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Research on animal health and welfare in organic farming—a literature review

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Abstract

Organic standards aim at good livestock health and welfare. A literature search on organic animal health and welfare was performed in October–November 2001 to investigate how well these aims compare with reality, and to see what areas have been researched. The search also made it apparent that national and historical differences in organic standards and in the way organic farming is understood must be considered when comparing results from different studies. The reasons for this are further discussed. Only 22 peer-reviewed papers were found in the search, mainly dealing with dairy cattle health and parasitology. Ten were comparative studies. In addition, two overviews were found. No papers focused on welfare issues other than health. The small number of papers published is not surprising in light of the development of organic farming and its philosophy. For example, organic researchers have been more interested in solving practical problems than publishing papers. However, this makes it impossible to draw general conclusions regarding the health and welfare of organic livestock. None of the published articles found indications that health and welfare are worse in organic than in conventional livestock farming, with the exception of parasite-related diseases. A cautious conclusion based on this material is that except for parasite-related diseases, health and welfare in organic herds are the same as or better than in conventional herds.

Keywords: Organic animal husbandry; Organic livestock production; Organic livestock research; Animal health; Animal welfare; Literature review

1. Introduction

Organic farming is gaining increasing interest from farmers, politicians, and consumers worldwide and especially in Europe. Generally, organic farming aims at creating a sustainable agroecological system based on local resources. Good animal health and welfare are important parts of such a system (Lund and Röcklinsberg, 2001). This is also recognized by the International Federation of Organic Agricultural Movements (IFOAM), the organization setting the basic standards for what can be labeled as organic (see Fig. 1). These standards are then elaborated into more detailed standards by national or local certification organizations. The EU adopted legislation for organic animal husbandry in 1999 (EC Regulation 1804/99; Anon., 1999).

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The IFOAM Basic Standards are presented as General Principles, Recommendations and Standards, where the General Principles are the goals that organic production and processing work towards.

In section 5.1 "Animal Husbandry Management" IFOAM states:

General principles
Management techniques in animal husbandry should be governed by the physiological and ethological needs of the farm animals in question. This includes:

- That animals should be allowed to conduct their basic behavioural needs.
- That all management techniques, including those where production levels and speed of growth are concerned, should be directed to the good health and welfare of the animals.

In section 5.7 "Veterinary Medicine" IFOAM states:

Recommendations
Natural medicines and methods, including homeopathy, ayurvedic medicine and acupuncture, should be emphasised.
When illness does occur the aim should be to find the cause and prevent future outbreaks by changing management practices.
Where appropriate the certification bodies should set conditions based on the farm's veterinary records to minimise the use of medicines.
The certification body/ standardising organisation should make a list of medicines and withholding periods.

Standards
5.7.1. The well-being of the animals is the primary consideration in the choice of illness treatment. The use of conventional veterinary medicines is allowed when no other justifiable alternative is available.
5.7.2. Where conventional veterinary medicines are used, the withholding period shall be at least double the legal period.

Fig. 1. IFOAM Basic Standards on animal husbandry management and veterinary medicine (IFOAM, 2000).

There was a genuine interest among the pioneers of organic farming in creating livestock systems that better fulfill animal needs than do the industrialized systems in conventional agriculture. Allowing animals their natural behavior has been a focus of these efforts. Animal welfare has also become a marketing argument for organic products, and in several countries consumers perceive organic farming products as more 'animal friendly' than conventional products (e.g. Holmberg, 1999; Danish Ministry of Food, Agriculture and Fisheries, 1999). The concepts of animal needs, natural behavior and animal welfare have been discussed in the context of organic farming in Lund and Röcklinsberg (2001); Algers (2001) and Alrøe et al. (2000, 2001).

On the other hand organic animal husbandry has been strongly criticized, e.g. by veterinarians, who have claimed that organic livestock often are not treated properly when sick because of longer withdrawal times prescribed by the organic standards and because alternative medicine (including methods not recognized by science) is preferred (Anon., 1998) (see Fig. 1).

Also, organic livestock production has been criticized because animals have been malnourished and more infected with parasites because of restrictions in administration of anthelmintics prescribed by national certification bodies (e.g. Anon., 1995; Vaarst et al., 2000). For example, the Swedish certification body KRAV states under the heading Health and medical treatment: 'routine prophylactic treatment with drugs or chemical agents is prohibited'. As pointed out by Lund and Röcklinsberg (2001) there is a conflict in the basic organic ideology between the aim of good individual animal health and welfare versus environmental concerns and food safety. The question is how these conflicts have been solved in practice and what the health and welfare of organic livestock actually is like.

The aim of this paper is to review relevant scientific literature focusing on animal health and welfare in organic farming. We also discuss some background issues that may explain the current research situation and suggest some factors that should be considered when presenting or interpreting results from organic livestock research.

2. Methods

The literature review was performed in October–November 2001. The following databases were searched: Agricola, Agris, Biological Abstracts, CAB Abstracts and ISI databases. The search was limited to literature published since 1991 in English, German, French and the Scandinavian languages. All livestock species were included in the review. The following search words were used and matched with all categories of livestock (beef, dairy, pigs, etc.): (organic or ecological) and (agriculture or farming) and (welfare or disease or health). Only articles published in the peer-reviewed scientific press were included. Also, requests were sent to some key persons (in Denmark, Sweden, Norway, Germany and England), asking if they knew of articles accepted for publication recently. Some of these in turn circulated it within their research departments. Five articles were found that way. However, we have most probably not been able to capture all submitted articles.

3. Results

Only 22 papers were found. Of these, seven deal with parasitology and 13 with health in organic dairy production (other than parasitology); one analyzes slaughter data for cattle, pigs and sheep; one is a questionnaire study of health in organic poultry production. In addition there are two overview papers, one on parasitology and one giving a general overview of health and welfare in organic livestock systems. No paper focused on aspects of welfare other than health. The earliest articles were published in 1996. All studies but one were performed in Europe (Table 1). Denmark and Sweden have the most published papers dealing with organic livestock farming.

Ten studies compared organic and conventional production. However, most were retrospective cohort studies with relatively small samples, and the analyses were not adjusted for time since conversion.

3.1. Papers on dairy production

Out of 13 articles dealing with dairy production, only five were comparative studies that also included conventional farms. Two of these were done in Norway and two in Denmark.

3.1.1. Comparative studies

One Norwegian study compared the frequencies of mastitis, ketosis and milk fever from 1994 to 1997, analyzing data from the Norwegian Dairy Herd Recording (Hardeng and Edge, 2001). All certified herds in 1994 with more than five cows were included, a total of 31 herds. Three conventional herds, matched on size and region, were randomly selected for each organic herd. Several interesting differences in management and feeding regime between organic and conventional herds also were noted. In conventional husbandry, 75% of the ration (based on energy) consisted of concentrates and silage, whereas in organic feeding these were only about 50% of the ration, while hay, pasture and root

Table 1
Published articles, countries of origin and topics

Country	No. of articles	Topics		
		Dairy	Parasites	Others
Denmark	8	5	3	
Sweden	8	2	4	1 Poultry health 1 Carcass quality
Norway	2	2		
Germany	2	1		1 Overview: animal health and welfare in organic livestock farming
Great Britain	2	2		
Switzerland	1	1		
New Zealand	1		1	
Total	24	13	8	3

crops also were important. In addition to summer grazing, most organic cows exercised outdoors for at least 30 min daily, a practice that is rare in conventional herds. Organic cows were significantly older (mean lactation number was 2.97 compared with 2.35), had a larger proportion of spring calving, and had a lower average yield [4784 compared to 6129 kg energy corrected milk (ECM) per cow per year]. Breed composition was more complex in organic herds, with indigenous breeds more common.

The study demonstrated comparatively better health performance in organic husbandry, particularly in relation to ketosis and mastitis, but also for milk fever (odds ratios were 0.33, 0.38 and 0.60, respectively). There was no marked difference in milk somatic cell count between the organic and conventional herds, which implies that the lower veterinary treatment did not lead to more chronic subclinical mastitis. As for milk fever, the lower maximum milk yield for organic cows explains some of the difference (4.6 kg/day less than in conventional herds).

The other Norwegian study used the same data source but focused on reproductive performance (Reksen et al., 1999). A total of 29 organic and 87 conventional herds were compared over 3 years, from 1994 to 1996. The herds were matched by size and geographical distribution.

Natural breeding was used more in the organic herds, accounting for 19–27% of pregnancies compared with 3–5% in the conventional herds. Annual replacement was 23% in the organic herds compared with 35% in the conventional herds. When adjustments were made for milk yield, breeding season, service and parity, the reproductive efficiency of the organic cows was significantly impaired during the winter compared with the conventional cows. This was because the cows' energy needs could not be met during winter with the feeding regimens used (a maximum of 20% concentrates was used).

The third comparative article is a Danish study of sole disorders in seven organic and six conventional herds with a total of 974 cows, performed from 1991 to 1993 (Vaarst et al., 1998). Herd was a strong risk factor, but no significant differences were found between housing systems or between organic and conventional herds.

Vaarst and Bennedsgaard (2001) discuss results from three Danish studies that focus on mastitis and use of medication in organic and conventional herds. They report that no significant differences could be found with regard to either incidence of mastitis treatments or somatic cell counts in 27 organic and 57 conventional herds. There was a marked tendency for shorter treatment periods for mastitis on organic farms (1.9 days vs. 3.2 days), although the sample was small (five organic and seven conventional herds). They found no 'specifically organic' treatment patterns among the studied farms. Vaarst and Bennedsgaard stress the importance of co-operation between the farmer and the veterinarian and the need for the latter also to 'convert' his or her thinking to find solutions appropriate to the goals and intentions of the organic farmer as well as to organic farming in general.

A study of the composition of raw milk from sustainable production systems compared 31 organic herds in Sweden with the same number of similar, conventional herds (Toledo et al., 2002). Somatic cell counts were low in both types of herds. Small organic herds had significantly lower cell counts than small conventional herds ($P < 0.05$). Also urea levels were significantly lower on organic farms ($P < 0.001$ and $P < 0.01$ for small and big organic farms compared with similar conventional farms).

3.1.2. Other studies

One of the first published studies that included health in organic herds is a German investigation done in 1992, where 268 organic dairy farmers with at least 10 cows were interviewed regarding feeding and management practices (Krutzinna et al., 1996). A high percentage of these farms completed their conversion only shortly before the investigation. The average milk yield was 4941 kg per cow per year and the average age was 5.7 years, compared with the German average of 5.3 years. (No information was given regarding the average yield of conventional cows.) The longer the farm was run organically, the older the cows were. (Few other comparisons were made with conventional rearing conditions or yields.) The importance of various herd health problems as ranked by the farmers was the same as in conventional agriculture: in descending order, the main problems were mastitis, fertility disorder and hoof diseases. Diseases were treated with various

methods, including conventional medicine (53%). The authors judged that the only area where the organic cows seemed to be in better health was metabolic disorders (ketosis and milk fever).

Two British studies monitored the health situation on organic farms in England and Wales with the aim of determining overall health status. The first was a 2-year study from 1993 to 1995, where animal health records were collected from 11 dairy herds (Weller and Cooper, 1996). The farms were either in the process of converting or had recently converted. Herd size ranged from 42 to 303 cows. The majority of herds had an all-year calving pattern and were housed in either straw-bedded cubicles or covered yards. No major health problems were recorded on the farms. The main health problem was clinical mastitis. Several farms used alternative treatments, but on the majority of farms antibiotics were used to treat the more severe cases. The authors estimated the recorded number of cases of lameness and ketosis to be relatively low.

The second British study was performed in 1995–1998 and included ten organic farms that were converted between 1991 and 1996 (Weller and Bowling, 2000). Herd size and other herd conditions were similar to the previous study. Average milk yield ranged from 5000 to 6000 l. Clinical mastitis was found to be the major health problem. The study showed differences between farms in the incidence of specific health problems and also in how diseases were treated; 34.4% of all ailments were treated with alternative remedies. The authors judged the health problems to be similar to or less than on conventional farms.

A study of clinical mastitis in 14 Danish organic dairy herds was performed between 1991 and 1993 (Vaarst et al., 1993; Vaarst and Enevoldsen, 1997). The objective of the study was to obtain a comprehensive description of clinical mastitis cases. However, not much information was given about the farms and no comparisons with conventional herds were made in this study. The latter is also the case in a study performed in 1997 to estimate the prevalence and investigate the etiology of subclinical mastitis in Swiss organic dairy herds (Busato et al., 2000). A random and stratified sample of 152 farms was visited twice during the year. There were big differences among the farms, since some had converted recently, mainly because government subsidies had been introduced, while others were pioneers sticking firm to organic principles. The average herd had 12.8 cows, which is equal to the Swiss average, but milk production was 16% lower. The authors conclude that there was a high prevalence of subclinical mastitis in these herds. There were especially high prevalences of contagious udder pathogens and high SCC in alpine dairies. Methods of prevention and therapy were mostly based on conventional procedures.

A Synthesis of Knowledge project on dairy cattle health and welfare was carried out in Denmark (Vaarst et al., 2001). Based on qualitative research interviews with veterinarians and agricultural advisors and on focus group interviews with newly converted organic farmers, an expert panel worked to find solutions to problem areas. Problems were related to adjustment to a new and unfamiliar practice, management in general, and inappropriate legislation for organic farming. Mastitis was mentioned as the most severe disease problem among dairy cows both before and after conversion. However, the biggest health and welfare problems were found among organic calves, particularly in the areas of group housing and grazing.

In Sweden, 26 organic dairy herds were studied for 1 year (Hamilton et al., 2002). Herds ranged in size from 12 to 64 cows and milk production from 3772 to 10 334 kg ECM per cow per year. Calves did not seem to be a big problem in these herds; they were in good condition in all but four herds, and young stock were in good shape and had good housing in all but six herds. No cows were found with symptoms of metabolic disorders. Body condition scores were adequate or good, except in two herds. Only sporadic cases of increased levels of acetone were found in the milk. Incidences of diseases treated by veterinarians were lower in these organic herds compared with the average in the local dairy association. The authors conclude that a good standard of health and welfare can be achieved in organic dairy herds.

3.2. Papers on parasitology

Seven studies deal with parasitological aspects of animal health. They cover several types of pro-

duction (poultry, sheep, sheep/beef and dairy). In addition there is an article giving an overview of the current situation and future prospects (Table 2).

3.2.1. Prevalence studies

Four studies looked at prevalence of parasites in organic herds (cattle, pigs, poultry and sheep).

Table 2
Overview of articles dealing with parasitological aspects of organic livestock production

Authors, year of publication	Country, year when study took place	Type of production	Description of study	Comparative study
Carstensen et al., 2002	Denmark 1999	Pigs	Prevalence of pig ectoparasites and sampling of parasite egg/larvae in pasture and pig feces in nine organic herds. Five visits per farm during March to October 1999	No
Dimander et al., 2000	Sweden 1997–98	Cattle	Grazing experiment over two seasons with young cattle on seminatural pasture lands Animals were infected with trichostrongylid larvae at turnout. Comparisons were made between groups that were either untreated and set-stocked, ivermectin bolus treated and set-stocked or untreated but moved in mid-July to ungrazed pasture	Yes
Höglund et al., 2001	Sweden 1997–98	Cattle	Status of internal parasitism on 15 organic cattle enterprises and evaluation of some management practices for parasite control Faecal samples and blood samples were analyzed Weight was recorded for first- and second-grazing season cattle	No
Lindqvist et al., 2001	Sweden 1997–99	Sheep	Prevalence of nematode infections. Fecal samples from 152 organic flocks: in each eight individuals were sampled according to a schedule	No
Niezen et al., 1996	New Zealand 1989–92	Sheep and cattle	On farm-study: control of parasites through integrated grazing management and breeding for resistance. Two studies are reported: A 3-year comparative study on a research farm in 'hill country' split into two identical units (organic and conventional). Extensive production A 2-year study on an organic research farm in the lowlands. Intensive production	Yes No
Permin et al., 1999	Denmark 1994–95	Hens	Prevalence of helminths 268 hens from 16 flocks/4 rearing systems studied during 1 year Examination of the trachea and gastrointestinal tract of each bird	Yes
Svensson et al., 2000	Sweden 1997	Dairy	Questionnaire study comparing methods of parasite control in organic and conventional herds 162 organic and 162 conventional farms (response rates: 84% and 72%)	Yes
Thamsborg et al., 1999	(Denmark)	Overview, all species	Literature study; discusses the possibilities for coping with parasites in organic rearing systems	

Results obtained by Höglund et al. (2001) indicate that dictyocaulosis is a problem in organic dairy herds in Sweden. Carstensen et al. (2002) found organic pigs had higher infection rates with helminth parasites compared to sows and pigs housed indoor in intensive systems (comparisons were made with a study by Roepstorff et al., 1998). Organic pigs were infected with *Ascaris suum* (28% of weaners, 33% of fatteners and 4% of sows), *Trichuris suis* (4% of weaners, 13% of fatteners, $<1\%$ of sows) and *Oesophagostomum* spp. (5% of weaners, 14% of fatteners, 20% of sows). No infections with *Hyostrongulus rubidus*, *Metastrongylus* spp. or *Strongyloides ransomi* were found in spite of fears that these species would increase as a result of the outdoor rearing. Results may reflect that a majority of herds had had outdoor pigs for only a few years. However, the prevalences were generally lower than those found in Danish organic farms surveyed in 1990 and 1991 (Roepstorff et al., 1992). The authors interpret this as due to better pasture rotation and improved hygiene in the housing of sows and piglets, in addition to better buildings in general. Single herd cases of exceptionally high infection levels could be explained by inexpedient management routines or by long time of recurrent use of the pasture for grazing pigs. No lice or scab were found on pigs.

Permin et al. (1999) compared the prevalence of gastrointestinal helminths among Danish poultry production systems. The study included broiler parent stock, commercial table egg production, and backyard chickens. The table egg production included three different systems: battery cage, deep-litter, and free range/organic. There was a higher risk of helminth infection in the free range/organic and backyard systems, but the prevalence also could be high in deep-litter systems. In the battery cage and broiler parent systems, helminths were rarely found.

Lindqvist et al. (2001) studied the prevalence of nematode infections in organically raised sheep in Sweden. They also studied management practices to relate them to parasite infections. A high proportion of flocks were infected with nematodes. Clinical outbreaks in lambs were highly dependent on egg output from the ewes. Even though infections of ewes could be considered moderate, the authors point out the risk that the infections will cause the parasite population to build up, which would significantly affect lamb growth. Lambs turned out onto permanent pastures showed higher counts of fecal nematode eggs than lambs that had grazed on pastures that had not carried sheep the previous year, even if the ewes were treated with anthelmintics before turnout.

3.2.2. Research on management strategies

Niezen et al. (1996) reported on 3 years of practical experience with lamb and cattle production without anthelmintics on two New Zealand research farms. In both farms, the switch to organic production caused only slight production losses. Acceptable productivity could be achieved more easily in sheep than in cattle. The authors were cautiously optimistic regarding the possibilities for developing future production systems that can insure farmers reliable economic returns comparable to those from conventional production. They ask for an integrated effort from parasitologists, plant breeders, nutritionists and systems researchers to find alternatives to current chemical methods for parasite control.

A Swedish questionnaire study compared methods and the magnitude of parasitic infections in dairy production (Svensson et al., 2000). Organic farmers had a greater awareness of various worm control strategies. They combined two or more grazing management strategies significantly more often (on average 2.4 different strategies compared to 1.0 for conventional farmers) but still seemed to have greater problems with parasite infections than did conventional farmers. Of the conventional farmers, 58% reported that they treated their animals prophylactically, mainly with controlled-release intra-ruminal devices. The most common prophylactic procedure on organic farms was to turn calves out on pastures not grazed by any cattle in the current or previous grazing season. This method was used on 40% of the organic farms, but on only 3% of the conventional farms. However, Höglund et al. (2001) concluded from a study of 15 Swedish organic dairy herds that good management—such as usage of parasite safe pastures and supplementary feeding—may help control gastrointestinal parasites. Dimander et al. (2000) found that early season grazing by untreated young

cattle resulted in sufficient overwintered trichostrongylidae larvae at the start of the following year to reduce live weight gain in young cattle grazing that year.

3.3. Other papers

3.3.1. Poultry

Berg (2001) sent out a qualitative questionnaire during spring 2000 to all Swedish organic egg producers. Of the 115 producers 49% returned the questionnaire. It was concluded that most of the health and welfare problems seen in conventional poultry systems with loose-housed or free-ranging birds can also be found in organic poultry farms. Organic poultry farmers are often enthusiastic, but sometimes lack basic knowledge. Thus there is a need for information about biosecurity, disease detection, and disease prevention.

3.3.2. Carcass quality

Hansson et al. (2000) compared organic and conventional carcass quality by analyzing all Swedish slaughterhouse statistics from 1997. Meat inspectors from the Swedish National Food Administration register pathological and other findings at a postmortem inspection of all slaughtered animals. The study involved about 3.9 million conventionally reared pigs, 570 000 cattle and 190 000 sheep, and 3484 organically reared pigs, 4949 cattle and 4997 sheep. There was a significant difference at the postmortem inspection of growing-fattening pigs; 28% of the conventional and 17% of the organic pigs had one or more registered lesions. Ascariasis in the liver was the most common pathological finding in the organic pigs (4.1%). In cattle, 28% of the organic and 27% of the conventional animals had registered abnormalities. Parasitic afflictions were more prevalent in organic herds. Eosinophilic myositis also was significantly more prevalent in organically reared cattle. Cows and heifers from organic herds showed significantly lower incidences of abscesses, arthritis, mastitis, and liver diseases such as lipidosis. Pathological findings in sheep were low both for conventional (10%) and organic (9%) animals. The most common finding in the organic sheep was parasitic infections of the liver (1.7%).

3.3.3. Overviews

Two overviews were found, one dealing with parasites (Thamsborg et al., 1999) and one giving a general overview of animal health and welfare in organic farming systems (Sundrum, 2001). These are considered in the Discussion.

4. Discussion

4.1. Development of organic livestock research

The small number of peer-reviewed articles was disappointing and may seem surprising. It can nevertheless be explained in light of the philosophy and development of organic farming, and this information gives an important background to the current research situation. Four factors are discussed below as relevant in this context: (1) the origin of organic farming as a ‘subcultural movement’, (2) the focus on practical problem solving in the early research on organic farming, (3) the perceived difficulty in publishing ‘organic’ results in the scientific press, and (4) the lack of an explicit philosophical basis for the organic animal husbandry.

Organic farming started as a ‘subcultural grass root movement’ (Christensen, 1998). In the beginning, production methods were developed primarily by the farmers themselves or by a few private research institutions (Niggli and Lockeretz, 1996; Wynen, 1997). Universities have generally been slow to follow the organic trend (Lund, 1996; Wynen, 1998; Beus and Dunlap, 1990, 1991) and there has been reluctance among researchers to become involved in organic agriculture because of the difficulties in gaining recognition within the existing professional infrastructure (Wynen, 1997). This means that few ‘career scientists’ focused on organic farming. There is also an abundance of anecdotal evidence about the difficulties in receiving research money for organic farming projects in the early days of organic farming. Wynen (1998) describes the situation as a paradigm shift, where in the beginning only a few scientists take the step towards the new theory, and these are usually considered ‘nonscientific’. The early organic researchers, on the other hand, were not interested in making up to the scientific system

of the time, and this entailed the use of alternative channels for publishing research results [Boehncke, personal communication].

The fact that almost two thirds of the articles in this study deal with parasitology probably reflects the concern among parasitologists regarding development of resistance in parasites controlled by chemical methods. Organic farming is one of the very few large-scale attempts to avoid the development of resistance.

Organic researchers have so far been more interested in solving acute and practical problems than publishing in the scientific press. Those early researchers who devoted themselves to organic farming generally felt an urgent need to find solutions to the many practical problems faced by organic livestock producers (Höök, 1997), rather than giving high priority to the slow and painstaking process of publishing scientific articles. Big studies including comparisons with conventional production systems have not been perceived as relevant by 'organic' researchers (Dlouhý and Nilsson, 1983). One researcher recently commented on the situation: ''Why should we spend half of our meager 'organic' funding mapping the situation in conventional herds?'' [Hovi, personal communication]. Rather, the feeling has been that organic farming should be developed in its own right (Wynen, 1998; Lockeretz and Anderson, 1993).

The early organic scientists claimed it was more difficult to publish articles dealing with organic farming in the established agricultural press (e.g. Youngberg, 1986; MacRae et al., 1989). This is in line with the theory of paradigm shift suggested by Wynen (1998). Two journals for publishing organic farming results[1] were started to counteract this resistance in the established scientific press.

In the early organic farming movement there was outspoken criticism against conventional 'reductionistic' science, which was rejected in favor of more 'holistic' methods to explore reality (e.g. Howard, 1943, pp. 185–186, 189; Hodges, 1982). This resulted in favoring other types of research methods, e.g. on-farm and qualitative studies and participatory research, and this contributed to the difficulties of publishing results in established scientific journals. Perhaps it also can explain why so few of the articles found in this review are comparative and work with classical experimental or epidemiological designs or statistics.

Organic animal husbandry has developed slower than organic plant production. The organic movement has developed primarily from environmental concerns, with an early focus on soil fertility and human health. This has meant that it has been more difficult to agree on guidelines for organic livestock production. For example, the EU regulations on organic livestock production came 8 years later than the regulations for plant production (Anon., 1999). Much of the early organic research was done on farms and by farmers, and it was cheaper and easier to experiment with crops than to design livestock trials. As a result, organic livestock research has lagged far behind organic plant and soil management research. At the first IFOAM Scientific Conference, held in 1977, there was only one paper on animals in the entire proceedings volume (Besson and Vogtmann, 1978). The lack of an explicit philosophical basis for the organic animal husbandry has also contributed to hampering development (Lund and Röcklinsberg, 2001).

The situation for organic livestock farming has however changed radically during the past decade. Organic farming has become mainstream, and thus it challenges not only 'odd thinking' researchers, and in several European countries there now is governmental research funding earmarked for organic farming. The difference between the organic and conventional epistmological approach has diminished. For example, systems research and qualitative methods are now more widely accepted in 'conventional' research. This all means that scientific publication focusing on organic production can be expected to increase significantly in the coming years. As a matter of fact, 10 of the articles in this review were published in 2001 or 2002, and while working on this review we came across another three articles covering organic animal health issues that in November 2001 were submitted for scientific publication. (However, submitted articles were not included in this study.)

[1]Biological Agriculture and Horticulture (UK) in 1982, and American Journal of Alternative Agriculture in 1986.

4.2. Evaluation of organic research

During the work with this article it became apparent that evaluation of organic livestock research requires particular considerations, e.g. when evaluating results from comparative studies, one must be cautious of to what extent these reach beyond systems differences and reveal real health differences. For example, treatment or culling criteria may differ between the systems, which may give misleading results in studies with this focus (Vaarst et al., 2001). Another example is systemic management differences that may affect the outcome, e.g. organic farmers must use milk and not milk powder as calf feed, which may affect tank cell count.

Also, to make a proper evaluation of organic research at all possible, certain general data need to be considered. We suggest that information regarding the following should always be provided with any results from organic systems (which is not generally the case in the articles in this literature search): conversion year, time since conversion, country where the study took place and the particular set of standards applied.

Knowing the conversion year of the studied farms is important for several reasons: (1) the organic standards are revised and changed regularly. (The IFOAM Basic Standards are revised every 2 years.)[2] Thus, it is important to know what practices were or were not allowed during the year(s) of the study, and to consider any implications for livestock health. (2) The general level of development of organic farming practices has changed over time. Especially for organic pigs and poultry, housing and management systems have developed significantly. (3) Organic feedstuffs have become significantly more available in the market, allowing other kinds of diets today. Thus, early results may not be representative of the current situation. (4) The average organic farmer may also have changed over time. Several studies indicate that the type of farmers choosing to be organic has changed from the early, idealistic pioneers who have a profound knowledge of organic 'ideology' (but perhaps have less experience as livestock producers), to farmers who convert mainly because of current favorable economic conditions for organic farming in several countries (Vartdal and Blekesaune, 1992; Lund et al., 2002). If early pioneers were likely to choose other management solutions than the latecomers, this may systematically affect animal health and welfare.

The time since conversion, i.e. since the studied farm(s) converted to organic farming, must be taken into consideration when evaluating the results, since this influences the knowledge and experience of the organic farmer, which in turn may affect herd health. Also, there is the question of whether the effects of conversion on herd health would have sufficient time to become evident.

The country where the study took place is a key piece of information. In addition to differences that always must be considered when comparing results from different countries, such as climate, farm and herd structures, and economic conditions for livestock production, there also are differences specific to organic farming. The IFOAM Basic Standards are interpreted and applied by national certification bodies. Thus, there are differences among the national standards that may be crucial for animal health. For example, Sweden bans the routine use of anthelmintics, but the neighboring country of Norway does not. In sheep production, this creates a major difference regarding health problems. Another example is the withdrawal period after treatment with allopathic medication, which in Sweden is twice the withdrawal period laid down by the Swedish National Food Administration for respective substance (however, it is at least 2 months and for antibiotics and chemotherapeutics it is 6 months) (KRAV, 2001, 5.4.8–12). In contrast, in Denmark the withdrawal period required by the private certification organization under the Danish Association for Organic Farming (LØJ) is three times the withdrawal period laid down by the Danish Veterinary and Food Administration. This difference may well affect how farmers cope with diseases. The use of alternative treatments may differ between countries. For example, Swedish veterinarians are by law forbidden to use any kind of homeopathy, while in Denmark some homeopathic remedies can be sold only with a veterinary prescription.

The general development and understanding of organic farming also differ among different coun-

[2] From 2003 revision will take place every 3 years.

tries. Taking the example of Norway and Sweden again, Norwegian organic farmers have been more consistently idealistic, and in part have had a different understanding of organic farming than in Sweden, where tougher economic conditions for agriculture in general have forced organic farmers to become more pragmatic in order to survive. Thus Norwegian organic dairy farmers have used indigenous breeds and have fed less grain and concentrates, and thus have had much lower yields compared with Swedish herds, which may of course affect health records.

4.3. Discussion of papers

The organic philosophy and standards represent a different approach in animal husbandry, and thus open the possibility of a different spectrum of diseases in organic production. Diseases related to abnormal animal behavior (such as tail biting in pigs), extreme production levels, or feeding regimens not adapted to the biology of the animals are probably less likely to be found in organic production, whereas diseases related to outdoor and loose housing/free range production are likely to be more frequent. Also, the longer withdrawal times and greater restrictions on medicine use prescribed in the standards may also affect animal health and welfare, as may different feeding principles (e.g. the ban on synthetic amino acids and vitamins as feed additives). During conversion, problems may appear since the farmer must learn and adjust to new practices (Vaarst et al., 2001). However, it is important to separate expected effects from actual, documented effects. In a recent Danish study, the concern expressed by some veterinarians that clinical diseases are not treated in organic herds was not found in practice in the majority of Danish organic herds (Vaarst et al., 2001). In the current review, the small number of comparative studies makes it impossible to draw general conclusions regarding animal health in organic production systems. There were only eight comparative studies, and the number of farms included in many studies was small. Also, very few studies focus on pigs and poultry, where the biggest differences in housing and management are to be found compared with conventional farming. Also, in many papers insufficient information is provided regarding conversion years, time since conversion and set of standards used, which also makes it more difficult to draw general conclusions from this material.

The comparatively large number of articles dealing with dairy production can be explained by the fact that this is the major type of organic livestock production. This is partly due to ruminants having a central function in organic farming, since they process the nitrogen-fixing leys necessary in organic crop rotations. But it also is because the differences between organic and conventional methods generally are smaller in dairy production than in pig and poultry production, making it relatively easy for dairy farmers to convert. Only five of the thirteen dairy studies were comparative, and of these the two Norwegian studies analyzed almost the same samples of cows (Hardeng and Edge, 2001; Reksen et al., 1999). A large proportion of these herds were still under conversion or had converted only recently, raising the question of how much the effects of organic management really showed in these herds. A further question is if the registered differences in treatments accurately mirror the difference in disease, or if systemic differences may be affecting the figures.

One comparative study found metabolic disorders (ketosis and milk fever) and mastitis to be less common in organic herds (Hardeng and Edge, 2001), and in one interview study the authors judged metabolic disorders to be the only area where organic cows were in better health (Krutzinna et al., 1996). The low feeding intensity on the Norwegian farms did significantly affect fertility in wintertime, but fertility can hardly be regarded as an indicator of welfare per se.

The two British studies recorded no major health problems in the examined herds (Weller and Cooper, 1996; Weller and Bowling, 2000). With the exception of a Norwegian study (Hardeng and Edge, 2001), mastitis was considered the major health problem in all studies that commented on it. One of the two studies that included dairy calves found that these constituted the biggest welfare problem in organic dairy production (Vaarst et al., 2001). Differences in farmers' awareness in different countries (e.g. depending on the advisory service) could explain some of the differences between the studies.

The parasitological studies revealed a higher prevalence of parasites in organic herds, as could be expected. This was true for pigs (Carstensen et al., 2002), hens (Permin et al., 1999), sheep (Lindqvist et al., 2001), and probably also dairy cattle (Svensson et al., 2000). Also, slaughter statistics show significantly more lesions from parasites in organic sheep, cattle and pig carcasses (Hansson et al., 2000). The animal welfare effects of these parasitic infestations are difficult to judge, however, at least for pigs and poultry [Thamsborg, personal communication]. But parasite infestation can be regarded as a risk factor for animal welfare even though no symptoms show, since a clinical outbreak may occur if, for example, the animal's general condition is impaired for other reasons.

Good management can bring down infections (Dimander et al., 2000; Höglund et al., 2001; Carstensen et al., 2002), and most authors are cautiously optimistic regarding future possibilities for coping with parasites in ways that are acceptable according to the organic standards (Niezen et al., 1996; Thamsborg et al., 1999). Thamsborg et al. (1999) conducted an extensive overview regarding the possibilities for developing methods for parasite control without using anthelmintics. They concluded that the prospects for controlling many nematode infections are good, but more research is needed under practical farming conditions. In a short-to-medium-term perspective, integrated control may combine grazing management with biological control using nematophagous microfungi and selected crops such as tanniferous plants.

A very cautious conclusion regarding animal health in organic systems based on this literature study is that parasite problems tend to be worse but that other health traits tend to be the same or better in organic farming compared with conventional. This is not surprising. As pointed out by Sundrum (2001), the organic standards provide several preconditions for good living conditions of farm animals and for practices aimed at improved welfare and health. However, parasite management is an area of conflicting interests: the aim of not using chemical treatments that may pollute the environment, cause resistance among parasites, and perhaps leave residues in the feed (a question of food safety and consumer confidence) conflicts with the animal welfare aim. The same is true for the use of antibiotics. These conflicts may be solved in the long term, but until then organic farmers and certification organizations should keep a close watch on this problem to avoid serious welfare consequences. Sundrum (2001) suggests the establishment of quality assurance programs, especially since organic farming places stronger demands on the qualifications of the farm management, including the higher risk of failing. Good advisory service and education of farmers are also important (see also Berg, 2001; Vaarst et al., 2001).

Health can be regarded as an important aspect when evaluating welfare (Broom, 1996); however, it is not the only one. For example, Broom has stressed the animal's ability to adapt to and cope with its environment as crucial for animal welfare. The papers found in this review give little information regarding this aspect of welfare. Also, there are no published behavioral studies comparing organic and conventional farms, although natural behavior is central in the organic understanding of animal welfare (Lund and Röcklinsberg, 2001; Alrøe et al., 2001). Of course, there have been many studies of animal behavioral needs, the effects of indoor and outdoor conditions, etc., on conventional farms, but there is a need to study whether or not well-established organic farms offer a better possibility for the animals to fulfil their behavioral needs (including feed that is natural to the species) and still maintain good health.

5. Conclusions

This literature review on organic animal health and welfare yielded only 22 peer-reviewed articles, none of which had a specific focus on behavior or welfare aspects other than health. The small number may be explained in the light of the philosophy and history of organic farming, and scientific publication dealing with organic systems can be expected to increase significantly in the coming years. Information regarding conversion year, time since conversion, country where the study took place and the particular set of standards applied must be provided together with research results. The papers found were mainly dealing with dairy production and

parasitology. Only ten articles were comparative studies of organic and conventional herds. None of the published articles found indications that health is worse in organic than in conventional livestock farming, with the exception of parasite-related diseases. Rather, in other aspects the tendency is that health and welfare in organic herds are the same as or better than in conventional herds. However, there is still lack of substantial evidence to allow general conclusions regarding animal welfare in organic farming.

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