Parasite control methods in organic and conventional dairy herds in Sweden

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Abstract

The objectives of this study were to compare methods of parasite control and to get an indication of the magnitude of parasite infections in organic and conventional dairy herds in Sweden. In February 1997, a questionnaire with mainly multiple choice alternatives was distributed to 162 organic and 162 conventional dairy farms in central Sweden. The response rates were 84% and 72%, respectively. A majority (58%) of the conventional farmers reported that their animals were treated prophylactically, mainly with controlled-release intraruminal devices. In organic production, parasite control methods involving grazing management combined with nutritional supplementation with concentrates and/or forage was the most frequently reported anti-parasite strategy. The most common procedure was to turn calves out on pastures not grazed by any cattle in the current or previous grazing seasons. This was employed by significantly more organic than conventional farms (40% vs. 3%), as was alternating grazing with other livestock species (27% vs. 3%). Sixty percent of the organic and 52% of the conventional farmers reported that they used nutritional supplementation in the autumn, and 48% and 29% of the producers, respectively, that they used nutritional supplementation in the spring, as methods to restrict parasite problems in their calves. Outbreaks of diarrhoea in first grazing season cattle and a lower weight gain during the grazing season than in the previous winter season, problems that may be due to parasite infections, were reported more frequently from organic herds. Despite an apparently increased awareness of various worm control strategies, organic farmers thus seemed to have greater problems with parasite infections than did conventional farmers. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Cattle; Dairy cattle; Parasite control; Grazing management; Organic farming

1. Introduction

Internal parasitic infection constitutes the major health problem in first grazing season (FGS) cattle and is recognized world-wide as the greatest cause of lost productivity in these animals (Sykes, 1994). The most important parasites of cattle in temperate climatic regions are the gastrointestinal nematodes, primarily Ostertagia ostertagi, but also to some extent Cooperia oncophora (Corwin, 1997), and the

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lungworm *Dictyocaulus viviparus* (Eysker, 1994). Infections with these parasites are rarely lethal but can occasion substantial losses in productivity from usually subclinical infections. Recently, the coccidia *Eimeria alabamensis* was identified as a cause of diarrhea in young calves immediately following turn-out (Svensson et al., 1994). *Fasciola hepatica* and *Parafilaria bovicola* are also of economic importance as they can result in the condemning of meat and offals. External parasites may also cause disease problems, especially during the housing period in late winter and early spring. To avoid ill-health and to maintain productivity it is essential to ensure good parasite control.

Schemes to combat nematode parasites in conventional dairy production in western Europe often include anthelmintics as an integral component (Shaw et al., 1998). In Scandinavia, the programmes are directed almost exclusively towards FGS calves, as this group is the most important in terms of susceptibility to infection (Nansen, 1993). However, the threat of anthelmintic resistance and the increasing awareness of waste products in the food put the use of prophylactic anthelmintic treatment in question, and give topical interest to non-chemotherapeutic approaches to worm control. There is an increasing demand for organically produced agricultural commodities and organic dairy farming has increased considerably in recent years; in Sweden, there were 11,500 cows on 360 farms raised according to organic farming criteria in 1997 (Anon., 1998a). Chemoprophylaxis as a means of nematode parasite control is prohibited in organic livestock production (Anon., 1998b). Instead, grazing cattle must be managed in such a way that no need arises for preventive medical treatment. Consequently, there is an urgent need for the promotion of non-chemotherapeutic alternatives and also to encourage a greater degree of sophistication in the ways in which anthelmintics are used in livestock management systems.

The purpose of this questionnaire study was to gather information on parasite control strategies employed by organic and conventional Swedish dairy farmers and to get an indication of the magnitude of parasite infections on the two types of farms.

2. Materials and methods

2.1. Questionnaire study

In February 1997, a form including a covering letter and a questionnaire was posted to producers contracted to supply whole milk to Sweden’s largest dairy company, Arla (Fig. 1). Information on the background to and the purpose of the study was presented, anonymity of those responding was assured and guidance was given regarding how to

[Fig. 1. Map of Sweden, showing the region where the Arla dairy company operates and hence where the study was performed, and the climatic zones within this area (modified after the Swedish Society for Horticulture). The black zones represents lakes.]
complete the questionnaire and how to obtain information about the results. Altogether 162 forms were posted to all farms that on May 1, 1996 were contracted for organic production (Fig. 2a), and to 162 conventional producers randomly selected from the 9364 conventional farmers that were registered as suppliers to Arla on February 1, 1997 (Fig. 2b). Farmers who did not respond were reminded on up to two occasions.

The questionnaire comprised 26 questions; 19 in the form of multiple choice alternatives and seven in the form of sentences where numbers of animals, kilograms of milk or area of the farm should be written into the blank spaces (Fig. 3). The questions concerned: farm and herd size, milk production, dates of turn-out and housing, type and area of pasture grazed by first-season grazers, and the farmers’ perception of the presence of parasitic diseases. Detailed information was also gathered about grazing routines and in particular, parasite control methods employed during the 1996 grazing season. In addition, conventional farmers were interviewed about their use of anthelmintic compounds. Information about any of these issues were not given on the questionnaire form or in the covering letter. Before the study the procedure was tested on ten farmers and amended whenever and where ambiguity existed.

The data obtained from this survey were expressed in relation to organic and conventional farms. The data were also divided into two categories according to whether or not the farmer had reported the 1996 year FGS calves to have a lower growth rate in the grazing season than in the preceding winter season and/or to have diarrhoea on pasture (Questions 18–19; Fig. 3). The term diarrhoea was not further defined in the questionnaire. The two categories as well as the groups of organic and conventional farms were compared regarding parasite control strategies and especially grazing management routines.

2.2. Statistical evaluation

Excel 5.0 (Microsoft) was used for data summary and in the descriptive analyses. Differences between organic and conventional farms regarding use of pastures, turn-out and housing dates, parasite control strategies and episodes of parasitic diseases were analysed with the Chi-square ($\chi^2$) test or Fisher’s exact test. Quantitative data, such as the area of the different types of farmland, milk production and group size, were compared with the Mann–Whitney U-test. Statistical analyses were made using StatView™ 4.1 (Abacus Concepts), and considered significant at the $P \leq 0.05$ level.

3. Results

3.1. Experimental farms

Altogether 135 (83%) of the organic and 115 (71%) of the conventional producers completed the questionnaire. The response rate to specific questions varied between 66% and 83% for organic producers and between 52% and 70% for conventional farmers. The questions with the lowest response rates concerned pasture area, average milk production, age at first calving and parasite-induced damages at slaughter. The percentages given below have been calculated using the number of farmers responding to each question as the denominator.

Organic producers reported that they had adhered to organic farming principles for between 13 months and 29 years (median 25 months). The average herd size was similar in both types of herd, viz. about 28 cows (Table 1). In both farming systems about half of the herds were a mixture of Swedish Red and White breed (SRB) and Swedish Friesian breed (SLB). Thirty-eight (29%) of the organic and 24 (21%) of the conventional producers reported that they had single breed herds with SRB animals, and 19 (15%) organic and 30 (27%) conventional farmers had single breed herds with SLB animals.

The area of cultivated land was significantly larger on organic farms ($Z = -4.24; P < 0.001$), due mainly to a greater access to pastures and ley (Table 1). Annual milk production, expressed in kilograms of energy corrected milk (ECM), was significantly lower ($Z = -5.29; P < 0.001$) in organic herds (6721±SD 1056) than in conventional herds (7729±SD 1367). The average age at calving was
Fig. 2. The geographic distribution of the 162 organic herds that on May 1 1996 were contracted for organic production by Arla dairy company (a) and the 9364 conventional farms which supplied milk to Arla on February 1st 1997 (b).
8. During 1996 _____ first grazing season calves were turned out to pasture, _____ of which were heifers and _____ bulls/steers.

16. Which strategy do you use to restrict parasite problems in your first grazing season calves during the grazing period?

[ ] none
[ ] deworm when the animals have diarrhoea or coughing
[ ] deworm prophylactically (without the animals being ill)

[ ] change pasture every or every other year
[ ] change pasture within the grazing season

[ ] the first grazing season calves graze together with second season grazing cattle or cows
[ ] the first grazing season calves graze together with other livestock species

[ ] second grazing season cattle or cows graze on the pastures before or after the first grazing season calves
[ ] sheep, horses or swine use the pastures before or after the first grazing season calves

[ ] delayed turnout until 25th of June
[ ] the pasture for first grazing season calves is first used for harvest of hay or silage
[ ] the pasture for first grazing season calves is ploughed

[ ] give supplemented feeding (hay/silage, concentrates) in the spring
[ ] give supplemented feeding (hay/silage, concentrates) in the autumn
[ ] other strategy, namely ____________________________

18. Did the 1996 year first grazing season calves have a decreased growth rate in the grazing season compared to the growth rate in the preceding winter season?

[ ] yes, mildly decreased
[ ] yes, moderately to severely decreased
[ ] no
[ ] I do not know

19. Did the 1996 year first grazing season calves have diarrhoea on the pasture?

[ ] yes, during the first two weeks after turnout
[ ] yes, in the end of the grazing season
[ ] yes, by __________________________
[ ] no
[ ] I do not know

Fig. 3. Parts of the questionnaire form sent out to 162 organic and 162 conventional dairy farmers. (In translation).
Table 1
The 25th, 50th and 75th percentiles (PC) for herd size, total cultivated area, areas for grain cultivation, ley and cultivated and natural grazing land (ha.) of 135 organic and 115 conventional dairy herds

<table>
<thead>
<tr>
<th></th>
<th>Organic farms</th>
<th></th>
<th>Conventional farms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 PC</td>
<td>50 PC</td>
<td>75 PC</td>
<td>25 PC</td>
</tr>
<tr>
<td>Number of cows</td>
<td>20.5</td>
<td>28</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Total area</td>
<td>54</td>
<td>75$^a$</td>
<td>107</td>
<td>35</td>
</tr>
<tr>
<td>Grain cultivation</td>
<td>11</td>
<td>20</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Ley</td>
<td>20</td>
<td>29$^b$</td>
<td>40</td>
<td>13</td>
</tr>
<tr>
<td>Cultivated grazing land</td>
<td>5</td>
<td>11$^c$</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Natural grazing land</td>
<td>7</td>
<td>15$^d$</td>
<td>24</td>
<td>3</td>
</tr>
</tbody>
</table>

$^a$ Different letters within the same row indicate significant differences at the 5% level.

27.2 in conventional herds and 27.5 months in organic herds.

3.2. Pastures utilized by first grazing season calves

In both farming systems, calves were reported to graze mainly natural pasturelands. Altogether 104 (77%) of the organic producers had natural pastureland for their calves, 77 (57%) used cultivated grazing lands, 67 (50%) used ley, while 11 (8%) kept their animals on other kinds of pasture. Calves grazed natural pastureland on 82 (71%) of the conventional farms, cultivated grazing lands on 54 (47%) farms, ley on 54 (47%) and other types of pastures on four (3%) of the farms. Of the organic farmers, 74 (56%) used one to two paddocks per group of calves, and 40 (37%) used three to four paddocks. Similar figures were recorded on conventional farms; viz. 62 (57%) used one to two paddocks and 47 (35%) used three to four.

3.3. Grazing animals

Male calves were turned out significantly more often ($\chi^2 = 14.71; P < 0.001$) in organic than in conventional production, i.e. on 74 (55%) compared with 34 (30%) farms, respectively. In addition, other livestock species grazed on the same pastures as FGS cattle were turned out on pasture between May 15 and June 20 (Fig. 4). In 1996, there was a tendency ($\chi^2 = 3.56; P = 0.059$) for calves on organic farms to be turned out after 20 June more often than calves on conventional farms. However, significantly ($\chi^2 = 4.15; P = 0.042$) fewer organic producers turned all their FGS animals out simultaneously (43% vs. 57%). Organic farmers also seemed to house their calves earlier in autumn. The cattle were housed in September on 62 (46%) of the organic farms and on 36 (32%) of the conventional farms and in October on 74 (55%) organic and 74...
Fig. 4. Dates of turn-out of groups of first grazing season calves in 133 organic and 112 conventional dairy herds in 1996. Calves were turned out in more than one group on 75 (56%) of the organic and 48 (43%) of the conventional dairy farms.

Table 2
Strategies for parasite control in organic and conventional dairy herds (terminology according to Michel (1985))

<table>
<thead>
<tr>
<th>Parasite control strategy</th>
<th>Organic farms</th>
<th>Conventional farms</th>
<th>Probability rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthelmintics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prophylactic treatment</td>
<td>65 (58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventative grazing management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change of pastures between seasons</td>
<td>54 (40)</td>
<td>3 (3)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Delayed turn-out</td>
<td>36 (27)</td>
<td>19 (17)</td>
<td>P = 0.095</td>
</tr>
<tr>
<td>Use of aftermath</td>
<td>39 (29)</td>
<td>8 (7)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Ploughing of pasture</td>
<td>7 (5)</td>
<td>3 (3)</td>
<td>P = 0.36</td>
</tr>
<tr>
<td>Diluting grazing management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed grazing, older cattle</td>
<td>23 (17)</td>
<td>17 (15)</td>
<td>P = 0.82</td>
</tr>
<tr>
<td>Mixed grazing, other species</td>
<td>16 (12)</td>
<td>1 (1)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Alternate grazing, older cattle</td>
<td>8 (6)</td>
<td>5 (5)</td>
<td>P = 0.82</td>
</tr>
<tr>
<td>Alternate grazing, other species</td>
<td>37 (27)</td>
<td>3 (3)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Evasive grazing management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change of pasture within season</td>
<td>54 (40)</td>
<td>22 (20)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Nutrition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplementary feeding in the spring</td>
<td>65 (48)</td>
<td>32 (29)</td>
<td>P = 0.003</td>
</tr>
<tr>
<td>Supplementary feeding in the autumn</td>
<td>81 (60)</td>
<td>58 (52)</td>
<td>P = 0.24</td>
</tr>
</tbody>
</table>

*Note that prophylactic treatment with anthelmintics is banned in organic farming according to the Swedish regulatory authority for organic animal production (KRAV).
(67%) conventional farms. However, 23 of 111 (17%) organic and 10 of 134 (9%) conventional producers housed their groups of calves within different months. All FGS calves were housed during the same week on 124 (55%) of the organic and conventional farms.

3.5. Parasite control strategies

Among conventional farmers, 65 (58%) reported that prophylactic anthelmintic treatment, was their main parasite control method (Table 2). Among organic farmers, on the other hand, the most chosen alternative among the potential control methods listed in the questionnaire as to limit parasite problems in FGS calves in the grazing season (Question 16; Fig. 3), was nutritional supplementation of the calves with concentrates and/or forage in the spring or in the autumn. The alternative was chosen by 97 (72%) of the farmers. The corresponding figure for conventional farms was 60 (54%), which gave a significant difference ($\chi^2 = 8.06; P = 0.005$).

Many organic farmers replied that they used grazing management for parasite control. The most common methods were to graze areas not used by any cattle in the current and previous grazing seasons or to change pasture within the grazing season. Both strategies were reported significantly more often ($\chi^2 = 48.03, 10.97; P < 0.001$) by organic than by conventional producers (Table 2). The preventive strategy to graze aftermath, i.e. fields where hay or silage have been harvested previously in the season, was reported more commonly by organic farmers ($\chi^2 = 17.40; P < 0.001$).

On conventional farms, pastures used by FGS calves in 1996 had been grazed by FGS calves previously in 1994 and 1995 to a greater extent than on organic farms ($\chi^2 = 20.28; P < 0.001$). Sixty-three (49%) of the organic producers and 94 (85%) of the conventional farmers had used the same pasture for their first-season grazers for two consecutive seasons, while 57 (45%) and 87 (80%) had done so for more than 2 years. However, 47 (82%) of the 57 organic farmers who kept their FGS cattle on the same pasture between 1994 and 1996, reported that they had also used the fields for grazing older cattle, sheep and horses or for other purposes such as cutting grass for silage. The corresponding number of conventional farms was 48 (55%).

In addition, the use of grazing strategies designed to dilute pasture contamination, such as mixed and/or alternate grazing with other livestock species, were reported by significantly more organic farmers ($\chi^2 = 32.93; P < 0.001; Table 2$) However, mixed and/or alternate grazing between calves and older cattle was reported to a similar extent in both farming systems (Table 2). In 1996, calves on 52% of both organic and conventional farms were periodically grazing the same pastures as mature cattle.

Organic producers combined two or more grazing management strategies significantly more often ($Z = -7.77; P < 0.0001$) than conventional producers. They used on average 2.4 different strategies, while the corresponding number for conventional producers was 1.0.

Only six (4%) of the organic farmers and 15 (13%) conventional ones reported that they did not take any measures at all to control gastrointestinal parasites in their FGS calves.

3.6. Anthelmintic usage

Forty-nine (38%) of the organic producers based their parasite control on prophylactic use of anthelmintics before they became organic producers and were contracted by the Swedish regulatory authority for organic animal production (KRAV). Once this association is established, farmers are required not to use chemophylaxis, though 18 (13%) of them reported that they have had to treat clinical gastrointestinal nematodoses since their association with KRAV.

During the 1996 grazing season, 63 (56%) conventional farmers used prophylactic anthelmintic treatment of their FGS animals and 54 of these (86%) treated the whole group simultaneously. It was notified that veterinarians performed the dosing on one-fourth of the farms. Slow-release intraruminal devices, containing either morantel, oxendazol or ivermectin, were the most commonly administered drugs and were used in 45 (68%) of the herds. These bolus were administered at turn-out according to
manufacturers’ recommendations. Other formulations of macrocyclic lactones were used in 11 (17%) herds, either as pour-ons, eight (13%), or by injection, three (5%). Oral formulations of benzimidazoles or tetrahydropyrimidines (i.e. pyrantel) were used in 15 (23%) of the herds. It was found that farmers used these compounds inadequately in about half of the cases. The most common neglect was to dose the animals once instead of the recommended two anthelmintic treatments, 3 weeks apart. In some herds, different types of anthelmintics were applied to different groups of calves.

3.7. Helminthoses

Organic producers reported significantly more often ($\chi^2 = 7.60; P = 0.006$) than conventional farmers that their calves had a lower weight gain in the 1996 grazing season compared to their weight gain in the previous winter season; 22 (17%) of the organic compared to five (5%) of the conventional producers. There was also a tendency ($\chi^2 = 3.25; P = 0.071$) for organic producers to more frequently than conventional farmers have reported that they had observed diarrhoea in their FGS calves in the grazing season 1996, viz. in 19 (14%) organic herds and seven (6%) conventional; post-turnout diarrhoea was noted by nine (7%) organic and five (5%) conventional farmers and diarrhoea toward the end of the grazing period was observed by six (5%) organic farmers and one (1%) conventional. No differences in grazing management practice were observed between farms which had reported poor weight gain and/or diarrhoea in their FGS calves and farms without signs of parasitic disease. In 1996, three (2%) organic and two (2%) conventional farmers noted late season coughing in their grazing calves. There were no differences between organically and conventionally raised cattle, concerning the presence of parasite-induced damages at slaughter, reported by the official meat inspection, between 1995 and 1997; 11 (8%) organic and eight (7%) conventional farms had received adverse remarks due to *Parafilaria bovicola* induced lesions in the meat. Remarks due to lung worm were reported by six (5%) organic and four (4%) conventional farmers and similar figures for condemned livers due to liver fluke were 45 (35%) and 28 (27%), respectively ($\chi^2 = 1.26; P = 0.26$).

3.8. Ectoparasites

Significantly more ($\chi^2 = 10.57; P < 0.001$) organic, 84 (62%), than conventional farmers, 46 (41%), reported that they had observed lice or mites on their cattle during the winter season 1996 or 1997. However, significantly fewer ($\chi^2 = 39.8; P < 0.0001$), of the organic producers who had noted ectoparasites reported that they treated their cattle with pesticides and/or pharmaceutical drugs, viz. 21 (25%) of the organic compared to 38 (83%) of the conventional producers.

Insecticides to control flies in grazing cattle were applied significantly less often by organic than by conventional farmers ($\chi^2 = 41.39; P < 0.001$) during the grazing season 1995 or 1996, viz. five (4%) compared to 41 (37%). Prophylactic use of pesticides or insecticides is not allowed in organic production according to KRAV.

4. Discussion

According to this study the vast majority of organic and conventional dairy enterprises in central Sweden implement a variety of measures to control parasites. The methods used are more or less concentrated on reducing the risk of transmitting nematode parasites to FGS animals. However, there were significant differences in the parasite control methods on conventional vs. organic dairy farms. Conventional producers relied mainly on prophylactic treatment with anthelmintics, whereas organic producers more often employed a combination of non-chemical methods. The most commonly reported strategies in organic production were nutritional supplementation together with grazing management. Although such non-chemical remedies were also applied in conventional dairy production, the integrated approach was in general more pronounced among the organic farmers.

Organic farms had a greater access to pastures and
ley than conventional farms (Table 1). On the other hand, the average number of FGS calves was higher on organic farms and animals of other livestock species also grazed the pastures used for FGS calves to a higher extent on organic than on conventional farms. In addition, according to the rules of KRAV, organic farms must feed their cows a minimum of 50% and their young stock a minimum of 70% forage for which they need a large area of ley. It is therefore likely that the stocking rate on pastures for FGS calves was not significantly lower on organic farms than on conventional farms.

It is surprising that the prophylactic use of antiparasitic drugs was reported by only 58% of the conventional farms in this study, in contrast with the situation among Scottish milk producers, 86% of whom were recently reported as treating their calves prophylactically with anthelmintics (Gettinby et al., 1987). Most of the drenching performed on Scottish farms was allied with movement of treated stock to safe pasture in mid summer. This ‘dose and move’ strategy is not widely practised by cattle farmers in Sweden. Antiparasitic treatment of cattle in Scandinavia has instead traditionally been aimed at restricting the contamination of pasture with worm eggs resulting from the ingestion of overwintered larvae. This is achieved by treatment with an effective anthelmintic early in the grazing season (Nansen, 1993).

This study shows that in central Sweden and — especially in conventional herds — the same fields were commonly used for calves for several consecutive years. This corroborates an earlier finding (Svensson, 1995) where 60% of Swedish dairy farmers used the same pasture for their FGS animals for at least 5 years. Similar figures were also reported in an earlier Swedish study in which 80% of the calves were kept on fields previously grazed for several years by calves only (Nilsson and Sorelius, 1973). However, organic producers seemed to be more aware of the risks of using the same pasture for their calves, as they more frequently changed pastures between seasons, used aftermath, or if the same field was actually used for several consecutive years, also utilized it for cutting grass for silage or grazing older cattle alternately with other livestock species, to a greater extent than conventional farmers.

In theory, pasture management can provide efficient conversion of herbage to animal products and effective control of nematode parasites. Grazing management strategies have been classed as preventive, evasive, or diluting (Michel, 1985). Preventive grazing is based on turning the calves out onto clean pasture, such as areas not grazed by any cattle during the previous season or aftermath. Evasive grazing relies on the movement of animals to safe pasture before the larval contamination on the original pasture has reach significant levels. In Denmark, young cattle moved to a clean pasture in mid-July were found to do better than FGS calves that were kept on the same pasture throughout the grazing season and were treated with anthelmintics in order to control ostertagiosis (Henriksen et al., 1975). In the present study, 40% of the organic farmers and 20% of the conventional farmers changed pasture during the grazing season. However, one could not judge from the questionnaire answers whether the timing of the transfer of animals was beneficial as regards parasite control.

Diluting strategies take advantage of the concurrent grazing of susceptible animals with a larger population of parasite-inert animals of the same, or different, livestock species in order to reduce herbage contamination. The beneficial effects of mixed grazing between older, resistant and more susceptible younger cattle has been demonstrated both in dairy production in Denmark (Nansen et al., 1990) and in beef herds on pasture in Belgium (Agnessens et al., 1997). However, in the present study there seemed to be no difference in the exploitation of this strategy between the two types of dairy management enterprise. In contrast, organic producers applied alternate and/or mixed grazing with other livestock species significantly more often than conventional farmers (Table 2). Alternate grazing between sheep and cattle is commonly practised and has been studied in relation both to production and to its effect on worm burden (Barger, 1997). For example, Barger and Southcott (1978) reported having achieved excellent parasite control for both sheep and cattle by means of occasional pasture interchange. In the present study, the horse was the most common alternate livestock species reported. Although alternate grazing of horses and cattle is
theoretically successful, it requires further evaluation in practice.

There is an interaction between parasitism and nutrition. Well fed hosts are better able to withstand the deleterious effects of parasites (Coop and Holmes, 1996). For example, it has been shown that antibody responses (e.g. IgG) in calves to infective Ostertagia ostertagi larvae were influenced by diet (Mansour et al., 1991). Ploeger et al. (1990) found that supplementary feeding decreased the level of gastrointestinal nematode infection in FGS calves estimated by serological parameters. In the present study, nutritional supplementation was a common strategy for parasite control on organic dairy farms, but was frequently included in the management on conventional farms as well, especially toward the end of the grazing period when the risk of parasitic gastroenteritis is increased. It would be interesting to assess the parasite control value of nutritional enhancement of resistance under Swedish field conditions.

In spite of an apparent awareness of the need for parasite control among organic farmers, there were indications that they had experienced helminthoses in their stock more often than conventional producers. Poor weight gain and/or diarrhea in the FGS calves was more common on organic farms. Although these signs are known to be caused by parasite infections, they may also be due to other factors. For example, weight gain is largely dependent on the animals’ access to grass or feed supplement. However, organic farmers used cultivated grazing land and aftermath to a slightly greater extent than conventional farmers and gave supplementary feed significantly more often, which logically should result in higher growth rate during the grazing period.

Organic farmers also reported ectoparasites on their cattle significantly more often than did conventional farmers, possibly due to ineffective treatment or closer observations of their animals. Only 25% of the organic producers had used pesticides to treat their animals.

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