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**Objective** This narrative review seeks to identify and summarise current research-based evidence and experience on information retrieval for systematic reviews in food and feed topics.

**Methods** MEDLINE (Ovid), Science Citation Index (Web of Science) and ScienceDirect (<http://www.sciencedirect.com/>) were searched in 2012 and 2016. We also contacted topic experts and undertook citation searches. We selected and summarised studies reporting research on information retrieval, as well as published guidance and experience.

**Results** There is little published evidence on the most efficient way to conduct searches for food and feed topics. There are few available study design search filters, and their use may be problematic given poor or inconsistent reporting of study methods. Food and feed research makes use of a wide range of study designs so it might be best to focus strategy development on capturing study populations, although this also has challenges. There is limited guidance on which resources should be searched and whether publication bias in disciplines relevant to food and feed necessitates extensive searching of the grey literature.

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## **Disciplines**

Animal Experimentation and Research | Large or Food Animal and Equine Medicine | Research Methods in Life Sciences

## **Comments**

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# **Information retrieval for systematic reviews in food and feed topics: a narrative review**

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## **Abstract**

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Systematic review methods are now being used for reviews of food production, food safety and security, plant health, and animal health and welfare. Information retrieval methods in this context have been informed by human healthcare approaches and ideally should be based on relevant research and experience.

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This narrative review seeks to identify and summarise current research-based evidence and experience on information retrieval for systematic reviews in food and feed topics.

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There is little published evidence on the most efficient way to conduct searches for food and feed topics. There are few available study design search filters, and their use may be problematic given poor or inconsistent reporting of study methods. Food and feed research makes use of a wide range of study designs so it might be best to focus strategy development on capturing study populations, although this also has challenges. There is limited guidance on which resources should be searched and whether publication bias in disciplines relevant to food and feed necessitates extensive searching of the grey literature.

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## **Conclusions**

There is some limited evidence on information retrieval approaches, but more research is required to inform effective and efficient approaches to searching to populate food and feed reviews.

## **Introduction**

Systematic reviews are a well-established methodology for evidence synthesis and decision making in human health research. Over recent years systematic review methodology has been adopted in a growing number of fields. This includes those related to food and feed, such as food production, food safety and security, plant health, and animal health and welfare. The SYREAF (Systematic Reviews for Animals & Food) webpages provide an indication of the types of questions addressed by systematic reviews in this context (<http://www.syreaf.org/>). The uptake of the systematic review method has been particularly strong in animal agriculture and veterinary medicine. The VetSRev database of systematic reviews of relevance to veterinary medicine and science contains citations for over 500 systematic reviews, critical reviews, and meta-analyses published since 2000, which include those related to the health and welfare of food-producing animals (<http://webapps.nottingham.ac.uk/refbase/>). Food and feed topics are also becoming a more frequent subject of review in the human health literature. For example, systematic review methods have been used to assess the public health impacts of food production methods (O'Connor et al., 2010a), the performance and safety of foods that make health claims (Eales et al., 2016), and the prevalence of foodborne illnesses and associated chronic sequelae in humans (Keithlin et al., 2015, Majowicz et al., 2014).

Systematic reviews in food and feed topics are increasingly influencing policy-making at both the national and international level. The UK Department for Environment, Food and Rural Affairs (DEFRA) (Department for Environment Food and Rural Affairs, 2015), the Food Standards Agency (FSA) (Mateus et al., 2016), the European Food Safety Authority (EFSA) (O'Connor et al., 2015), and the Food and Agriculture Organization of the United Nations (FAO) (Food and Agriculture Organization of the United Nations and World Health Organization, 2016) have all commissioned and funded recent systematic reviews to inform their work. This is particularly apparent in the context of risk assessment where systematic reviews align with the One Health agenda. One Health recognises that the health of animals, humans, and ecosystems are connected and therefore require a multi-sectoral, interdisciplinary approach to address potential or existing risks (Gibbs, 2014).

The European Food Safety Authority (EFSA) has formally adopted systematic review and meta-analysis as their preferred methodology to produce evidence-based risk assessment models in food and feed topics. This decision was based on an analysis of systematic review methods in the context of Regulation (EC) No 178/2002 (European Parliament and Council of the European Union, 2002). This Regulation recommends that EFSA undertake risk

assessments in an independent, objective, and transparent manner on the basis of all available scientific information and data. To support the application of systematic review methodology to food and feed risk assessments, EFSA has published guidance for the conduct of such reviews (European Food Safety Authority, 2010). These guidelines have been authored by EFSA scientific officers and external members with expertise in food and feed topics, systematic reviews, and information science.

As the importance of systematic reviews in food and feed research grows, there is a need to ensure review methods are appropriate, robust, and relevant. Early systematic review methods in this context have tended to be informed by methods developed for systematic reviews of human health topics, in the absence of relevant methodological research specific to food and feed. The application of methods from other fields must be evaluated, and new research and methods more suitable to the challenges of the new context may need to be tested. Information retrieval is one key element of the systematic review process. All systematic reviews should be based on extensive literature searches that prioritise sensitivity in order to ensure that as many as possible of the necessary and relevant studies are included in the review (Higgins et al., 2011). This paper identifies and summarises current research-based evidence and experience on information retrieval for food and feed systematic reviews. As current research evidence is lacking in many areas, we also discuss potential issues related to information retrieval in food and feed topics that we argue require consideration by researchers in this field.

## **Methods**

### *Methods: the review question*

We undertook a narrative review to identify and summarise current research-based guidance, research evidence, and experience on information retrieval to populate food and feed systematic reviews.

Food and feed topics were defined as topics related to food for human consumption, including its nutrients, safety, and all aspects and inputs of production.

Research evidence and experience was sought on the following themes that are common to information retrieval practice and are used to structure many guidelines and manuals:

- Information retrieval manuals and guidelines currently available;
- How to build search strategies and the use of search filters;
- The resources that should be searched;
- How to document and report the search process.

### *Methods: the literature search*

To identify evidence-based guidance or primary research that addresses searching for studies in any field related to food and feed, we undertook a search of MEDLINE (Ovid), Science Citation Index (Web of Science), and ScienceDirect (<http://www.sciencedirect.com/>) in 2012. This was subsequently updated in December 2016 (see Supporting Information). The original search strategy was designed by an experienced information specialist and then peer-reviewed by a second experienced information specialist. We also sought relevant material from topic experts and undertook citation searches on key papers to identify further evidence missed by the database searches.

### *Methods: Publication selection*

Records were exported into EndNote reference management software. A single reviewer screened the records and removed obviously irrelevant records based on an assessment of the titles and abstracts. A single reviewer assessed the full-text of the remaining documents for relevance to the review eligibility criteria. Documents were selected for inclusion if they contained evidence-based guidance or original research on information retrieval in topics related to food and feed and reported on the themes described above. Documents exclusively about information retrieval in the context of animal experimentation for pre-clinical research were excluded. The research evidence and the guidance identified were summarised.

## **Results**

A search undertaken in May 2012 identified 7199 records. After deduplication, 3875 records were assessed for relevance. An update search, undertaken in December 2016, identified an additional 5579 records. After deduplication, 3743 records were assessed for relevance. Other search methods, such as citation searches and contact with topic experts, returned an additional 104 results.

Sixteen documents were selected as containing original research on information retrieval themes in topics related to food and feed. These documents are summarized below. In addition to the research studies, a number of documents were identified that provided evidence-based guidance for searching in food and feed topics. These are also described below.

### *Information retrieval manuals and guidance*

A number of guidance documents and manuals were identified that aim to provide evidence-based instruction to those carrying out searches in food and feed topics. These include those that deal specifically with information retrieval (Glanville et al., 2013, Kawasaki, 1998, Murphy, 2007) and those that contain guidance on searching as part of a wider discussion of

systematic review methodology in the food and feed context (Devos et al., 2017, European Food Safety Authority, 2010, Lean et al., 2009, O'Connor et al., 2014a, Rajić and Young, 2013, Sargeant et al., 2006a, Young et al., 2014b).

These guidance documents are largely supported with citations from the human health literature or mirror established conventions for searching in human health, such as those described in the Cochrane Handbook (Higgins and Green, 2011) and the Centre for Reviews and Dissemination's (CRD) guidance for undertaking reviews in healthcare (Centre for Reviews and Dissemination, 2009).

The area where the guidance documents give most consideration of the specific food and feed context is in the choice of resources to search. There is no agreed acceptable number of information sources that should be searched to inform a systematic review in any discipline; this is usually presented as a decision that depends on the focus of the review question and the resources available to the review team. However, the available guidance suggests that food and feed reviews may require the use of a wider range of resources than are typically needed for reviews undertaken in human health. This is because food and feed review questions may require evidence from a number of disciplines including medicine, agriculture and veterinary science (Glanville et al., 2013). MEDLINE/PubMed, AGRICOLA, CAB Abstracts, the databases within Web of Science, and Scopus are described as key resources for systematic reviews in animal agriculture and veterinary medicine, with MEDLINE/PubMed and CAB Abstracts the minimum requirement (O'Connor et al., 2014a). Current recommendations for selecting which sources to search are largely based on a theoretical knowledge of the databases' subject coverage, although the studies by Grindlay et al. (2012), Kawasaki (2004) and Waddell et al. (2008) are cited by some authors (Glanville et al., 2013, O'Connor et al., 2014a, Young et al., 2014b).

Current guidance for searching to inform systematic reviews in food and feed topics recommends the inclusion of strategies to identify unpublished literature (Devos et al., 2017, O'Connor et al., 2014a, Rajić and Young, 2013, Young et al., 2014b). Various sources and methods are recommended in these documents including trial registers (both clinical registers and those specific to food and feed topics), databases of theses and dissertations, web search engines, web pages of relevant organisations, hand-searching conference abstracts, and contacting authors and other topic experts. These recommendations are based on evidence from studies considering the identification of unpublished clinical trials in humans, or examples of specific food and feed systematic reviews where the inclusion of grey literature was significant.

## *Information retrieval research: how to build search strategies and the use of search filters*

We identified no primary studies that explored or researched the structure of search strategies for food and feed topics.

Three studies by Bartol were identified that describe the variation between CAB Abstracts and Agris in the indexing of agricultural research (Bartol, 2009a), the use of subject indexing and free-text searches to retrieve agricultural research from non-agricultural bibliographic databases (Bartol, 2012), and the food and nutrition related subject headings available in a number of biomedical and agricultural thesauri (Bartol, 2009b). The author suggests that whilst retrieval in food and agriculture topics can be enhanced by the inclusion of subject headings in search strategies, searchers should be aware of some of the challenges in using database thesauri effectively in this context. The same food or agricultural topic may be indexed very differently in different databases, thesauri display significant variation in the way food and agricultural terms are structured, and scope notes can be vague and unhelpful.

Three studies investigated the application of search filters developed to identify studies in the context of human health, to food and feed topics (Murphy, 2002, Murphy, 2003, Talens-Bou, 2017).

The PubMed “Clinical Query” built-in search filters for studies reporting on etiology, prognosis, diagnosis, and treatment or prevention were translated for CAB Abstracts. The objective was to test their sensitivity and precision when applied to veterinary literature in a key database for this discipline (Murphy, 2002). The performance of the filters in identifying veterinary evidence was subsequently investigated in their native interface, PubMed (Murphy, 2003). The performance of the filters was unsatisfactory in both PubMed and CAB Abstracts, with low precision a particular issue. Murphy concluded that the poor performance of these filters should lead us to consider whether study design search filters are appropriate for identifying veterinary literature given the wide range of study types that are required in this context and the variability of language used to describe them (Murphy, 2003).

Talens-Bou (2017) tested the use of existing animal population search filters developed specifically for laboratory animals used in preclinical studies in the context of human health (de Vries et al., 2011, de Vries et al., 2014, Hooijmans et al., 2010) to identify trials in livestock. These existing filters were not designed to retrieve trials in livestock populations and may not be optimised for this purpose. However test searches in the context of zoonotic diseases has suggested they may be effective at identifying studies in farm animals and other non-experimental animal hosts (Talens-Bou, 2017).

### *Information retrieval research: sources to search*

Six studies provided evidence for the most appropriate sources to search to identify food and feed research (Bartol and Baricevic, 2002, Glanville et al., 2014, Grindlay et al., 2012, Kawasaki, 2004, Pham et al., 2016, Waddell et al., 2008)

A 2012 study identified CAB Abstracts as an essential source to identify studies in veterinary medicine because of its coverage of relevant journals (Grindlay et al., 2012). CAB Abstracts indexed over 90 per cent of the veterinary journals identified by the authors; this was significantly more than any of the other databases studied either alone or in combination (Grindlay et al., 2012). A similar study assessed information sources for their coverage of agriculture literature and again identified CAB Abstracts as the best information source; indexing 92 per cent of the primary agriculture journals included in the study (Kawasaki, 2004).

A number of older studies assessing the coverage of agricultural literature by bibliographical databases are collated by Bartol and Baricevic (2002). These studies are dated (the earliest was published in 1980 and the most recent in 1998) and largely published in the journals of professional associations, such as the Quarterly Bulletin of the International Association of Agricultural Information Specialists. We were unable to access the full-text of the original publications. However, Bartol and Baricevic's (2002) summary of these studies suggest that while overlap in the coverage of resources such as Agris, AGRICOLA, and CAB Abstracts was identified, no one resource provided comprehensive coverage of agricultural research. They suggest that searchers looking for agricultural research should therefore use more than one database covering this topic area.

Relative recall methodology (Sampson et al., 2006) has been used to investigate the yield of a number of resources relevant to the work of EFSA, and the most efficient combination of these resources (Glanville et al., 2014). The included studies from five systematic reviews were identified. Each included study was then searched for in a series of resources to determine whether they could be retrieved. CAB Abstracts, AGRICOLA, and BIOSIS were among the highest yielding databases in the animal health topics. Biomedical databases, such as MEDLINE, Embase, and CENTRAL, performed most strongly in the reviews related to food or nutritional supplements in humans. While all of the included studies from the human reviews could be found in the resources tested, nine studies from the two animal health reviews were conference abstracts or reports that were not included in any of the bibliographic databases. The authors note that their findings were based on a small sample of specific systematic reviews and therefore may not be generalisable to all food and feed topics (Glanville et al., 2014).

The impact of searching only one bibliographic database, supplemented with ancillary sources such as hand-searching, in agri-food public health topics was tested by reproducing three systematic reviews (Pham et al., 2016). A search of a single database impacted on fifteen of the 143 meta-analyses conducted by these reviews as a significant number of included studies were not identified by this approach. The authors additionally tested the impact of searching only bibliographic databases and excluding sources to identify grey (or unpublished) literature. Five meta-analyses were impacted, either because they could not be performed as there was insufficient data without the inclusion of grey literature, or because the omission of data from grey literature resulted in a wider confidence interval (Pham et al., 2016).

The consequences of introducing efficiencies in the choice of resources to search has also been explored in the context of zoonotic public health. The searches for three completed systematic reviews were simplified by restricting the resources searched to three “top ranking” databases identified by a survey of topic experts. The authors concluded that the use of three major databases was sufficient (Waddell et al., 2008). It should be noted that this study is only reported in abstract form and is lacking important information, such as the three databases tested.

#### *Information retrieval research: documenting and reporting the search process*

Four studies provided evidence on the quality of reporting of literature searches for reviews in food and feed topics (Kamioka et al., 2017, Sargeant et al., 2006b, Toews, 2017, Waddell et al., 2009)

Toews (2017) assessed the search methodology of a sample of systematic reviews and meta-analyses published in veterinary journals between 2011 and 2015 in the context of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. All of the 75 included systematic reviews provided some information on search methodology. However, 95 per cent did not include a reproducible search strategy i.e. line by line results.

A recent quality assessment of systematic reviews of functional foods conducted to support Japanese labelling claims found that the search methodology for 47 per cent of the included reviews were poorly described and/or implemented (Kamioka et al., 2017).

Earlier assessments of search reporting have been carried out on narrative literature reviews of topics related to zoonotic public health and microbial food safety. Only two of the 132 literature reviews assessed by Waddell et al. (2009) and 0 of the 65 reviews assessed by Sargeant et al. (2006b) provided any description at all of the methods used to identify evidence.

## Discussion

We identified only a small body of research specific to food and feed searches. As a result, the guidance for information retrieval to inform reviews in this context is limited in terms of being evidence-based. This may reflect the fact that specific food and feed systematic review methods are still at an early stage of development compared to other fields where systematic review methods have been established longer. The uptake of systematic review methods and research into practice is still progressing quite slowly despite the size of both the commercial market and the food and feed research community.

The published guidance relies heavily on evidence and conventions from the human health literature. However, food and feeds review may have substantial methodological differences that have the potential to require alternative search approaches (Sargeant et al., 2006a). Even systematic reviews of a food-related intervention in humans, such as a review of the efficacy of “functional foods” containing probiotics or plant stanols, may require the use of a wider range of information sources than systematic reviews of clinical interventions (Eales et al., 2016, Glanville et al., 2015). Moreover, the rationale for the search approaches used to identify clinical trials in human health is based on a large body of research providing evidence on the nature and quality of research evidence in this field. It is not clear whether this evidence and the assumptions about information retrieval that are based on it are equally applicable outside of human health. A comparison of the “information infrastructure” in human and veterinary medicine suggests several aspects of veterinary research infrastructure that may impact on information retrieval practice are undeveloped. These include reporting standards, clinical trial registration, database indexing, search filters and organisational support for systematic reviews (Toews, 2011). This means that reports of research in livestock, for example, may not be consistently described or easily retrievable.

Our experience and knowledge of food and feed research, and published research evidence, suggest that information retrieval in food and feed topics may be more complex than simply lifting established methods from human health research.

### *Searching for specific study designs: randomised controlled trials*

Systematic reviews of intervention studies in human health usually prioritise randomised controlled trials (RCTs) for inclusion as the highest level of evidence for evaluating efficacy. As a result, much effort has been invested by Cochrane (formerly the Cochrane Collaboration) over the last twenty years to identify reports of RCTs in the context of human health research (Higgins et al., 2011). This includes the development of the Cochrane Highly Sensitive Search Strategies for identifying randomised trials in MEDLINE (Lefebvre et al., 2011) and more recently the work of the Cochrane Centralised Search Service which searches a range of databases, including EMBASE, to gather reports of RCTs to add to the CENTRAL Register of Controlled Trials.

This review did not identify any evidence that indicates whether or not the existing Cochrane Highly Sensitive Search Strategies for identifying randomised trials in MEDLINE or EMBASE can be used to identify trials in livestock populations with acceptable sensitivity. We suggest that applying a filter designed to retrieve reports of clinical trials in human health to finding trials conducted in livestock may be problematic. Livestock involved in clinical trials are grouped and housed differently from human populations. As a consequence, trial design in this context often requires additional elements, such as factorisation, blocking, and experimental challenge. These are not as frequently employed in human trials and therefore not considered in the development of existing RCT filters. Research in food animals addressing the same basic question may also be conducted in different ways. For example, a trial may be conducted using individual animal intervention allocation or group intervention allocation, and be carried out in experimental conditions or under typical commercial conditions (Sargeant and O'Connor, 2014a). This variability in the way that trials may be carried out, and therefore described in the titles and abstracts available in databases, makes it difficult to capture them effectively with a search filter. The development of search strategies to identify reports of RCTs for systematic reviews in food and feed topics may be further hindered by the poor reporting of trial methodology in this field (Sargeant et al., 2009a, Sargeant et al., 2009b, Snedeker et al., 2012). Although the CONSORT statement of recommendations for the reporting of randomised trials in clinical medicine was first published in 1996 (Begg et al., 1996), the development of reporting guidelines for RCTs in livestock and food safety trials was introduced comparatively recently. The REFLECT statement was first published in 2010 and is an evidence-based minimum set of items for reporting livestock trials with production, health, or food-safety outcomes (Sargeant et al., 2010) (O'Connor et al., 2010b). The anticipated improvement in reporting, and hence retrieval, will probably take more time to materialise.

#### *Searching for specific study designs: non-randomised trials and observational studies*

Veterinary science, animal nutrition, food safety, and food production research prioritises RCTs as the preferred evidence type for systematic reviews of interventions, just as human health research does (Sargeant and O'Connor, 2014a). However, the relative lack of publically available RCTs conducted in animal populations means that systematic reviews in animal health and welfare are more likely to require the identification of observational studies and non-randomised studies than reviews of the effects of interventions in human health (Sargeant et al., 2016a). The commercial nature of many interventions for food production means a significant proportion of trials that are carried out are conducted by companies and are not made publically available. Reviewers must rely on evidence in the public domain and this is more likely to involve an observational study design.

Research in animal populations also commonly involves challenge studies, whereby both the intervention and the disease occurrence are allocated by the investigator, a methodology that is much less prevalent in trials using human participants (Sargeant and O'Connor, 2014a). A challenge study involves the deliberate exposure of animals to a pathogen or toxin, or the deliberate inducement of a non-infectious disease. Animals may then be allocated to experimental or control arms in order to produce a preventative or therapeutic intervention model (Wisener et al., 2014). Although challenge studies may employ randomisation to group subjects and may include a control group, they are rarely described as RCTs in the title, abstract or indexing fields of records in bibliographic databases.

In addition to a lack of RCTs relevant to reviews of food and feed interventions, it is often common for food and feed reviews to include observational studies, because of the questions they seek to answer. Although systematic reviews in human health are becoming increasingly diverse in the types of question they address (and the study designs that are eligible to answer those questions), systematic reviews undertaken to inform health policy through health technology assessment most commonly assess clinical and cost-effectiveness. Decision-makers in food and feed topics, however, frequently require systematic reviews for the purpose of risk assessment (Aiassa et al., 2015). Such reviews, required by bodies such as EFSA and DEFRA, evaluate the likelihood of occurrence of adverse effects to human health, animal health and welfare, plant health, and the environment. This necessitates the identification of a broader range of study designs than RCTs (Aiassa et al., 2015, Rajić and Young, 2013). For example, systematic reviews considering the prevalence of diseases or conditions (Tusevljak et al., 2012), their zoonotic potential (Waddell et al., 2015), or risk factors associated with their transmission (Denagamage et al., 2015) require the retrieval and inclusion of observational and other non-randomised studies.

There are no published health care search filters for observational study designs that are extensively validated for retrieval with an acceptable balance of sensitivity and precision (Waffenschmidt et al., 2017). This reflects the fact that such studies are more likely to be poorly or inconsistently described and indexed, and so are difficult to capture with a search filter. Those filters that do exist for study designs other than RCTs are exclusively from the human health field and do not cover the important challenge trial design (InterTASC Information Specialists' Sub-Group, 2014). It is not clear whether existing filters for observational, epidemiological and other nonexperimental studies in human healthcare can be applied to animal or plant health reviews without impacting on their performance. Moreover, the use of such study designs filters may not even be desirable given the wide range of potentially relevant study designs that might be included in food and feed reviews. For many of the question types addressed by systematic reviews of food and feed topics, there is no consensus around the hierarchy of evidence (European Food Safety Authority, 2010). It is therefore common for such reviews not to specify particular study designs in their pre-defined eligibility criteria. Stringing together a series of study design filters may indeed

result in no improvement in precision (i.e. does not reduce the retrieval of ineligible studies), which is usually the objective when using a filter.

The development of useful search filters may be complicated by inadequate reporting of observational studies in the context of food and feed research. An analysis of 100 observational studies in pre-harvest food safety found that only 38 per cent used one of the “big three” labels (case-control, cohort, and cross-sectional studies) to describe the study design used (Sargeant and O'Connor, 2014b). The recent publication of STROBE-Vet, a reporting standard for observational studies in animals, may improve the consistency of methodological reporting going forward and make it more feasible to identify such study designs consistently with a search strategy (O'Connor et al., 2016b, Sargeant et al., 2016).

### *Searching for specific populations*

The challenges inherent in searching for study designs in the food and feed literature may mean that searches for systematic reviews in these fields do not routinely focus their searches in this way. In order to retrieve a manageable volume of results, and limit the proportion of irrelevant records that require processing, it becomes more desirable to increase precision elsewhere in the search strategy while taking care not to exclude any potentially relevant material. This may be particularly important in reviews commissioned to inform policy and decision-making. Such reviews often cover broad topic areas related to the assessment of risk and require evidence synthesis to be undertaken rapidly with limited resources (Aiassa et al., 2015). One obvious focus might be to develop the population concept. However, searching for population concepts with an appropriate balance of sensitivity and precision has its own difficulties.

The Cochrane RCT filter for MEDLINE excludes animal studies using the search line `exp animals/ not humans.sh` (Cochrane Collaboration, 2008). This limit has been widely accepted as a “safe” way to limit a search to human populations in MEDLINE. In reviews where the population is livestock rather than humans, it is unclear how to address this type of population limit. Although the need for precision in some large multidisciplinary databases may make it desirable to reduce the number of irrelevant records by safely removing studies in humans, no published search filter designed to retrieve livestock populations has been identified. Existing animal population search filters have been developed specifically for laboratory animals used in preclinical studies in the context of human health (de Vries et al., 2011, de Vries et al., 2014, Hooijmans et al., 2010) and their applicability to studies in livestock is at an early stage of investigation (Talens-Bou, 2017). The laboratory animal filters contain many terms related to animals that are prevalent in preclinical research, such as rodents and primates, but are unlikely to retrieve relevant studies in livestock. Filters that include terms specific to laboratory animals may result in the retrieval of a large number of irrelevant records that must be processed and assessed, limiting the value of the existing filters as a tool to increase search precision. It is likely that the livestock population concepts

currently have to be developed from scratch by each review team, rather than benefiting from existing predefined filters. Any future filter designed specifically to identify livestock populations will struggle to distinguish between preclinical animal studies performed in the context of human health research and trials in livestock because some animals, such as pigs, are commonly found in both.

Searches for systematic reviews in food and feed topics may also need to differentiate between the animal and the product, something that is difficult to achieve without excluding relevant material. For example, a review of post-harvest interventions to control *Salmonella* in pork or beef products would be likely to identify a large volume of irrelevant records in live pigs and cattle that require processing and screening (Food and Agriculture Organization of the United Nations and World Health Organization, 2016). This increases the time and resource burden of the review. Although it is unlikely that any search strategy could adequately address this issue without sacrificing the required sensitivity, it is important to highlight the potential for very high levels of “noise” when searching for food and feed topics. This is compounded by the limited options available for addressing this challenge within the current Boolean approaches to searching databases.

Differences between countries and geographic regions in the intensity of agriculture and methods of animal husbandry, such as diet, housing, and other management practices, are significant in the conduct of feed and food reviews (Sargeant et al., 2006a). The limits to the appropriateness of combining data from incomparable systems may mean that reviews including a livestock population are more likely to have eligibility criteria related to specific geographic regions. Due to conflicting evidence on the impact of including non-English language studies on effect estimates, current guidance for information retrieval in human health suggests that no language limits are applied to searches for systematic reviews (Higgins and Green, 2011). In systematic reviews of livestock populations the potential for language bias introduced by limiting to English language studies may be less significant where the review objective is related to a population, intervention or outcome primarily of relevance in English-speaking countries, because of the geographic variation in farming practices (O'Connor et al., 2014a). However, as in human health, this is clearly topic-specific. A 2016 review of pain mitigation strategies in neonatal piglets documented that a significant proportion of the evidence was published in non-English language sources (O'Connor et al., 2016a). How this may impact on review conclusions is currently unknown; we have not identified any research evidence on the extent and effects of language bias in food and feed research.

### *Information sources: bibliographic databases*

The comparative and relative value of searching different bibliographic databases is the area of information retrieval in food and feed topics in which most research evidence was identified. Research into the coverage of key veterinary and agricultural journals has suggested that CAB Abstracts is the most important resource for these topic areas (Grindlay et al., 2012, Kawasaki, 2004). However, quantifying the volume of relevant journal titles covered by an individual information source is a simple, pragmatic method to identify those resources that may be most useful. More sophisticated methods to assess database utility and yield, such as relative recall (Sampson et al., 2006) or capture-recapture (Spoor et al., 1996), have been used in information retrieval research in the human health care field and could be a valuable next step in confirming and expanding upon these findings.

Guidance suggests that searches in food and feed topics should consider a wide range of databases to ensure evidence from across multiple relevant disciplines is identified. However, we only have limited preliminary research investigating the most efficient combinations of databases to search (Glanville et al., 2014). The EFSA Inventory lists 199 information sources of relevance to systematic reviews of food and feed that provide searchable bibliographic data records or full-text reports of research (European Food Safety Authority, 2017). With such a large number of potential resources from which to choose, evidence-based guidance is clearly needed to ensure that searchers are selecting an efficient combination of resources that maximise the retrieval of unique records for a range of question types and disciplines.

### *Information sources: grey and unpublished literature*

Search approaches to identify trials in human health are shaped by our understanding of publication bias; research has suggested that statistically significant and favourable findings are more likely to be published and published quickly in journals (Hopewell et al., 2007, Scherer et al., 2007). Studies with non-significant or unfavourable results are likely to be more difficult to find since they may remain unpublished, or are published outside of journals, or in languages other than English. However, failure to identify such studies may result in an over-estimation of treatment effect. This premise underpins search approaches for systematic reviews of clinical trials in human health. It is expected practice that review authors search for unpublished trials, grey literature, and studies published outside of English language sources in order to minimise the possibility of publication bias (Higgins and Green, 2011, Kugley et al., 2017).

However, this evidence informing the current understanding of publication bias and its impact comes from analysis of RCTs in human health and their impact on meta-analyses of treatment effects in human beings (Higgins and Green, 2011). It is not clear whether publication bias impacts equally on non-RCTs, which are more significant to reviews in food

and feed topics. Therefore the justification for such extensive searches for unpublished evidence is less clear in the food and feed context. We also have comparatively little evidence to support searching extensively for “difficult-to-find” evidence outside of the human health field. Research has identified publication bias in food and feed related literature (Ceballos et al., 2009, Duffield et al., 2008, Haxton and Findlay, 2011, van der Schot and Phillips, 2013) and relatively poor publication rates in disciplines related to food and feed (Brace et al., 2010, Snedeker et al., 2010, Wieser et al., 2016). We also have some examples of reviews in food and feed topics that included a significant proportion of grey literature (Wilhelm et al., 2011) and in which the exclusion of unpublished evidence would result in insufficient data to undertake a meta-analysis (Pham et al., 2016). However, further evidence is needed to enable us to understand the impact of publication bias on the conclusions of systematic reviews in food and feed topics.

Although current guidance does recommend searching for unpublished studies to include in reviews in food and feed topics, we have identified no research evidence to support which methods and sources may be most effective and efficient. Such evidence only exists for the human health field and much of this is not applicable to food and feed research as it is concerned with sources such as registries of human trials and documents from regulatory agencies for human medicines and devices (Arber et al., 2013). The development of a prospective trial registry for veterinary trials, one of the objectives of VetAllTrials (<http://vetalltrials.org/>), may increase research interest in the retrieval of unpublished studies for reviews of food and feed topics and make the identification of this type of evidence more feasible.

#### *Future developments in information retrieval for food and feed*

Research evidence to underpin food and feed systematic review methods and to help us determine whether different evidence identification processes are required in this context is still largely lacking. Increasing appreciation of the usefulness of food and feed systematic review methods and generating interest in conducting research to explore these methods may be challenging (Pham, 2014, Young et al., 2014a). Ensuring research findings and guidance impact upon food and feed review practice is also important. An internal EFSA survey found that although guidance on searching was seen as important by respondents, their use of existing information retrieval tools designed specifically for food and feed, including a methods manual, was limited (European Food Safety Authority, 2016).

One activity that can spur new research is an assessment of the strengths and weaknesses of current practice. Given the relatively low volume of systematic reviews in food and feed, researchers have not yet widely surveyed and analysed systematic review practice in this field.

Our lack of understanding about how searches for systematic reviews in food and feed topics are currently undertaken hampers our ability to identify and prioritise the aspects of information retrieval that are most in need of research or evidence-based guidance. The poor search reporting identified in relatively small samples of systematic and narrative reviews of food and food topics suggests that collating sufficient information on current search practices is unlikely to be straightforward (Sargeant et al., 2006b, Toews, 2017, Waddell et al., 2009). Initiatives such as the publication of the EFSA critical appraisal tool for assessing extensive literature searches in food and feed topics (European Food Safety Authority, 2015) may encourage greater consideration of the quality of searches and should provide evidence of areas in which practice could be improved by research. Continued efforts to improve reporting standards for research involving animals may also increase the importance of search quality if search methodology is included in these standards. Existing reporting standards for animal research are collated by the MERIDIAN resource (<https://meridian.cvm.iastate.edu/>).

Further research into information retrieval for food and feed topics does not necessarily have to be informed by traditional approaches from the human health field. Searches to inform reviews of clinical effectiveness, cost-effectiveness, or epidemiology are classically clearly focused, predefined, and use a conceptual structure such as PICO (population, intervention, comparator, outcome) or PEO (population, exposure, outcome). However, as the systematic review methodology is adopted and adapted by new disciplines, and used to answer different types of questions, alternatives to this approach are increasingly being explored. There is a growing understanding that systematic reviews of complex topics are not suited to traditional models of information retrieval developed for reviews of clinical effectiveness evidence. Such reviews may require the identification of interdisciplinary research in a broad range of information formats, involve inconsistent vocabulary and difficult-to-define concepts, and an understanding of the topic that evolves as the review progresses [Paisley S. and Levay, P. Searching for complex topics: theory and practice. Presentation at December ISSG meeting – unpublished 2016]. To meet these challenges, researchers in the fields of social science and public health are investigating the use of innovative techniques, such as text mining and cluster searching for complex reviews (Booth et al., 2013, O'Mara-Eves et al., 2015, Paynter et al., 2016, Shemilt et al., 2014). Systematic reviews in food and feed share many of the same characteristics, making them a promising candidate for similar approaches. We have used OmnizViz data analysis and visualisation software to cluster very large volumes of records from a broad scoping search on the welfare implications of farming sheep. Clustering the records in this way, and rapidly assessing the clusters, indicated the topics where there was sufficient evidence to undertake a full systematic review (O'Connor et al., 2014b). However, the use of such techniques has not been widely reported in food and feed reviews to date.

## Conclusion

Current available evidence and guides to information retrieval for systematic reviews of food and feed topics are based heavily on research from the human health field. However, it is unclear whether search approaches developed to identify clinical evidence are appropriate for food and feed systematic reviews, given the significant methodological differences. Any searcher beginning searches to inform food and feed reviews should adopt a questioning attitude to the task and should be aware that few tools may be available to assist with strategy development. An understanding of the nature of the questions being addressed by systematic reviews in food and feed research, and search methods currently used to inform them, is necessary to identify the aspects of information retrieval in this field that are most in need of further research and investigation. Increased uptake and acceptance of systematic review methods by the wider food and feed community may provide the impetus for greater interest in search issues in this context, and the undertaking of research to inform evidence-based guidance for best practice in information retrieval.

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