46. Society and ethics in animal breeding: a bibliometric analysis

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Abstract

A bibliometric analysis was performed to explore to what degree published animal breeding studies (on cattle, pigs and poultry) explicitly address societal issues and ethics, and what themes were addressed. A combination of search terms in Scopus resulted in about 24,500 publications on farm animal breeding since 1990, of which 673 included a society- or ethics-related term. A two-person manual second (on titles) and third (on the title, key words and abstract) selection step reduced the number to 270 papers that met our criteria, so overall, about 1% of the identified published animal breeding studies explicitly refers to themes being a societal issue in the title, key words or abstract. The number of papers per publication year increased rapidly after the year 2001, and peaked around 2010. Animal welfare and behaviour (AW) was the trait that was addressed most, especially for poultry, and to a lesser extent also for pigs and cattle. Explicit reference to ethics was made in 65 (24%) of the 270 selected papers. In this 'explicit on ethics' subset, the themes genetic modification (GM), biotechnology (BT) and AW were dominant. The subset of studies on GM that explicitly mentioned ethics was assessed in more detail, to examine how, and to what extent, the topic of ethics was discussed, and whether specific actions were mentioned. The inclusion of ethics in these publications varied along a broad spectrum, ranging from ethics only being mentioned as being relevant to ethics being the main topic of the paper. Several studies called upon different stakeholders to take action, mainly in terms of actively taking part in discussions. This study concludes that: (1) the human eye/brain seems to be necessary to select on criteria in a bibliometric study like the present – the visual inspection removed about 60% of the 'hits' for being false positive; (2) animal breeding work on AW issues seems to be more prone to use wording that is explicit on societal issues compared to breeding work on other sustainability issues; (3) studies on BT, GM and AW are the main categories containing explicit reference to ethics, papers on other themes mention ethics to a considerably lesser extent; and (4) between the studies on GM that explicitly mention ethics, there is substantial variation in how they deal with ethical reasoning.

Keywords: animal welfare, genetic engineering, genetic modification, genetic selection

Introduction

The Western society is sensitive to processes and results of animal farming practices. The increasing acknowledgement of moral status of animals unquestionably plays a role in this. Animal breeding (that is, the process of genetic selection in populations to systematically change genetic characteristics of the next generations) is an integral part of the animal production system. Animal breeding activities can both be a cause for concern and a solution to problems. For decades already, undesired side-effects of conventional breeding practices (see for example Rauw *et al.* (1998)) are issues of societal unease. Also, the introduction of genetic modification or gene editing is clearly an example of ethical concern (see for example Naab *et al.,* 2021). In the late nineties and early 2000s, several studies addressed issues related to breeding activities (Gamborg and Sandøe, 2005), often using the term 'sustainability' as the entry. In the SEFABAR project, which was an EU-funded collaboration between the breeding industry and several academic disciplines, Liinamo and Neeteson (2001) concluded that most breeding studies were relevant to sustainability issues, but little of them were really explicit on this. Now, two decades later, we raise a similar question, but on the explicit reference of societal and ethical issues related to animal breeding

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activities. A bibliometric analysis was performed, in which we assessed general trends in publications on societal aspects of animal breeding, regarding the species and main societal or ethical issues under study. We specifically focused on dairy cattle, pigs, and chickens. Moreover, to highlight how these publications address these issues, we analysed a subset of papers in more detail. In the subset of studies that specifically mentioned ethics in the title, keywords or abstract, and addressed the topic of genetic modification or engineering, we assessed how, and to what extent, the topic of ethics was discussed, and whether specific actions were mentioned.

Methods

The bibliometric analysis was performed in Scopus, using a three-step selection process (Table 1). The first step consisted of a search in Scopus using a combination of a set of keywords regarding: (1) animal; (2) breeding; (3) society or ethics; and (4) concerns. In the following two steps, false positive hits were excluded. In these steps, at least two people decided together which decision should be made, to reduce subjectivity in the selection process.

Using the final data set of publications (n=270; Table 1), the examined topics (Table 2) were assessed for each of the publications, based on the title and keywords (and when not conclusive, based on the abstract). A distinction was made to categorise the studies into: (1) having animal traits as the topic of attention; or (2) having breeding methodology as the topic of study. Moreover, each abstract was assessed to characterise the type of study as either 'experimental' (based on an experiment, a dataset, simulation study or similar) or 'descriptive' (reviewing literature, reporting from expertise, et cetera), and to assess whether the term ethics was explicitly mentioned ('ethic', with potential prefixes or suffixes) or not.

To highlight how the resulting publications address ethical issues, we selected a subset of publications to examine in more detail. We selected publications that met two criteria: (1) explicit mentioning of ethics in the title, keywords or abstract; and (2) genetic modification (GM) as the topic under study, as GM is a novel, progressive technology for which choices are to be made on its acceptability for practical application. In total, 21 publications met these criteria, 18 of these were available in English and were included. These publications were examined in more detail to determine how, and to what extent, the topic of ethics was discussed, and whether specific actions were mentioned in these publications, and if so, who should take these actions.

Table 1. Workflow and selection criteria used in the bibliometric analysis.

Step in the workflow	Description of the process
Step 1: Literature search (n=673)	Automated search in titles, abstracts and key words, in publications from 1990 onwards (search performed on the 3rd of December, 2021). Only publications with at least one of the required search terms for each of the categories below were included: - *Animal*: animal AND production; animal AND farm*; dairy AND cattle; poultry; pig* - *Breeding*: breeding AND selection; genetic AND selection; breeding AND genetic - *Society or ethics*: soci*; public; ethic*; moral* - *Concerns or discussion forms*: concern*; issue*; problem*; dilemma*; question*; demand*; worry; worries; debate; discourse; discussion
Step 2: Selection based on titles (n=400)	Title based manual exclusion of false positives: papers that did not address breeding or the species of interest (for example pigeons and guinea pigs, due to the term pig*)
Step 3: Selection based on title, key words and abstract (n=270)	Manual exclusion of publications that did not have animal breeding or genetic engineering in the species of interest as a topic of focus, based on the title, key words and abstract

Table 2. Structuring of topics examined in the publications.

Species under study	What societal or ethical issue is explicitly mentioned?	
	Animal (trait) related	**Methodology related**
Chickens	Animal health	Animal genetic resource management
Pigs	Animal welfare/behaviour	Biotechnology
Dairy cattle	Environment	Breeding goal definition
Across species	Food safety/security	Genetic modification
	Heat stress	General methods
	Meat quality	
	Multiple	
	Resilience/robustness	

Results

In total, approximately 24,500 papers on farm animal breeding since 1990 were identified. After inclusion of the societal aspects constraint and our subsequent selection, 270 papers were left. This shows that, with our selection criteria, few publications on animal breeding (around 1%) appear to address societal issues. The number of publications on societal aspects of animal breeding increased from about the year 2000 onwards, peaking around the year 2010 (Figure 1). Of these 270 publications, 86 (32%) were classified as belonging to the category 'experimental'. The topics that were studied differed per species (Table 3). A large proportion of the publications focused on animal welfare and behaviour (AW), especially for poultry (48%). For pigs, many studies focused on meat quality, besides AW. For cattle, aside from AW, many studies focused on animal health. For the papers on animals in general, the main theme was GM. Table 3 illustrates in brackets, per species-topic combination, the percentage of publications that explicitly mentioned ethics. Out of the 270 publications, 65 (24%) mentioned ethics explicitly in either the title, keywords or abstract, resulting in 90 species-topic combinations that included ethics. A number of topics include relatively many studies that explicitly refer to ethics: AW, environment (ENV) and resilience or robustness (RES; although it must be noted that for both ENV and RES these high percentages are based on a very limited number of studies, see Table 3), biotechnology (BT), and GM. For the other themes, few studies explicitly mentioned ethics.

Two observations in the analysis of the publications on GM mentioning ethics draw attention: (1) the variation in the degree of addressing ethics, ranging from ethics only being mentioned as being relevant, but not elaborating, to ethics being the main topic of the paper; and (2) the degree to which, and to whom, there is a plea for action. An example of minor addressment of ethics comes from Bhat *et al.* (2017), who mention the term ethics only in the abstract, stating:

> Nonetheless, barring ethical concerns gene-editing entailing economically important genes offers a tremendous potential for breeding animals with desirable traits.

Another example comes from Doran *et al.* (2018), who only cited ethical concerns as a motive for genetic approaches to identify male chicks *in ovo* to avoid the current practice of culling male chicks post-hatch, which is considered an ethical issue. An example of extensive elaboration on ethics comes from Kramer and Meijboom (2021), who discuss a novel definition of 'telos' (that is, the set of good activities that members of a species typically pursue and are equipped to perform well), and apply this

Table 3. Number of publications[1] addressing specific topics by species, with the percentage of studies explicitly mentioning ethics per species-topic combination shown in brackets.

Topic under study		Chickens	Pigs	Dairy cattle	Across species
Animal (trait) related	Animal health	3 (0%)	5 (20%)	12 (17%)	9 (22%)
	Animal welfare/behaviour	26 (23%)	15 (40%)	13 (38%)	20 (70%)
	Environment	0 (0%)	1 (100%)	4 (50%)	5 (40%)
	Food safety/security	2 (0%)	1 (0%)	6 (17%)	3 (0%)
	Heat stress	1 (0%)	1 (0%)	1 (0%)	0 (0%)
	Meat quality	1 (0%)	11 (27%)	0 (0%)	1 (0%)
	Multiple	4 (25%)	2 (0%)	2 (0%)	4 (0%)
	Resilience/robustness	2 (100%)	1 (0%)	1 (0%)	2 (50%)
Methodology related	AGRM[2]	2 (0%)	3 (0%)	5 (0%)	14 (0%)
	Biotechnology	1 (100%)	0 (0%)	1 (100%)	14 (50%)
	Breeding goal definition	1 (0%)	0 (0%)	5 (0%)	4 (50%)
	Genetic modification	4 (50%)	1 (100%)	7 (43%)	27 (56%)
	General methods	1 (0%)	1 (0%)	5 (0%)	7 (14%)
Other	Other	6 (0%)	16 (19%)	26 (4%)	25 (16%)

[1]Publications addressing multiple topics or multiple of our key species (chickens, pigs and/or dairy cattle) are included multiple times, resulting in n=335.

[2]AGRM = animal genetic resource management.

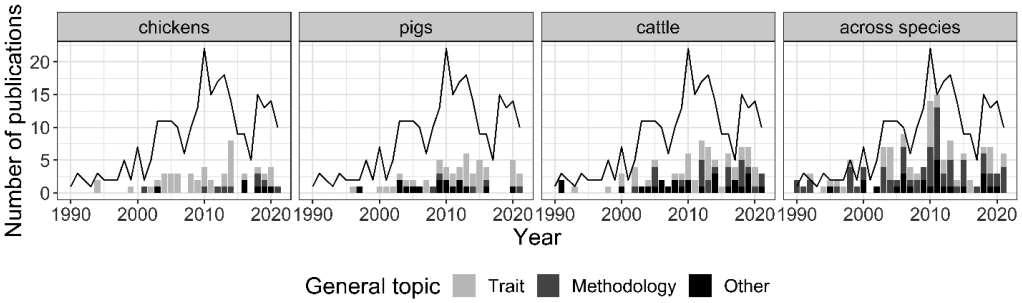

Figure 1. Number of publications on the different general topics and species. The black line represents the total number of publications by year (n=270), whereas the bars represent, per species, the number of studies focussing on certain general topics. Publications addressing multiple topics or multiple of our species categories are included multiple times (n=335).

to genome editing and genomic selection aimed at improving welfare of the animals. Several studies mentioned actions that can be taken and called upon different stakeholders. For example, Olsson and Sandøe (2004) called for action by animal welfare scientists, stating:

> [...] by using their expertise, animal welfare scientists can help research and development specialists and pure scientists to pursue developments in biotechnology in an acceptable way, and can call a halt, where necessary, to applications with an unacceptable impact on animals.

Another study, for example, called upon researchers and ethical animal research committees to consider specific principles in decision-making (Rose *et al.*, 2013). Moreover, in various publications, animal breeding organisations or companies, scientists and GM food industry leaders were called upon to engage in discussions.

Discussion

In this bibliometric study, we examined general trends in publications on societal aspects of animal breeding, regarding the species and main societal or ethical issues under study. Moreover, we analysed a subset of papers on GM, explicitly mentioning ethics, in more detail.

In the bibliometric analysis it became clear that the specificity of our search string was low, as only 40% of the initially obtained publications actually matched our goals. This highlights the importance of manual selection steps. The choice of search terms potentially has a large impact on which papers are found, and a different combination of search terms might have resulted in different outcomes. However, in our case, we selected the search terms based on a discussion with three persons, including testing various other combinations of search terms (not presented here). Nevertheless, in hindsight the use of the term 'poultry' may have resulted in some missed studies, as not all studies on laying hens and broilers may explicitly refer to 'poultry'. Most of the examined publications were not based on experimental work and many were focussed on animal breeding or genetic engineering in general, as opposed to focussing on one or more specific species or selection traits. In this, the (non-validated) impression has grown that most studies that explicitly use society-directed terms are probably of another nature than conventional 'animal breeding studies'. A large amount of studies dealt with AW, which is not surprising, given that AW is an important societal concern ('consumer concern' in earlier literature). However, the fact that nearly half of these publications explicitly referred to ethics is notable, seeing the low percentage of reference to ethics for most other animal-related traits. Popularly stated, 'doing good' as a breeder is apparently more prone to be mentioned explicitly when referring to AW than for other sustainability traits, such as animal health or food safety and security.

The subsequent analysis of ethics in GM studies revealed that the extent to which ethical concerns are discussed strongly differed between studies. Furthermore, many studies also mentioned more general concerns, such as escape of GM animals (Houdebine, 2014). Moreover, different stakeholders were called upon to take action, with the main action being to actively engage in discussions on (the ethics of) GM in animal breeding. Several studies emphasized that the goal of GM is of relevance for determining whether its use is deemed ethically acceptable. For example, Kramer and Meijboom (2021) discussed that, using their concept of 'telos', the use of breeding technologies for removing or changing physical features and disenhancing animals (that is, decreasing animals' capacity to suffer) by removing their desire to engage in characteristic activities would not be supported, whereas adapting animals to increase their robustness against environmental stressors would not be intrinsically objectionable. Interestingly, a number of studies highlighted that genetic engineering or modification is not so different from traditional selection practices, which have already resulted in issues regarding AW, and might even aid in countering these issues (e.g. Greger (2010)). Furthermore, although many papers discussed whether it is ethically acceptable to use GM, the reverse was also addressed:

> [..], it is clear that the alternative to refrain from using any form of GM or genome editing is also an active choice that requires ethical considerations. (Eriksson *et al.*, 2018).

Overall, this study revealed that the degree of ethical reflection varied strongly between the identified publications.

To summarize, this study shows that of the 1% of animal breeding related papers that address societal aspects explicitly, most address AW. Many studies on BT, GM and AW contained explicit reference to ethics, yet in the subset of studies on GM that mention ethics, there is substantial variation in the extent to which they do so.

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