock being deposited outside, will most certainly reduce the number of cases of human illness, and thereby also reduce the costs and suffering related to this disease. CamCon has now expanded the knowledge base enabling the industry to produce Campylobacter free chickens / chickens with low levels of Campylobacter, and provided the industry with easy to use learning tools and a basis for a certification program for doing so.

CamCon did not succeed in developing effective ready-to-use interventions using bacteriophages or vaccination, nor has other research groups succeeded in this so far. Therefore, the short term focus will still be on biosecurity. Besides that biosecurity has several extra benefits, it also quite cheap as calculated in WP4. The challenges of implementing biosecurity at CamCon-level – as defined in the CamCon educational tools - will vary between countries/companies, and the human factor is important, as strict biosecurity requires awareness and commitment of the farm house personnel. This is focused upon in the educational tools developed in CamCon.

The main advantage of biosecurity upgrade over more targeted interventions to reduce Campylobacter in the intestine, is that biosecurity works at a general level and is simultaneously effective against many other hazards, whereas more targeted interventions mostly only work on a single bacteria, virus etc. By reducing the burden of Campylobacter coming from broilers, the industry can improve poultry health and the economy in the poultry industry and additionally gain trust by the consumers because they produce products free from harmful pathogens.

One important experience gained in CamCon, is that there is a discrepancy between the recommended level of biosecurity in a country/company, and the level that is actually practiced on-farm in the everyday schedule. This is very important to realize, as it is difficult to make improvements if the farmers do not receive thorough training or are tested in the skills required. The educational material developed in CamCon is available for poultry producers worldwide, and can help the industry to improve the biosecurity.

Although CamCon did not succeed in developing effective bacteriophage-treatment protocols or vaccines, the results from CamCon regarding bacteriophages and vaccines can be built upon to achieve further progress in these challenging research areas, hopefully producing effective means to reduce Campylobacter in the future.

The air sampling and detection technique developed in WP3 holds potential for further investigation. The sensitivity, ease of handling and cost-effectiveness indicates that this is a realistic alternative to the boot swap sampling performed widely today. Future technology advances could render semi-continuous monitoring of poultry production facilities possible, and provide an early warning system for entry of Campylobacter into the poultry flock.

Main dissemination activities

The e-learning tool produced by CamCon (and available through the CamCon Web site) is produced in both an English and a Spanish version. Work is being done after CamCon ended in April 2015 to also produce a German and a Danish version to be able to reach even more poultry producers across Europe (and worldwide). Information about the educational material and where to find it was actively distributed to the poultry industry across Europe. This educational tool is easy to use for poultry producers, and provides a theoretical basis for understanding the sources of Campylobacter, how the transmission to the poultry flocks takes place, and the biosecurity procedures that will prevent such a transmission. It is important that this theoretical understanding is followed by training of the biosecurity practices, and the companies/authorities should provide such assistance to the farmers.

Several scientific publications have been and will be produced to inform the scientific community about various aspects of Campylobacter in poultry, both regarding epidemiology, rapid methods, vaccines, bacteriophages, risk assessment and economy.

Also, a report on data regarding poultry production in six very different European countries has been produced, data which authorities and others needing comparable data have access to at the CamCon Web site.

CamCon has been presented – both in general and more specific topics – at many meetings across Europe, and also at international meetings (especially at several CHRO-meetings, the meeting point for the scientists worldwide which are interested in Campylobacter, CamCon has been/will be presented at the biannual meetings in 2011, 2013 and 2015).

A Stakeholder Seminar was held in April 2015, presenting the results from CamCon, and also demonstrating the teaching material. The Seminar had more than 60 registered participants, both from the industry, several national Authorities and the scientific community. The registered participants represented 11 different European countries.

Exploitation of results
CamCon demonstrated that reducing the burden of Campylobacter in broilers currently will not be achieved by one intervention or management factor. It will require a wide approach directed at biosecurity, house design and also management of flocks. The risk factors identified in CamCon should be taken into account when considering the design of new poultry houses, and the type of drinking systems and incorporation of fly screens into the design of new houses should be considered.

The educational tools described above will enable the poultry industry to create certification programs which can be used for producing Campylobacter free broilers. This will give the industry an opportunity to produce more safe and more “valuable” products.

The work on bacteriophages and vaccines has expanded the knowledge base regarding these important intervention possibilities, and hopefully, at some point in the future, one will succeed in producing effective products giving the industry another way of producing low risk broilers with regards to Campylobacter. Risk assessment studies suggest that the effect of the interventions on public health risk may be large.

Address of project public website and relevant contact details

www.camcon-eu.net. It will continue to be online for five years after the end of the project. After that, the teaching material will be available via other channels.

Project coordinator: Merete Hofshagen, Norwegian Veterinary institute. email: merete.hofshagen@vetinst.no

4.2 Use and dissemination of foreground

Section A (public)

Publications

LIST OF SCIENTIFIC PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
No.	Title / DOI	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Date of publication	Relevant pages	Is open access provided to this publication ?	Type
1	Foodborne Disease Prevention and Broiler Chickens with Reduced Campylobacter Inf ection	Simon Bahr ndorf f , Lena Rangstru p-C hristensen , St een Nordento ft , Birthe H ald	Emerging Infectious Diseases	Vol. 19/Is sue 3	Centers for Disease Control and Preventi on (CDC)	United States	01/03/2013	425-430	Yes	Peer revie wed
2	Preventing Campylobacter at the Source: Why Is It So Difficult? 10.1093/cid/c it555	J. A. Wage naar , N. P. Fr ench , A. H. Havelaar	Clinical Infectious Diseases	Vol. 57/Is sue 11	Oxford University Pr ess	United States	01/12/2013	1600-1606	Yes	Peer revie wed
3	Monitoring Campylobacter in the poultry production chain — From culture to genes and beyond 10.1016/j.mim et.2015.03.007	Mathilde H. Josefsen , Ar un K. Bhunia , Eva Olsson Engvall , Mett e S.R. Fac hmann , Je ffrey Hoorfar	Journal of Microbiologic al Methods	Vol. 112	Elsevier	Netherlands	01/05/2015	118-125	Yes	Peer revie wed
4	Poultry flocks as a source of Campylobacte r contaminatio n of broiler carcasses	K. Wieczore k, J. Osek	Polish Journal of Veterinary Sciences	18 (1)	Polish Academy of Sc iences Publishing Ho use		01/01/2015	101-106	Yes	Peer revie wed
5	Low-Cost Monitoring of <I>Campyloba cter</I> in Poultry Houses by Air Sampli	M. S. R. S ønderga ard ,	Journal of Food Protection	Vol. 77/Is sue 2	International Associ ation for Food Prote	United States	01/02/2014	325-330	No	Peer revie wed

	ng and Quantitative PCR	M. H. Josefsen , C. Löfström , L. S. Christen sen , K. Wieczorek , J. Osek , J. Hoorfar			ction					
6	Unique features of chicken Toll-like receptors	A. Marijke Keestra , Marcel R. de Zoete , Lieneke I. Bouwman , Mahdi M. Vaezirad , Jos P.M. van Putten	Developmental and Comparative Immunology	Vol. 41/Issue 3	Elsevier Limited	United Kingdom	01/11/2013	316-323	Yes	Peer reviewed
7	Plasticity in behavioural responses and resistance to temperature stress in Musca domestica http://dx.doi .org/10.1016/j.anbehav.20 14 .11.003	Anders Kjærsgaard , Wolf U. Blanckenhorn , Cino Pertoldi , Volker Loeschcke , Christia n Kaufmann , Birthe Hald , Nonito Pagès , Simon Bahrndor ff	Animal Behaviour	Vol. 99	Academic Press Inc.	United States	01/01/2015	123-130	Yes	Peer reviewed
	Biology of Campylobacter infection	Bouwman LI, van Putten JP	Epidemiology, evolution and molecular biology		Caister Academic Press Ltd	UK	01/07/2012	231-250	No	Article
	Campylobacter : animal reservoirs, human infections, and options for control	Jaap Wagenaar , Diane Newell, Ruwani Kalupahan a, Lapo Mughini-Gras	Zoonoses - Infections Affecting Humans and Animals		Springer Netherlands	Dordrecht	01/01/2015	159-177	No	Article

LIST OF DISSEMINATION ACTIVITIES								
No.	Type of activities	Main Leader	Title	Date	Place	Type of audience	Size of audience	Countries addressed
1	Organisation of Conference	VETERINAER INSTITUTTET - N ATIONAL VE TERINARY I NSTITUTE	Campylobactger in Primary Poultry P roduction	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
2	Oral presentation to a wider public	DANMARKS T EKNISKE UN IVERSITET	European poultry production and risk factors for Campyl obacter	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
3	Oral presentation to a wider public	DIANOVA AS	From science to industry - a learning and certification tool	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
4	Oral presentation to a wider public	THE UNIVERSITY OF LIVERPOOL	Epidemiology of Campylobacter and t he CamChain pro ject	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
5	Oral presentation to a wider public	DANMARKS T EKNISKE UN IVERSITET	Rapid methods	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
6	Oral presentation to a wider public	THE UNIVERSITY OF LIVERPOOL	Campylobacter s urvival in the envir onment	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
7	Oral presentation to a wider public	STICHTING DIENST LAN DBOUWKUNDIG ONDERZOEK	Campylobacter i nterventions and con trol - Bacteriophages	14/04/2015	CamCon Stakehol der Seminar, Co penhagen, Denmark	Scientific comm unity (higher educat ion, Research) - Ind ustry - Policy makers	66	International
8	Oral presentation to a wider public	UNIVERSITEIT UTRECHT	Campylobacter i nterventions and con	14/04/2015	CamCon Stakehol der Seminar, Co	Scientific comm unity (higher educat	66	International

			trol - Vaccines		penhagen, Denmark	ion, Research) - Industry - Policy makers		
9	Oral presentation to a wider public	DANMARKS TEKNISKE UNIVERSITET	Campylobacter interventions and control - Biosecurity and flies	14/04/2015	CamCon Stakeholder Seminar, Copenhagen, Denmark	Scientific community (higher education, Research) - Industry - Policy makers	66	International
10	Oral presentation to a wider public	DANMARKS TEKNISKE UNIVERSITET	Quantitative risk assessment	14/04/2015	CamCon Stakeholder Seminar, Copenhagen, Denmark	Scientific community (higher education, Research) - Industry - Policy makers	66	International
11	Oral presentation to a wider public	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Cost effectiveness of interventions	14/04/2015	CamCon Stakeholder Seminar, Copenhagen, Denmark	Scientific community (higher education, Research) - Industry - Policy makers	66	International
12	Oral presentation to a scientific event	PANSTWOWY INSTYTUT WETERYNARYJNY - PANSTWOWY INSTYTUT BADAWCZY	Distribution of antibiotic resistant Campylobacter isolated from poultry flocks and corresponding carcasses in Poland	19/09/2014	Int. Conf. "Current Approaches to Health and Diseases in Animals and Humans". Lublin, Poland	Scientific community (higher education, Research)		International
13	Posters	PANSTWOWY INSTYTUT WETERYNARYJNY - PANSTWOWY INSTYTUT BADAWCZY	Geographical distribution of Campylobacter species in poultry flocks and chicken carcasses in Poland	01/09/2014	Food Micro 2014 Conference, Nantes, France	Scientific community (higher education, Research)		International
14	Posters	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Implementación de medidas de bioseguridad en granjas de broilers para reducir la prevalencia de Campylobacter: cuestiones prácticas, problemas y soluciones.	02/10/2014	51 Symposium Científico de Avicultura (AECA-WPSA), Valencia, Spain	Scientific community (higher education, Research) - Industry - Policy makers	150	International
15	Oral presentation to a wider public	FUNDACIO CENTRE DE RECERCA EN SANITAT AN	Campylobacter control in broiler farms	28/11/2014	Technical seminar for the poultry sector organized by the Agriculture	Industry - Policy makers		Spain

		IMAL CRESA			Department of Catalonia.				
16	Posters	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Eficacia de la intensificación de las medidas de bioseguridad en granjas de pollos de engorde frente a la colonización de Campylobacter termófilos.	02/10/2014	51 Symposium Científico de Avicultura (AECA-WPSA), Valencia, Spain	Scientific community (higher education, Research) - Industry - Policy makers	150	International	
17	Oral presentation to a scientific event	UNIVERSITEIT UTRECHT	In ovo vaccination with chimeric Campylobacter jejuni flagellin with intrinsic adjuvant activity	16/07/2014	AIRG (Avian Immunology Research Conference Group), Guelph, Canada	Scientific community (higher education, Research)		International	
18	Oral presentation to a wider public	DIANOVA AS	CamCon. Novel approaches to Campylobacter control in primary poultry production.	28/03/2014	National Farmers Union Conference, Warwickshire, UK	Industry		UK	
19	Posters	DANMARKS TEKNISKE UNIVERSITET	Dispersal, behavioral responses and thermal adaptation in Musca domestica.	13/07/2014	Seventh International Symposium on Molecular Insect Science, Amsterdam, Netherlads	Scientific community (higher education, Research)		International	
20	Web sites/Applications	DANMARKS TEKNISKE UNIVERSITET	CamCon ? novel approaches to control Campylobacter in primary poultry production	01/01/2013	Safefood Campylobacter Knowledge Network, Ireland	Scientific community (higher education, Research) - Industry - Policy makers		Ireland	
21	Oral presentation to a scientific event	DANMARKS TEKNISKE UNIVERSITET	CamCon ? novel approaches to control Campylobacter in primary poultry production	01/09/2013	CHRO (Int. Workshop on Campylobacter, Helicob. and related org.), Aberdeen, UK	Scientific community (higher education, Research)	600	International	
22	Posters	DANMARKS TEKNISKE UNIVERSITET	Musca domestica as a potential vector of Campylobacter jejuni.	01/09/2013	CHRO (Int. Workshop on Campylobacter, Helicob. and related org.), Aberdeen, UK	Scientific community (higher education, Research)	600	International	
23	Posters	THE UNIVERSITY OF LIVERPOOL	A Role for Flies (Diptera) in the Transm	01/09/2013	CHRO (Int. Workshop on Campylo	Scientific community (higher educat	600	International	

			ission of Campy lobacter?		bacter, Helicob. and related org.), Aber deen, UK	ion, Research)		
24	Posters	DANMARKS T EKNISKE UN IVERSITET	CamCon ? Multi national study of Ca mpylobacter risk fac tors on broiler farm s, Part one ? Denmar k and Norway.	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
25	Posters	FUNDACIO C ENTRE DE R ECERCA EN SANITAT AN IMAL CRESA	Dynamics of Cam pylobacter spp. infe ction in Spanish bro iler farms: a longit udinal 18-months study.	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
26	Oral presentation to a scientific event	FUNDACIO C ENTRE DE R ECERCA EN SANITAT AN IMAL CRESA	House fly (Musca domestica) as a ve ctor for Campyl obacter jejuni and C ampylobacter coli in Spanish broiler far ms.	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
27	Posters	DANMARKS T EKNISKE UN IVERSITET	Fly screens in Spani sh broiler houses - an initial pilot study	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
28	Posters	DANMARKS T EKNISKE UN IVERSITET	Fly Screening 101: Technical approa ches to ensure venti lation performance without flie	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
29	Oral presentation to a scientific event	UNIVERSITEIT UTRECHT	Immunogenicity of a Campylobacter j ejuni flagellin-based subjunit vaccine in chickens	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International
30	Posters	DANMARKS T EKNISKE UN IVERSITET	Low cost semi-c ontinuous quantifica tion of Campylo bacter by air sampli ng in broiler houses	01/09/2013	CHRO (Int. Work shop on Campylo bacter, Helicob. and related org.), Aber deen, UK	Scientific comm unity (higher educat ion, Research)	600	International

31	Posters	DIANOVA AS	Towards a best practice for Campylobacter prevention at farm and house level	01/09/2013	CHRO (Int. Workshop on Campylobacter, Helicob. and related org.), Aberdeen, UK	Scientific community (higher education, Research)	600	International
32	Oral presentation to a wider public	DIANOVA AS	Towards a best practice for Campylobacter prevention at farm and house level	01/09/2013	CHRO (Int. Workshop on Campylobacter, Helicob. and related org.), Aberdeen, UK	Scientific community (higher education, Research)	600	International
33	Oral presentation to a scientific event	PANSTWOWY INSTYTUT WETERYNARYJNY - PANSTWOWY INSTYTUT BADAWCZY	Campylobacter contamination of chicken carcasses in relation with their prevalence in poultry flocks.	19/09/2013	?Food Safety Risk Analysis ? Fifty years with Codex Alimentarius in the European Region?, Pulawy, Po	Scientific community (higher education, Research)		International
34	Posters	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Papel de la mosca doméstica (Musca domestica) como vector de Campylobacter jejuni y Campylobacter coli en granjas de pollos de engorde de España.	02/10/2013	The 50th Scientific poultry congress (WPSA-AECA), Spain	Scientific community (higher education, Research) - Industry - Policy makers	400	International
35	Posters	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Prevalencia y estacionalidad de Campylobacter termófilos en granjas de pollos de engorde de Cataluña.	02/10/2013	The 50th Scientific poultry congress (WPSA-AECA), Spain	Scientific community (higher education, Research) - Industry - Policy makers	400	International
36	Oral presentation to a scientific event	VETERINAER INSTITUTTET - NATIONAL VETERINARY INSTITUTE	CamCon ? a novel approach to controlling Campylobacter in primary poultry production	30/08/2011	CHRO (Int. Workshop on Campylobacter, Helicob. and related org.), Vancouver, Canada	Scientific community (higher education, Research)		International
37	Oral presentation to a scientific event	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Control futuro de Campylobacter en broilers.	02/10/2013	The 50th Scientific poultry congress (WPSA-AECA), Spain	Scientific community (higher education, Research) - Industry - Policy makers	400	International
38	Posters	DANMARKS TEKNISKE UNIVERSITET	Broiler production management in six European countries	30/08/2011	CHRO (Int. Workshop on Campylobacter, Helicob. and	Scientific community (higher education, Research)		International

			? similarities and differences		related org.), Vancouver, Canada			
39	Oral presentation to a wider public	DANMARKS TEKNISKE UNIVERSITET	CamCon	27/09/2011	avec Conference	Industry	200	International
40	Organisation of Workshops	DANMARKS TEKNISKE UNIVERSITET	Worskhop WP4 at CamCon Annual Meeting	07/04/2014	CRESA, Barcelona, Spain	Scientific community (higher education, Research)	22	International
41	Organisation of Workshops	DANMARKS TEKNISKE UNIVERSITET	Workshop Biosecurity at CamCon Annual Meeting	07/04/2014	CRESA, Barcelona, Spain	Scientific community (higher education, Research)	22	International
42	Organisation of Workshops	DANMARKS TEKNISKE UNIVERSITET	Workshop WP4 at CamCon Annual Meeting	24/04/2012	DTU, Copenhagen, Denmark	Scientific community (higher education, Research) - Policy makers	34	International
43	Organisation of Workshops	THE UNIVERSITY OF LIVERPOOL	Workshop WP1 at CamCon Annual Meeting	24/04/2012	DTU, Copenhagen, Denmark	Scientific community (higher education, Research) - Policy makers	34	International
44	Oral presentation to a wider public	DANMARKS TEKNISKE UNIVERSITET	Fly Screen to Reduce Campylobacter in Broiler houses	27/06/2014	Meeting with NEPLUVI, Association of Dutch Poultry Processing Industries	Industry - Policy makers		The Netherlands
45	Organisation of Workshops	DANMARKS TEKNISKE UNIVERSITET	Workshop WP4 at CamCon Annual Meeting	14/04/2011	DTU, Copenhagen, Denmark	Scientific community (higher education, Research)	33	International
46	Organisation of Workshops	THE UNIVERSITY OF LIVERPOOL	Workshop WP1 at CamCon Annual Meeting	14/04/2011	DTU, Copenhagen, Denmark	Scientific community (higher education, Research)	34	International
47	Organisation of Workshops	UNIVERSITEIT UTRECHT	Workshop WP2 at CamCon Annual Meeting	15/04/2011	DTU, Copenhagen, Denmark	Scientific community (higher education, Research)	34	International
48	Posters	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Evaluación de dos tipos de matrices para la detección y aislamiento de Campylobacter termófilos en granjas de broilers	18/10/2012	AVEDILA Conference	Scientific community (higher education, Research)		Spain

49	Posters	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	Phage Therapy of Campylobacter colonization in broilers	04/08/2011	Scientific/Stakeholder meeting: Healthy and Safe Food from food production chain, Wageningen, NL	Scientific community (higher education, Research) - Industry - Policy makers		The Netherlands
50	Web sites/Applications	VETERINAERINSTITUTTET - NATIONAL VETERINARY INSTITUTE	CamCon web site: www.camcon-eu.net	18/10/2010	www.camcon-eu.net	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias		International
51	Web sites/Applications	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	La bioseguridad como estrategia de control de Campylobacter en avicultura.	01/09/2014	http://albeitar.portalveterinaria.com/noticia/13485/Articulos-aves/La-bioseguridad-como-estrategia-d	Scientific community (higher education, Research) - Industry - Civil society - Policy makers - Medias		International
52	Oral presentation to a wider public	VETERINAERINSTITUTTET - NATIONAL VETERINARY INSTITUTE	CamCon	07/05/2014	DG SANCO Workshop, Brussels	Scientific community (higher education, Research) - Industry - Policy makers	81	International
53	Oral presentation to a scientific event	VETERINAERINSTITUTTET - NATIONAL VETERINARY INSTITUTE	CamCon	05/10/2010	EU-RL Campylobacter meeting, Uppsala, Sweden	Scientific community (higher education, Research)		International
54	Oral presentation to a wider public	FUNDACIO CENTRE DE RECERCA EN SANITAT ANIMAL CRESA	Control de Campylobacter en granja	10/06/2015	Jornadas profesionales de avicultura, Soria (Spain)	Scientific community (higher education, Research) - Industry		Spain

Section B (Confidential or public: confidential information marked clearly)

LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS,UTILITY MODELS, ETC.					
Type of IP Rights	Confidential	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant(s) (as on the application)

OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND								
Type of Exploitable Foreground	Description of Exploitable Foreground	Confidential	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use or any other use	Patents or other IPR exploitation (licences)	Owner and Other Beneficiary(s) involved
General advancement of knowledge	Learning material (E-learning programme, Best Practice Manual and the draft Voluntary Certification Programme).	No		Better biosecurity can make it possible to produce CAmpylobacter free chickens.	Poultry Industry	The information material was placed on the CamCon web site in April 2015. It was also actively communicated at the CamCon Stakeholder Seminar in Copenhagen 14 April 2015.	None	Dianova

ADDITIONAL TEMPLATE B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND	
Description of Exploitable Foreground	Explain of the Exploitable Foreground
Learning material (E-learning programme, Best Practice Manual and the draft Voluntary Certification Programme).	The learning material is available to the General Public and has been actively promoted to the European Poultry Industry and will enable everyone to learn more about Campylobacter and biosecurity.

4.3 Report on societal implications

B. Ethics

1. Did your project undergo an Ethics Review (and/or Screening)?	No
If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final reports?	

2. Please indicate whether your project involved any of the following issues :

RESEARCH ON HUMANS	
Did the project involve children?	No
Did the project involve patients?	No
Did the project involve persons not able to consent?	No
Did the project involve adult healthy volunteers?	No
Did the project involve Human genetic material?	No
Did the project involve Human biological samples?	No
Did the project involve Human data collection?	No
RESEARCH ON HUMAN EMBRYO/FOETUS	
Did the project involve Human Embryos?	No
Did the project involve Human Foetal Tissue / Cells?	No
Did the project involve Human Embryonic Stem Cells (hESCs)?	No
Did the project on human Embryonic Stem Cells involve cells in culture?	No
Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No
PRIVACY	
Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	No
Did the project involve tracking the location or observation of people?	No
RESEARCH ON ANIMALS	

Did the project involve research on animals?	Yes
Were those animals transgenic small laboratory animals?	No
Were those animals transgenic farm animals?	No
Were those animals cloned farm animals?	No
Were those animals non-human primates?	No

RESEARCH INVOLVING DEVELOPING COUNTRIES

Did the project involve the use of local resources (genetic, animal, plant etc)?	No
Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	No

DUAL USE

Research having direct military use	No
Research having potential for terrorist abuse	No

C. Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	1	0
Work package leaders	3	3
Experienced researchers (i.e. PhD holders)	21	23
PhD student	7	1
Other	32	9

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	7

Of which, indicate the number of men:	2

D. Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project ?	No

6. Which of the following actions did you carry out and how effective were they?	
Design and implement an equal opportunity policy	Not Applicable
Set targets to achieve a gender balance in the workforce	Not Applicable
Organise conferences and workshops on gender	Not Applicable
Actions to improve work-life balance	Not Applicable
Other:	

7. Was there a gender dimension associated with the research content - i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?	No
If yes, please specify:	

E. Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?	Yes
If yes, please specify:	Wellcome Trust Nuffield students (high school students) ~6, Work experience students (high school students, veterinary and biology undergraduate students) ~17, Honours year veterinary and biology undergraduate students ~20, Specifically on projects to do with CamCon, 1 MSc student and 1 BVSc undergraduate student, however many other projects were on Campylobacter and of relevance to CamCon. Local and National event (2014) on Campylobacter aimed at school children and the general public to raise awareness of Campylobacter and our research.

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?	Yes

F. Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

Main discipline:	1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)
Associated discipline:	4.2 Veterinary medicine
Associated discipline:	1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

G. Engaging with Civil society and policy makers

11a. Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14)	Yes
11b. If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?	No
11c. In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	

12. Did you engage with government / public bodies or policy makers (including international organisations)	Yes, in communicating /disseminating / using the results of the project

13a. Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?	Yes - as a secondary objective (please indicate areas below - multiple answer possible)
13b. If Yes, in which fields?	
Agriculture	Yes
Audiovisual and Media	No
Budget	No
Competition	No
Consumers	No
Culture	No
Customs	No
Development Economic and Monetary Affairs	No
Education, Training, Youth	No
Employment and Social Affairs	No
Energy	No
Enlargement	No

Enterprise	No
Environment	No
External Relations	No
External Trade	No
Fisheries and Maritime Affairs	No
Food Safety	Yes
Foreign and Security Policy	No
Fraud	No
Humanitarian aid	No
Human rightsd	No
Information Society	No
Institutional affairs	No
Internal Market	No
Justice, freedom and security	No
Public Health	Yes
Regional Policy	No
Research and Innovation	No
Space	No
Taxation	No
Transport	No
13c. If Yes, at which level?	International level

H. Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	9
To how many of these is open access provided?	6
How many of these are published in open access journals?	5
How many of these are published in open repositories?	0
To how many of these is open access not provided?	3
Please check all applicable reasons for not providing open access:	
publisher's licensing agreement would not permit publishing in a repository	No
no suitable repository available	No
no suitable open access journal available	Yes

no funds available to publish in an open access journal	No
lack of time and resources	No
lack of information on open access	No
If other - please specify	
15. How many new patent applications ('priority filings') have been made? ("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).	0

16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	
Trademark	0
Registered design	0
Other	0

17. How many spin-off companies were created / are planned as a direct result of the project?	0
Indicate the approximate number of additional jobs in these companies:	0

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:	Difficult to estimate / not possible to quantify, None of the above / not relevant to the project

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:	0Difficult to estimate / not possible to quantify

I. Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?	No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?	No

22. Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?	
Press Release	No
Media briefing	No

TV coverage / report	No
Radio coverage / report	No
Brochures /posters / flyers	Yes
DVD /Film /Multimedia	No
Coverage in specialist press	Yes
Coverage in general (non-specialist) press	No
Coverage in national press	Yes
Coverage in international press	No
Website for the general public / internet	Yes
Event targeting general public (festival, conference, exhibition, science café)	No

23. In which languages are the information products for the general public produced?	
Language of the coordinator	No
Other language(s)	Yes
English	Yes

Attachments	
Grant Agreement number:	244547
Project acronym:	CamCon
Project title:	Campylobacter control - novel approaches in primary poultry production
Funding Scheme:	FP7-CP-FP
Project starting date:	01/05/2010
Project end date:	30/04/2015
Name of the scientific representative of the project's coordinator and organisation:	Dr. Merete Hofshagen VETERINAERINSTITUTTET - NATIONAL VETERINARY INSTITUTE
Name	
Date	24/06/2015

This declaration was visaed electronically by Merete HOFSHAGEN (ECAS user name nhofshme) on 24/06/2015