Organic livestock farming
A critical review

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Received 30 March 1999; received in revised form 13 January 2000; accepted 9 February 2000

Abstract

Based on production guidelines, organic livestock farming has set itself the goal of establishing environmentally friendly production, sustaining animals in good health, realising high animal welfare standards, and producing products of high quality. By striving for these goals, organic livestock farming meets the demands of an increasing number of consumers who are critical of conventional production methods. The paper gives an overview of the present state of the art in the different issues. Possibilities and limitations to perform the self-aimed goals under the basic standards of organic farming are discussed. Concerning environmental protection, the basic standards of organic farming are suited to reduce environmental pollution and nutrient losses on the farm level markedly. With reference to the health situation of dairy cows in both organic and conventional dairy farms, comparative studies show that currently there seem to be no fundamental differences between the production methods. In relation to animal welfare, organic livestock farming, based on minimal standards that go beyond the legislation standards, provide several preconditions for good living conditions of farm animals. Concerning product quality, there is little evidence for a system-related effect on product quality due to the production method. It is concluded that the benefits of the basic standards are primarily related to environmentally friendly production and to the animal welfare issue while the issues of animal health and product quality are more influenced by the specific farm management than by the production method. There is evidence to support the assumption that organic livestock farming creates stronger demands on the qualification of the farm management, including the higher risk of failure. As a consequence, quality assurance programs should be established to ensure that the high demands of the consumers are fulfilled. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Organic livestock farming; Environmentally friendly production; Animal health; Animal welfare; Product quality

1. Introduction

In recent years conventional livestock farming has been impressively successful at increasing the performance of farm animals and decreasing the production costs. At the same time, production-intensification has pushed the issues of environmentally friendly production, animal health and welfare into the background, especially because these are cost- and labour-intensive. The willingness of an increasing number of consumers to pay premium prices (Bennet, 1996; Badertscher-Fawaz et al., 1998) could enable the farmers to reduce the economical
pressure on the production costs. As a consequence, organic agriculture depends to a high degree on the consumers’ demands for organically produced products and for added values like biodiversity, species preservation, protection of nature, of landscape, of groundwater or of animals etc. which are closely related to the production process (Philips and Sorensen, 1993; Knauer, 1995; Mignolet et al., 1997). This requires a consumer-oriented approach in response to shifting market principles.

In contrast to conventional livestock production, organic livestock farming is defined by basic guidelines. The first guidelines have been developed by a private association in 1924 in order to elaborate an alternative opposite to the development in conventional production (Schaumann, 1995). Main aspects of criticism were the increasing use of chemical substances, especially mineral fertilizers and pesticides, and the reduced way of thinking in relation to the production process. In contrast to conventional agriculture, the farm is considered as a farm organism, where the integrative and holistic aspects were placed into the fore (Köpke, 1993).

The guidelines have been formulated and further developed by the International Federation of Organic Agriculture Movements (IFOAM, 1996) and meanwhile have found application all over the world. Furthermore, the basic standards of IFOAM have been used as the baseline for developing the EEC-Regulation for organic agriculture.

2. EEC-Regulation for organic livestock farming

In the European Countries, the EEC-Regulation 1804/1999, supplementing regulation no. 2092/91 on organic production has been passed and will become law in August 2000. The EEC-Regulation provides a standard that involves the right to label food as organic. It includes specifications for housing conditions, animal nutrition and animal breeding, as well as animal care, disease prevention and veterinary treatment and will create a framework for organic livestock production and labelling products in all European countries on an equal legal base. The maximum number of livestock density is limited to two livestock units per hectare. For a transition period, the use of a limited proportion of conventional feed is authorised. The maximum percentage per year is 10% in the case of herbivores and 20% for other species. The use of synthetic amino acids and growth promoters is forbidden.

The minimal standards in relation to animal welfare are primarily focussed on locomotion area, floor characteristics and husbandry practices. Dry litter as well as group penning are prescribed for all farm animals. Tethering of farm animals is forbidden. The indoor area is supplemented by an outdoor area that must be at least 75% of the indoor area.

There is, however, a scepticism from scientists towards the effectiveness of organic agriculture in relation to the self-created goals (Branscheid, 1996; von Alvensleben, 1998). The question arises whether the principles of organic livestock farming really enable a markedly better production than conventional principles. Up to now there are only few comparative studies available, which refer to keeping cattle, while studies for organic pig and poultry production are rare. The objective of this paper is to give an overview of the current situation in organic livestock production with regard to environmentally friendly production, animal health and welfare, based on research in the field, and to discuss the possibilities of ensuring quality of the products under the basic standards.

3. Environmentally friendly production

The main specifications concerning environmentally friendly production in organic livestock farming have to do with the renunciation of pesticides and mineral nitrogen, with the need to reduce the number of farm animals per area unit and the handicap to minimise the amount of bought-in foodstuffs. Without these substitutes, organic farming must rely on efficient nutrient circulation within the farm to maintain soil fertility and high production. Reduction of pollution or energy consumption is reached by a systemic and causally related approach, while conventional strategies are often based on technical and management related measures (Kristensen and Halberg, 1997).

An overview of the impact of livestock production on climatic factors and a comparison between organic and conventional production is given by Haas
The study showed that organic agriculture has clear benefits in reducing environmental pollution in comparison to conventional agriculture.

To assess nutrient losses on the farm level, the most common methodologies involve using balance sheets of the whole farm. Calculations demonstrate that the systemic effect of organic agriculture has great implication on the nutrient balance and the balance-surplus in relation to the product (Halberg et al., 1995; Spiekers and Hahner, 1995; Hoppe et al., 1996; Geier et al., 1997; Martinson, 1998). There is reason for the assumption that the benefit of the system-related factors on minimising pollution are much more effective as compared to management-related factors, such as increasing animal performance per animal per year. For example, reducing nitrogen input of 100 kg N ha$^{-1}$ is more than doubly efficient in relation to the balance surplus than increasing average milk yield for 1.000 kg cow$^{-1}$ and year (Mejs and Mandersloot, 1993).

By analyzing agricultural energy utilization through system modelling, Refsgaard et al. (1998) found conventional dairy production to be more intensive with a greater feeding ration and a higher proportion of high-protein feed, but also higher yields. However, the conventional yields were not sufficiently higher to compensate for the extra use of energy compared with the organic feeding ration.

In summary, the basic standards of organic farming provide suitable tools to minimise environmental pollution and nutrient losses on the farm level. These seem to be more effective than measures in conventional production. However, there is a high variability within organic farms in relation to their efforts and their nutrient efficiency.

4. Disease patterns

Metabolic disorders

Looking at the disease patterns as an indicator of animal health at herd level, several authors found a decrease in the incidence of metabolic disorders on organic compared to conventional farms (Ebbesvik and Loes, 1994; Vaarst and Enevoldsen, 1994; Krutzinna et al., 1996). The decrease in metabolic disorders is discussed as a factor of a general reduced production level in organic livestock farming (Vaarst et al., 1993; Böhncke, 1997). On average, milk yield per cow per year in organic production is lower compared to conventional production (BMELF, 1997; Kristensen and Kristensen, 1998). Because of the renunciation of supplementation by conventional produced foodstuffs, genetic performance capacities are often not exhausted. Although the relationship between milk yield and predisposition for diseases is not well understood, there are reasons for the assumption that high yielders react to inadequate conditions more sensitively than animals with an average performance (Butler and Smith, 1989; Wanner, 1995).

Mastitis

Concerning the incidence of mastitis, studies revealed that mastitis was of the same or even of greater relevance on organic than on conventional farms (Augustburger et al., 1988; Offerhaus et al., 1993; Krutzinna et al., 1996; Weller and Cooper, 1996; Spranger, 1998). In contrast Vaarst and Enevoldsen (1994) and Ebbesvik and Loes (1994) found a lower incidence of clinical mastitis in organic compared to conventional dairy herds. It is most likely that some local or national conditions like traditions for management, use of medication or herd size could explain differences between the results. However, the limitation of the data do not justify further statements.

Results about the incidence of reproductive disorders and other diseases in organic dairy herds are less significant due to a small number of farms within those studies. However, studies in different countries showed that the reproductive life span of dairy cows was significantly higher in organic compared to conventional farms (Offerhaus et al., 1993; Ebbesvik and Loes, 1994; Krutzinna et al., 1996).

According to Enevoldsen and Gröhn (1996), most of the diseases appear to be multivariate responses to a complex set of interrelated causal factors and are often due to mistakes of the farmer, inadequate handling and inappropriate housing conditions. Management-related factors, such as regular checks of the milking machine, feed analysis and the calculation of the diet are, and prove to be, of high importance for animal health (Schukken et al., 1990; Bartlett et al., 1992; Barkema, 1998). Whether these management-related factors are practised differently
between the two production methods cannot be concluded from the present data. However, it can be supposed that the management-related strategies mentioned above are more often used and farmers are more aware of the benefits of management-related factors on highly specialised farms than on mixed farms. Due to their reliance on efficient nutrient circulation, mixed farms follow, in most cases, the basic concept of organic farming, although the degree of mixture can be widely different (Hermansen and Kristensen, 1998). Feeding, handling and taking care of the farm animals are in competition with various other farm activities, being different on organic mixed farms compared to highly specialised conventional farms. Because time capacity and competence of the farmers are limited, excessive demands provoke conflicts within the farm management and, in consequence, lead to deficits on one or more of the various agricultural fields (Table 1). There are reasons to support the assumption that those fields most relevant to the farmer’s income are of the highest management priority.

In contrast to conventional production, the basic standards of organic livestock production include regulations concerning housing conditions, which are suited to serve as preventive measures. For example, increasing the space of the floor and providing litter for bedding can provide a reduction in conflict behaviour and the incidence of injuries and claw disorders (Müller et al., 1989; Bergsten, 1994; Hindhede et al., 1996). On the other hand, litter includes hygienic risks for the incidence of mastitis (Fehling, 1998). Additionally, being limited to home-grown feed stuffs can cause imbalances in the diets with possibly negative effects on animal health (Sundrum, 1997a).

In summary, comparative studies investigating the health situation of organic and conventional dairy farms show that there seems to be no fundamental difference between the production methods with reference to the animal health status of dairy cows. Management is the most important factor in both production methods. However, organic livestock farming creates stronger demands on the qualification of the farm management. The risk for inappropriate handling increases when capacities are overtaxed due to requirements of multiple demands.

5. Animal welfare

Direct measurements of animal welfare at herd level are not described in the literature. Sandoe et al. (1996) argue, that there is no consensus on operational definitions of animal welfare which indicate how scientists should measure welfare in practise. Despite the missing consensus, indirect approaches have been developed in order to assess the appropriateness of housing conditions in terms of animal welfare and to distinguish between poor and good living conditions for farm animals (Bartussek, 1988; Sundrum et al., 1994; Bracke et al., 1997). In Austria, an assessment concept was developed as a means of certifying the level of welfare on organic farms, which must obtain a specific level before being recognised as organic (Bartussek, 1999). According to Sundrum (1997b) and Bartussek (1999), these assessment concepts have proven suitable for detecting weak points within housing conditions and allow comparison of welfare preconditions on different farms to be made. However, there are still a lot of questions concerning the assessment concepts which are not yet answered satisfactorily. Especially the weighing of different aspects is still an unsolved problem.

By using an assessment concept, Hörning (1998) found housing conditions on organic dairy farms to be more appropriate for the requirements of dairy cows compared to conventional farms. Organic farms were characterised by higher dimensions of the feeding and locomotion area in loose housing stables. In an investigation including 268 organic dairy farms in Germany, Krutzinna et al. (1996) found the proportion of loose housing stables to be higher in

<table>
<thead>
<tr>
<th>Agricultural fields</th>
<th>Conflicts of aims</th>
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<tbody>
<tr>
<td>Crop rotation</td>
<td>Energy-rich basic ration=+cash crops</td>
</tr>
<tr>
<td>Manure</td>
<td>Grassland=+cash crops</td>
</tr>
<tr>
<td>Investments</td>
<td>Farm machinery=+housing conditions</td>
</tr>
<tr>
<td>Working time</td>
<td>Animal care=+marketing, harvesting or</td>
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<td></td>
<td>other emergencies</td>
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organic compared to the average in conventional livestock production.

The legal preconditions of housing conditions for organic livestock are provided by the EEC-Regulation 1804/1999. The most relevant standards, in comparison to the current Council Directives for the protection of calves, pig and laying hens, are presented in Table 2. The minimal standards of the EEC-Regulation reach a level that is clearly higher than the minimal standards of the Council Directives and, concerning dairy cattle, higher than private branded programmes (Sundrum, 1999). Additionally, the EEC-Regulation on organic livestock farming includes regular checks by independent and qualified inspectors at least once a year. Because the check-system ensures a high degree of realisation of the minimal standards, the EEC-Regulation is an essential advance in comparison to the Council Directives.

Experimental studies have revealed the suitability of minimal standards to improve animal welfare at herd level. For example, enlarging the locomotion area and providing litter bedding have been found to be of substantial benefit for animal health and welfare of cows (Hindhede et al., 1996), calves (Groth, 1984), pigs (Ernst, 1995) and laying hens (Horne and Niekerk, 1998). The ban of stanchion barns means a fundamental advance for the living conditions of cattle. Locomotion, social behaviour and the decrease of several diseases is clearly improved in loose housing systems as compared to stanchion barns (Herlin, 1994). Furthermore, stanchion barns often are of an inappropriate size and display poor technical execution because they have been in use for a long time (Sundrum and Daase, 1997).

Although raising the level of minimal standards is intended to improve the housing conditions, a higher level of minimal standards cannot be treated as equivalent to appropriate livestock housing conditions and high animal welfare status out of different reasons.

In the first place, minimal standards represent only

<table>
<thead>
<tr>
<th>Farm animals</th>
<th>EEC-Council Directives on protection of farm animals</th>
<th>EEC-Regulation on organic livestock farming</th>
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<tbody>
<tr>
<td><strong>Dairy cows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion area</td>
<td>No Council Directives</td>
<td>6.0 m² indoors + 4.5 m² outdoors</td>
</tr>
<tr>
<td>Floor characteristics</td>
<td></td>
<td>Lying space with litter (bedding)</td>
</tr>
<tr>
<td>Husbandry practices</td>
<td></td>
<td>Keeping tethered is forbidden</td>
</tr>
<tr>
<td><strong>Calves</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion area</td>
<td>1.3 m²</td>
<td>1.5 m² indoors + 1.1 m² outdoors</td>
</tr>
<tr>
<td>Floor characteristics</td>
<td>Dry litter bedding</td>
<td>Dry litter bedding</td>
</tr>
<tr>
<td>Husbandry practices</td>
<td>Group penning after 8th week</td>
<td>Generally group penning</td>
</tr>
<tr>
<td><strong>Sow with piglets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion area</td>
<td>Isolated, non-perforated floor</td>
<td>7.5 m² indoors + 5.0 m² outdoors</td>
</tr>
<tr>
<td>Floor characteristics</td>
<td></td>
<td>Dry litter bedding</td>
</tr>
<tr>
<td><strong>Fattening pigs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion area</td>
<td>0.65 m²</td>
<td>1.3 m² indoors + 1.0 m² outdoors</td>
</tr>
<tr>
<td>Floor characteristics</td>
<td>Safe floors</td>
<td>Dry litter bedding</td>
</tr>
<tr>
<td>Husbandry practices</td>
<td>Tools for occupation &gt; 1 h</td>
<td>No tail-docking and tooth-clipping</td>
</tr>
<tr>
<td><strong>Laying hens</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotion area</td>
<td>450 cm²</td>
<td>1660 cm² indoors + 4 m² outdoors</td>
</tr>
</tbody>
</table>

*A Area per animal.

1° Up to 110 kg live-weight.

2° For calves up to 2 weeks of age.
a small section of the interrelationship between farm animals and their living conditions. Beside the housing conditions, the quality of stockmanship and management, the patterns of feeding, climatic factors and the hygienic situation all have significant influences on animal health and welfare (Rushen and De Passillé, 1992; Bergsten, 1994). These factors are not part of the Council Directives or the EEC-Regulation due among others to the difficulties in quantification and to the frequency of changes within short periods of time.

Secondly, minimal standards are primarily based on political decisions and are often a compromise between different interests that are not, in all cases, related directly to the animal welfare issue.

Thirdly, the meaningfulness of on-farm assessment by design criteria is limited. Design criteria lack validation when the responses of the animals are not assessed directly in the specific situation. Due to differences in genetic origin, age, sex or in the experiences during ontogenesis, farm animals can vary widely in their requirements in relation to the housing condition. Furthermore, specific housing conditions can have contrary effects on animal behaviour and animal health. For example, outdoor area and litter bedding provide benefits for the execution of different behaviour patterns but include relevant hygienic risk factors for animal health, especially concerning parasites. Sandoe et al. (1996) pointed out that there is a considerable lack of knowledge about the interactions among the various factors, stressing the need for a strategy that focuses directly on the response from the animals on the farm. Certification of animal welfare should always be supplemented with some kind of records of how well the animals actual fare in the system (Johnson and Sandoe, 1999).

In summary, the higher level of the minimal standards in organic livestock farming and their regular check provide several preconditions for good living conditions of farm animals. This reflects a clear improvement compared to the conventional situation. However, those minimal standards are not necessarily a guarantee for appropriate housing conditions. On-farm assessment can improve the meaningfulness of statements concerning the appropriateness of housing conditions in relation to animal welfare.

6. Product quality

A clear comparison between organic and conventional produced products is difficult to establish due to the great variation within the production methods, concerning among other things, intensification, feeding ration or breeds used. Honikel (1998) gave an overview of the limited number of published studies dealing with milk, beef, pork and eggs. The author concluded that the characteristics of product quality, the nutritional, hygienic, sensorial and technological factors are not very different between the production methods. In some factors organic food gets better marks, in others conventionally produced food scores higher.

Branscheid (1996) argued that organic production could lead to a lower quality of carcass and meat due to a reduced energy supply and growth rate as the consequence of the extensive production method, while intensification has positive implications on carcass characteristics. On the other hand, implications of a reduced nutrient supply on carcass qualities can be compensated for by choosing breeds more adapted to the basic fodder on the farm. The renunciation of high live-weight gains provides the use of crossing with breeds famous for providing relish when eaten, due to higher intramuscular fat content (Kreuzer, 1994; Claus, 1996). Furthermore, the renunciation of amino acid supplementation in the diet of fattening pigs results in a reduction in pig performance but in an increase of intramuscular fat content (Sundrum et al., 2000).

According to hygienic aspects, Honikel (1998) suspected that there might be a higher risk for the contamination of products with parasites due to a higher rate of outdoor-systems in organic compared to conventional farming. Concerning milk quality, Hauert (1990) found no differences between the microbial count of organic and conventional milk. According to the residues of drugs, organic products are expected to be far less contaminated than conventional products due to the restricted use of chemotherapeutic agents. However, comprehensive investigations are also missing in this case.

In summary, there is little evidence for a system-related effect on product quality due to the production method. Product quality is primarily a function of farm management, showing a high variability
in both organic and conventional livestock production.

7. Conclusions

Organic livestock farming is not a production method to solve all problems in livestock production. It is primarily a production method for a specific premium market with high requirements for the quality of the production process, demanding high management qualification. For the development of organic livestock farming it is important to ensure the confidence of the consumers in organic products by realising the self-created demands to a high degree.

Studies indicate that a considerable number of farms cannot cope, in all respects, with the high demands (Sundrum and Daase, 1997; Spranger, 1998). One explanation for deficits may be due to the fact that time requirements for animal husbandry are in competition with other agricultural fields and often fail to be of first priority. Furthermore, taking steps of precaution concerning animal health and welfare are, to a certain degree, in opposite to the objectives of high productivity and low production costs (Kuhlmann, 1998). Despite their benefits for animal welfare and environmentally friendly production, the basic standards seem to be insufficient to ensure a higher animal health status and a higher product quality compared to conventional production. In order to improve the situation, quality assurance programs should be established and controlling systems should be improved to ensure the high demands of the consumers. Under the pressure of the decreasing official money and in expectation of the dramatic cut of subvention money along with the future EU-policy (Agenda 2000), subvention is expected to be linked more closely to the ecological performances of each farmer. This will open more possibilities for organic livestock farming for monetary compensation, if the ecological performances that are connected with the production method are honoured directly by official money.

Organic livestock farming is a challenge not only for the farmer but also for agricultural research and interdisciplinary work. The following items should be pursued with high priority:

- Developing the assessment of process qualities
- Epidemiological studies to evaluate risk factors
- Farmer decision support systems to improve the quality production process
- Socio-economical investigations concerning the acceptance of organic livestock production
- Resultant impacts of different agricultural strategies
- Elaborating methods and indicators for on-farm assessment of animal welfare in a far-reaching and objective way

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