NJF Report • Vol. 1 • No 1 • 2005

Nordic Association of Agricultural Scientists

NJF-Seminar 369

Organic farming for a new millennium
-status and future challenges

Published by
Nordic Association of Agricultural Scientists (NJF),
Section I: Soil, Water and Environment
Swedish University of Agricultural Sciences

Alnarp, Sweden June 15-17, 2005

Electronic version available at www.njf.nu

ISSN 1653-2015

Nordic Association of Agricultural Scientists

SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES SLU

ÖREBRO LÄNS LANDSTING

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We are grateful for financial support to the seminar from these sponsors!

Preface

These proceedings contain the "hardware" of NJF seminar 369, "Organic farming for a new millennium – status and future challenges". The committee has chosen to launch the proceedings in parallel with the seminar. In other words, there is only one written version of the seminar papers available, and that version is presented in the following pages. The aim of the book is to help the delegates to follow the oral presentations, and to give additional information about the posters. The papers are presented in the same order as the presentations are scheduled in the seminar programme. After the seminar, the seminar proceedings will be published in electronic form. All authors and chair leaders who have been editing the abstracts (see the programme) are hereby thanked for their valuable contributions!

The idea to arrange a multidisciplinary seminar on organic food and farming research within NJF came up at the NJF congress in Turku, Finland in 2003. Section 1; Soil, water and environment, took the responsibility, and a committee representing the Nordic countries was established. The Finnish representative also represented the Baltic countries. As the chair of this committee, I wish to express my gratitude to all the committee members: Gärd L-Bäckström (Sweden), Jesper Rasmussen (Denmark), Mikko Rahtola (Finland), Asdis Helga Bjarnadottir (Iceland), and Grete Lene Serikstad (Norway). A special "Thank You!" goes to our local committee members at SLU Alnarp, Charlott Gissèn and Gunnar Svensson. It has been a pleasure to be a member of this committee, and I hope that the participants in the seminar will also remember the seminar as a pleasant event of the summer of 2005.

NJF has arranged multidisciplinary seminars about organic food and farming before, the most recent in Mikkeli, Finland in 1994 (seminar 237). The committee found it to be an appropriate time to hold a Nordic-Baltic assembly again with the aim of discussing and further developing organic agriculture in our part of the world. Since 1994, several national conferences within organic agriculture have developed on a regular basis in our region, and the organic perspective is usually an obvious part of most seminars on food and farming. Still, we believe there is a need for NJF from time to time to conduct seminars solely on organic agriculture. The large number of participants that signed up for the seminar proves that we were right in our assumptions, and we are happy to welcome you all to interesting and inspiring days in the Swedish Agricultural University at Alnarp.

On behalf of the seminar committee,

Anne-Kristin Løes, chair

NJF seminar 369:
Organic farming for a new millennium – status and future challenges

SLU Alnarp, 15.-17.6.2005

Programme

Wednesday 15.6.05

13.00-15.00 Plenary session
Room: Aulan, Alnarpsgården, "Nya aulan"
Chair: Svein Skøien, Chairman of Section 1, NJF

13.00-13.10 Welcome to SLU Alnarp
Roland von Bothmer, Swedish University of Agricultural Sciences, Faculty of Landscape Planning, Horticulture and Agriculture

13.10-13.20 A musical welcome:
Let's sing together!

13.20-13.50 Sweden in a Green economy
Svante Axelsson, The Swedish Society for Nature Conservation
13.50-14.00 Questions to Svante Axelsson

14.00-14.50 Organic farming, food quality and human health
Angelika Meier-Ploeger, Kassel University, Germany
14.50-15.00 Questions to Angelika Meier-Ploeger

15.00-16.00 Refreshments and posters
Room: Foajén, Alnarpsgården

16.00-18.30 Parallel sessions

18.30 Dinner at Alnarp
Room: Alnarpskrogen

16.00-18.30 Session A: Market development and farmers' economy

Room: Aulan, Agricum, "Gamla aulan"
Chair: Gudbrand Lien, Norwegian Agricultural Economics Research Institute

16.00-16.25 Eivind Brendehaug, Western Norway Research Institute:
The influence of business strategies on the supply, demand and market development of organic food in the Nordic countries

16.25-16.50 Lena Ekelund, Swedish University of Agricultural Sciences:
Consumers' preferences and marketing of organic products

16.50-17.15 Jouni Kujala et al, University of Helsinki:
Organic marketing initiatives and rural development – lessons learned for the organic industry

17.15-17.40 Ola Flaten et al, Norwegian Agricultural Economics Research Institute:
Characteristics, goals and motivations among organic dairy farmers in relation to time of conversion

17.40-18.05 Lars-Bo Jacobsen, Danish Research Institute of Food Economics:
Prospects for organic farming in Denmark

18.05-18.25 Final discussion

16.00-18.30 Session B: Food quality and human health

Room: Sal 107, Alnarpsgården
Chair: Grete Lene Serikstad, Norwegian Centre for Ecological Agriculture

16.00-16.20 Riikka Laukkanen et al, University of Helsinki, Faculty of Veterinary Medicine:
Pathogenic *Yersinia* and *Listeria monocytogenes* in organic pork production

16.20-16.40 Gro Skøien Johannessen, National Veterinary Institute, Norway:
Contamination of lettuce with *E. coli* from the use of animal manure as fertilizer

16.40-17.00 Vida Rutkoviene et al, Lithuanian University of Agriculture:
Changes in soil characteristics and product quality under the influence of long-term organic farming

17.00-17.20 Charlotte Lauridsen et al, Danish Institute of Agricultural Sciences:
Organic food and health - status and perspectives

17.20-17.40 Charlott Gissén, Swedish University of Agricultural Sciences:
Farming systems and nutritional quality of cereals

17.40-18.00 Bength Lundegårdh, Swedish University of Agricultural Sciences:
Organic cultivating systems and food quality

18.00-18.25 Final discussion

Thursday 16.6.05

9.00-9.30 Plenary session
Room: Aulan, Agricum, "Gamla aulan"
Chair: Gunnar Svensson, Swedish University of Agricultural Sciences

Joining resources to improve organic food and farming research
Erik Steen Kristensen, Danish Research Centre for Organic Farming

9.30-13.00 Parallel sessions, interrupted by

10.30-11.30 Refreshments and posters

13.00-14.00 Lunch
Room: Alnarpskrogen

14.00-18.00 Excursions, see separate programme
Starting from: Alnarpsgården, Bobo's heart

19.00 Seminar dinner
Room: Alnarpskrogen

9.30-13.00 Session C: Vegetables and berries
Room: Aulan, Agricum, "Gamla aulan"
Chair: Johan Ascard, Jordbruksverket, Swedish Board of Agriculture

9.30-9.50 Björn Gunnlaugsson et al, The Agricultural University of Iceland:
Organic fertilisers for greenhouse vegetables

9.50-10.10 Michèl J. Verheul, The Norwegian Crop Research Institute:
A rational growing system for organic production of greenhouse tomatoes

10.10-10.30 Marja Kallela, MTT Agrifood Research Finland:
Variety trials of broccoli in organic farms

11.30-11.50 Marjo Keskitalo, MTT Agrifood Research Finland:
Control of potato late blight by caraway oil in organic farming

11.50-12.10 Birgitta Rämert, Swedish University of Agricultural Sciences:
The ecology of the cultivation system: Green manure as a multifunctional "tool" in vegetable production

12.10-12.30 J. Pekarskas et al, Lithuanian University of Agriculture:
Effects of mineral fertilizers on quality of organic vegetables and its assessments by different methods

12.30-12.50 Pirjo Kivijärvi, Tuomo Tuovinen and Riitta Kemppainen, MTT Agrifood Research Finland: Mulches and pheromones – plant protection tools for organic blackcurrant production

12.50-13.00 Final discussion

9.30-13.00 Session D: Cereals, oilseeds and legumes

Room: Sal 107, Alnarpsgården
Chair: Charlott Gissén, Swedish University of Agricultural Sciences

9.30-9.50 Jørgen E. Olesen, Danish Institute of Agricultural Sciences:
Learning from a long-term crop rotation experiment

9.50-10.10 Lars Munkholm et al, Danish Institute of Agricultural Sciences:
Subsoil loosening eliminated plough pan, but had variable effect on crop yield

11.10-11.30 Eve Veromann, Institute of Plant Protection, Estonia:
Pests and their natural enemies in the organic oilseed and turnip rape

11.30-11.50 Z. Kadzuliene et al, Lithuanian Institute of Agriculture:
Peculiarities of some legumes and cereals under organic farming system

11.50-12.10 Ievina Sturite et al, The Norwegian Crop Research Institute:
Dynamics of nitrogen in white clover plants in production and environmental perspectives

12.30-12.50 Agrita Svarta et al, Research Centre of LAU Skriveri, Latvia
Organic crop production and seed growing

12.50-13.00 Final discussion

9.30-13.00 Session E: Animal health and feeding of ruminants

Room: Husdjurssalen, Agricum, 2nd floor
Chair: Gunnela Gustafson, Swedish University of Agricultural Sciences

9.30-9.50 Lise Grøva, Norwegian Centre for Ecological Agriculture, Norway:
Animal health and welfare in dairy farming – and advisory tool for securing animal welfare on farm level

9.50-10.10 Olav Reksen, Norwegian School of Veterinary Science:
Reproductive performance in organic dairy husbandry

10.10-10.30 Lisbeth Hektoen, Norwegian School of Veterinary Science:
The use of alternative veterinary medicine in organic dairy farming

11.30-11.50 Sissel Hansen, Norwegian Centre for Ecological Agriculture:
Sulphur supply: a challenge for organic farming?

11.50-12.10 Gudbrand Lien, Norwegian Agricultural Economics Research Institute:
100% organically produced feed - how to adjust in organic farming systems

12.10-12.30 Lisbeth Mogensen, Danish Institute of Agricultural Sciences:
Productivity, economy and nutrient balances on organic dairy farms using different strategies for homegrown feed

12.30-12.50 Eeva Kuusela, University of Joensuu, Finland:
Grazing management for Nordic organic dairy farming

12.50-13.00 Final discussion

Friday 17.6.05

9.00-9.30 Plenary session

Room: Aulan, Agricum, "Gamla aulan"
Chair: Gärd L-Baeckström, Research-Unit, Örebro University Hospital, Sweden

Baltic Ecological Recycling Agriculture and Society (BERAS project)
Helena Kahiluoto, MTT Agrifood Research Finland and *Artur Granstedt,* The Biodynamic Research Institute, Sweden

9.30-10.00 Refreshments and posters

Room: Foajén, Alnarpsgården

10.00-14.15 Parallel sessions, interrupted by

12.00-13.00 Lunch

14.15-15.00 Plenary session, closing up

Room: Aulan, Alnarpsgården, "Nya aulan"
Chair: Anne-Kristin Løes, Norwegian Centre for Ecological Agriculture

14.15-14.30 Poster prize and a brief summing up of the seminar

14.30-15.00 Inger Källander, Ekologiska Lantbrukarna: Organic farming in a global perspective – our way into the future

10.00-14.15 Session F: Farming systems: N-efficiency, biodiversity and environmental effects

Room: Aulan, Agricum, "Gamla aulan"
Chair: Helena Kahiluoto, MTT Agrifood Research Finland

10.00-10.20 Marina A. Bleken et al, Norwegian University of Life Sciences:
Closing the plant-animal loop: a prerequisite for organic farming

10.20-10.40 Ulf Hanell et al, Örebro University, Sweden:
Nitrogen studies of conventional and organic wheat cultivation, 1992-2002.

10.40-11.00 Ilse A. Rasmussen et al, Department of Integrated Pest Management Research Centre Flakkebjerg:
Management of perennial weeds and nitrogen leaching in arable cropping systems

11.00-11.20 Pia Frederiksen et al, National Environmental Research Institute, Denmark:
Density, structure and management of landscape elements on Danish organic farms

11.20-11.40 Johan Ahnström et al, Swedish University of Agricultural Sciences:
Organic farming enhances biodiversity – but there is a larger picture

11.40-12.00 Discussion

13.00-13.25 Winfried Schäfer et al, MTT Agrifood Research Finland:
Biogas from manure – a new technology to close the nutrient and energy circuit on-farm

13.25-13.50 Timo Sipiläinen et al, MTT Agrifood Research Finland:
Learning in switching to organic farming

13.50-14.15 Final discussion

10.00-14.15 Session G: Plant protection, challenges and solutions

Room: Sal 107, Alnarpsgården
Chair: Jesper Rasmussen, The Royal Veterinary and Agricultural University, Denmark

10.00-10.20 Anne Luik et al, Estonian Agricultural University:
Studies in environmentally friendly plant protection in Estonia

10.20-10.40 Ricardo Holgado et al, The Norwegian Crop Research Institute:
Importance of nematodes in organic farming

10.40-11.00 Fredrik Fogelberg, Hedmark University College, Norway:
Mechanical weed control in vegetables

11.00-11.20 Erik F. Kristensen et al, Danish Institute of Agricultural Sciences:
Inter-row weed control by use of band steaming

11.20-11.40 Timo Lötjönen, MTT Agrifood Research Finland:
Sonchus arvensis- a challenge for organic farming

11.40- 12.00 Discussion

13.00-13.20 Lars Monrad Hansen et al, Danish Institute of Agricultural Sciences:
Intercropping of fabae beans *(Vicia fabae L.)* and spring barley *(Hordeum vulgare L.)* to reduce the incidence of the black bean aphid *(Aphis fabae Scop.)*

13.20-13.40 Ann-Charlotte Wallenhammar et al, The Agricultural Society in Örebro, Sweden:
Field surveys of Fusarium root rot in organic red clover leys

13.40-14.00 Theo Ruissen, Norwegian Centre for Ecological Agriculture:
Plant health management in organic farming, an organic or an organismic challenge?

14.00-14.15 Final discussion

10.00-14.15 Session H: Production systems; pork, poultry and sheep

Room: Husdjurssalen, Agricum, 2nd floor
Chair: Jørgen Svendsen, Swedish University of Agricultural Sciences

10.00-10.25 Eva Salomon et al, Swedish Institute of Agricultural and Environmental Engineering (JTI): Outdoor pig systems in organic agriculture - animal environment, plant nutrient management and working environment

10.25-10.50 Lotta Rydhmer et al, Swedish University of Agricultural Sciences: Reproduction and maternal behaviour in organic piglet production

10.50-11.15 Anne-Charlotte Olsson et al, Swedish University of Agricultural Sciences: Studies on housing alternatives for organic pork production

11.15-11.40 Magdalena Høøk Presto et al, Swedish University of Agricultural Sciences: Amino acid supply to pigs and poultry in organic farming

11.40-12.00 Discussion

13.00-13.20 Holma et al, University of Helsinki: Organic egg production in Finland: Management of animal welfare and food safety

13.20-13.40 Sara Antell et al, Swedish University of Agricultural Sciences: Laying hens in a mixed grazing system with cattle and geese

13.40-14.00 Vibeke Lind, The Norwegian Crop Research Institute: Potatoes or barley silage to ewes

14.00-14.15 Final discussion

What happens where?

Useful map: http://www.slu.se/page.cfm?page=474

Date	Time	Session	Room	Note
15. June	10.00-	Registration desk opens	Foajén, Alnarpsgården	
15. June	13.00-15.00	Plenary session, welcome	Aulan, Alnarpsgården	”Nya aulan”
15. June	15.00-16.00	Posters etc	Foajén, Alnarpsgården	
15. June	16.00-18.30	Session A	Aulan, Agricum	”Gamla aulan”
15. June	16.00-18.30	Session B	Sal 107, Alnarpsgården	
15. June	18.30-	Dinner	Alnarpskrogen	
16. June	09.00-09.30	Plenary session, joining resources	Aulan, Agricum	”Gamla aulan”
16. June	09.30-10.30, 11.30-13.00	Session C	Aulan, Agricum	”Gamla aulan”
16. June	09.30-10.30, 11.30-13.00	Session D	Sal 107, Alnarpsgården	
16. June	09.30-10.30, 11.30-13.00	Session E	Husdjurssalen, Agricum	2nd floor
16. June	13.00-14.00	Lunch	Alnarpskrogen	
16. June	Excursions	Starting from	Alnarpsgården, Bobo´s heart	
16. June	19.00-	Banguet	Alnarpskrogen	
17. June	09.00-09.30	Plenary session, baltic ecological…	Aulan, Agricum	”Gamla aulan”
17. June	09.30-10.00	Posters etc	Foajén, Alnarpsgården	
17. June	10.00-12.00, 13.00-14.15	Session F	Aulan, Agricum	”Gamla aulan”
17. June	10.00-12.00, 13.00-14.15	Session G	Sal 107, Alnarpsgården	
17. June	10.00-12.00, 13.00-14.15	Session H	Husdjurssalen, Agricum	2nd floor
17. June	14.15-15.00	Plenary session, ending of seminar	Aulan, Alnarpsgården	”Nya aulan”

The influence of business strategies on the supply, demand and market development of organic food in the Nordic countries

E. Brendehaug
Western Norwegian Research Institute, Box 163, N-6851 Sogndal, Norway

Abstract

This paper discusses the development of the production and markets of organic milk at two dairy companies, namely Arla of Sweden and Tine of Norway. After the re-launch of organic milk, sales developed differently at the two companies. In order to investigate why this was the case, we carried out and compared two case studies examining the changes in rationality, goals, strategies and measures for the ecologically products. We discovered essential differences in the two companies. In Arla, in contrast to Tine, organic milk fills a defined need in the company; it is integrated into the overall market strategy to strengthen the value of the company trademark. Consequently measures are developed to enlarge both markets and production, e.g. giving the consumers arguments to buy organic milk and using founds for advertising.

Keywords: organic milk, business strategies, marketing

Introduction

In the debate concerning why there is variation in the development of markets for organic products both within and between countries, two reasons are often given: weak demand and poor development of the product supply. In the first case, low sales are accounted for by referring to low consumer demand; in the second case, the emphasis is on the consumer having a poor choice of organic products in comparison to conventional products. Both explanations may be relevant, depending on the level of development the organic market has reached. In this paper, the emphasis is on the development of the production and market for organic milk in Sweden (Arla) and Norway (Tine)[1]. As Figure 1 demonstrates, sales have developed differently at the two companies. Our overall question is, whether the differences can be explained by the different strategies of the two companies. We will examine whether it was rational for the dairy industry to develop production and markets for organic milk, and how the strategies and measures employed by the dairy companies have influenced production and market development.

Materials and methods

By means of the two case studies of the dairy companies Arla (Sweden) and Tine (Norway) we have studied changes in rationality, goals, strategies and measures for organic products. The study examines the period from when the companies first launched organic milk up through 2001. The data collected is both qualitative and quantitative, with an emphasis on interviews of employees in the two companies and analysis of various documents. The companies have provided us with figures for the development of sales of organic milk as a percentage of the total low-fat milk sales.

[1] In the presentation at *Nordic Agriculture in Global Perspective 2005*, we will also include analysis of the case of MD Foods of Denmark.

Results

Based on the empirical data we have classified the development of the production and sale of organic milk into three phases:

Phase 1: the first generation of organic milk produced by the companies;

Phase 2: the re-evaluation of roles, goals, strategies and measures for organic milk;

Phase 3: the second generation of organic milk production and sale was launched, with important changes to the product and marketing strategy from the first launch.

In Table 1 we show the dates for the first and second launches of organic milk at the companies, together with some characteristics of the products offered.

Table 1. Year and product for first and second launch by Arla and Tine.

Company	First launch		Second launch	
	year	Productprofil	year	Productprofil
Arla	1991	Ekomjölk, 2.0%	1994	Ekologisk, 1.5%
Tine	1995	Dalsgården, 1.5%	2001	Økologisk, 1.5%

In the figure below year 1 corresponds to 1991 for Arla and 1995 for Tine (first launch of organic milk). The re-launch was in year 4 (Arla) and year 7 (Tine) in the figure.

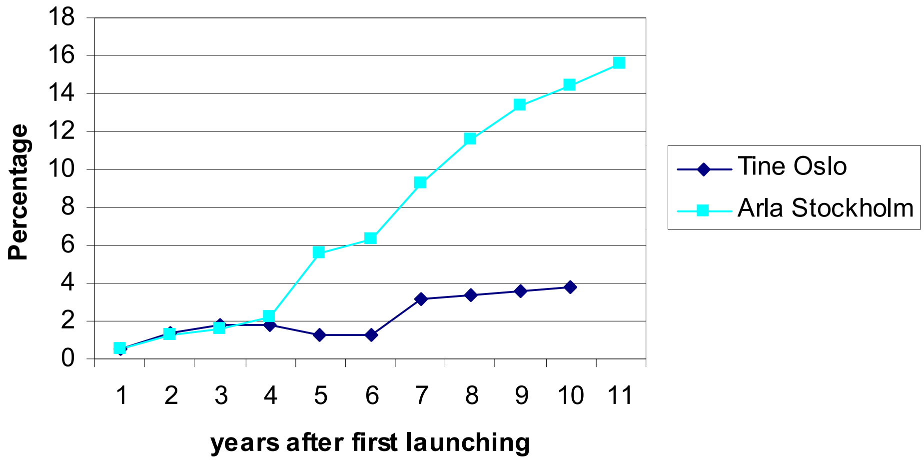

Figure 1. Sale of organic low fat milk as a percentage of conventional low-fat milk sales in Stockholm and Oslo. Re-launch in year 4 (Arla) and in year 7 (Tine).

Phase 1: The first generation of organic milk

This phase was characterised at both companies by the fact that organic milk was launched on the market as a special product targeted at a small group of consumers. The difference in relation to conventional milk concerned several aspects of production. For instance, the fat percentage was different from that of standard milk; it was non-homogenised; and the packaging was different. Commenting on this period, the development manager at Arla remarked, “It was as if we were selling motor oil”. At the same time, the product was released at a relatively high price, distribution was not as efficient as for traditional milk, and the

advertising and in store profiling was far weaker. The strategy and measures were developed to meet demand from consumers who were already strongly motivated to buy organic products. As the sales figures in Figure 1 indicate, sales lay between 1% and 2% of the low-fat milk sales during this period.
The companies did not consider organic milk to be an interesting product from a commercial perspective, and it did not fit in with their established values. It was a 'non-compatible' product. Organic milk was considered, especially by the farmers, but also by the employees of the companies, as being a problematic product for conventional agriculture and dairy industry. It was therefore deemed not to be economically rational from a commercial perspective to develop production and markets.

Phase 2: Re-evaluation of organic milk's role
Weak sales figures resulted in a negative reaction from markets, organic farmers and the authorities. External pressure and internal motivation in the companies resulted in a re-evaluation of goals, strategies and measures. Arla of Sweden undertook the most critical analysis of its strategies and measures. The Arla marketing department challenged the board to think anew, regarding the view that organic milk stood in opposition to conventional milk. After a long and hard debate, in which both parties had to compromise, a balance was reached. It was agreed that organic milk should not be marketed as being better than conventional milk, but the product should be profiled in such a way that it provided consumers with reasons for buying it. During the launch campaign of phase 3, organic milk was described as 'the milk of the future'. Organic milk was given a new role at Arla. Organic products were developed so as to contribute added value to the company by identifying their trademark with an environmental image. One of the employees in the marketing department expressed this in the following manner:

> "We see the product as providing a good image for Swedish agriculture - a pioneer product. When we advertise organic milk we advertise all our milk."

Consequently, it became an aim to increase both production and sales. Arla set a production goal for organic milk of 10% of total milk sales, to be reached by the year 2000. Due to a re-evaluation, organic milk came to be considered as a commercially interesting product. It acquired a business-strategic importance within the company.

Discussion was also initiated at Tine between the marketing department and the board concerning the established view that organic milk was contrary to conventional milk. This resulted in the board altering its outlook concerning organic milk, which was now considered to be a supplement to conventional milk and not necessarily of better quality. However, it has taken a long time for this change of attitude to be established further down in the organisation. At Tine, organic milk was not given the role of strengthening the Tine trademark, and the company never developed a strategy concerning what the company intended to do with the product. The person responsible for organic milk at Tine says:

> "There has not been a high level of awareness at Tine concerning the place of organic production within the company. The possibilities have not been fully exploited (…) nor has the commercial aspect been an important motivating factor for Tine."

Phase 3: The second generation of organic products were launched
In accordance with the re-evaluation of phase 2, organic milk was launched again at both companies as a general product aimed at a broader group of consumers. The packaging design and product characteristics were normalised in relation to conventional milk. Both Arla and Tine launched products using the trademarks of the respective companies. At the same time, the price was reduced, and the distribution and profiling strengthened. The ambition of these measures varied between the companies in relation to the differing motivation factors and the

commercial potential as expected by the company. We have found one exception: the consumer price. At the re-launch year and one year later consumer price in Norway and Sweden has been at the same level, relatively to conventional low fat milk (Table 2). But the price reduction two years after the re-launch in Norway (to 177% of conventional milk) occurs in the shops without any price decline from Tine. This shows the importance of retailer's strategies and measures.

Table 2. Consumer price as a percentage of conventional low-fat milk at re-launching and years later.

Company	At re-launch	1 year later	2 years later	4 years later
Arla	128	128	127	122
Tine	128	125	117	-

Data: Arla, 1999a & Tine, 2005a.

Both companies adopted measures to increase production, which was successful in both cases. After the re-launch in 2001, Tine anticipated an increase in sales which would correspond to the sales achieved by Arla after their re-launch in 1994. As figure 1 indicates, the companies achieved a response from the market through increased sales, but for Tine the growth flattened out after a short period. Stagnation resulted in resignation within the marketing department at Tine, and after the launch-campaign in 2001; the product was not followed up with campaigns, except in special shops in cooperation with retailers. Arla has used significantly higher funds on advertising than Tine (se table 3).

Table 3. Budget on advertising at re-launch and years later.

	At re-launch	1 year later	2 years later	3 years later
Arla, million SVK.	5-10	3-4	4-5	3-4
Tine, million NOK.	5	0,5	0,5	0,5

Data: Arla, 1999b & Tine, 2005b.

In contrast with Arla, Tine has not had a proactive marketing strategy for organic products, but a demand-pull strategy, in which the company's aim is to reach consumers who already prefer organic milk. Tine does not see it as their responsibility to
" …answer questions concerning why the consumers should buy organic products, although it seems to be the main question consumers ask at the present time." (Bruset, 2003).
Director Bjørg Bruset in Tine believes also that organic milk will never be an area of the company's operations where their efforts will be focused to any great extent – the volume is too small for that, she said.

Discussion

Innovative products should at least offer relative advantages and also correspond to established values, if they are to fulfil important conditions for diffusion and adoption (Rogers, 1995). This was not the case during phase 1 amongst the employees in the companies or the larger consumer groups. As far as the companies were concerned, organic milk was viewed as being a 'necessary evil' of no commercial interest, which was only

marketed in order to satisfy the organic farmers, the authorities and a small group of consumers. The companies did not consider it as their responsibility to develop markets for organic milk. The diffusion theory indicates two ways of improving the conditions for adoption (Rogers, 1995):
- Modify the product to the company's needs, technology and culture;
- Change established values and perceptions within the company.

The companies used both of these strategies in phase 2, but Arla were more thorough in assigning their organic product a completely new role. Their organic milk fills an internally defined need in the company; it is integrated into the company's overall strategy. The motivation at Tine has changed little since phase 1. Although the same external changes were made concerning the product as in Arla, the product was not assigned an expanded role in relation to their overall market strategies. Hence resulting in a far weaker signal being sent to the employees, concerning the importance of the product; and the profiling aimed at the consumers was also much weaker than was the case at Arla. In 2002, after stagnation in sales, the marketing department became resigned, which in turn affected the motivation of the sales personnel. This result corresponds to other studies (Forbord, 2001; Heidenmark, 2000).
There may also be other reasons why the development of sales differed greatly between Tine and Arla. Conventional agriculture may have a stronger position in relation to consumer trust in Norway than it does in Sweden. Such differences are shown between Norwegian and Danish consumers, but these studies also found that the most important reason not to buy organic food in Norway was due to lack of products in the stores (bad products supply) (Bjørkhaug & Storstad, 2001). Experiences from stores-tests in Norway show a considerable increase in organic milk sales where the product offer has been essentially improved (Ren Mat, 2005). This also support our results that weak product offer is a reasonable explanation for low sales statistics when the market is underdeveloped.

Conclusion

The different roles and strategies for organic milk within the companies may explain the different development of sales. In Arla:
- organic milk fills a defined need in the company; it is integrated into the overall market strategy to strengthen the value of the company trademark;
- measures are consequently developed to enlarge both markets and production, e.g., giving the consumers arguments to buy organic milk and using founds for advertising.

Tine is lacking an internal motivation for the product. The product has not been assigned any specific role in Tine's overall business strategy and is not seen as a product of commercial interest. The motivation is connected to fulfilling the company responsibilities by meeting the interests of organic farmers, authorities and some consumer groups. This motivation influences the design, strength and implementation of measures, and does not give sufficient signals to either the employees in Tine or the consumers.

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Consumers' preferences and marketing of organic products

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Abstract

The competitive situation for organic products has become tougher on the Swedish market and they now have to compete with conventional products, where the retailer's own private brands are gaining ground. The early market growth was largely driven by an interest by major retailer chains to offer organic food as part of their image building strategies. The consumers' decision-making and choice take place at the point of purchase, and the grocery store is crucial as a marketing place of organic products. Not only the overall strategy of supermarkets but also the activity and interest of the managers and staff in the stores are important. Our studies indicate that there is a difference in attitude of buyers and non-buyers of organic products in that the former seem more health oriented and the latter more inclined toward the planning of a meal, in a social context. In our conjoint analysis the respondents have greater utility of product origin (Swedish) than of production method (organic), with price being the most important attribute. Similar quality associations were stated for Swedish and for organic product. The implication for marketing should be carefully considered.

Keywords: organic, consumers, marketing, competition, supermarkets, Sweden

Introduction

From the mid 1990s, the Swedish market for organic food products has grown rapidly, with an annual increase of around 20-30 per cent, but has slowed down in recent years. The total market share of organic food in Sweden is small and estimated at around 3 per cent by value. There is a national goal of 20 per cent of all arable land in Sweden being organically cultivated by the year 2005 (www.regeringen.se/sb/d/1028). The obstacles for continued market growth are the relatively higher consumer prices of organic food, and also less continuity in supply, and sometimes less attractive product appearance. The competitive situation has become tougher and organic products have to compete with conventional products, where the retailer's own private brands are gaining ground. While much of the previous market growth of organic food can be derived from an early interest by major retailer chains to offer organic food as part of their image building strategies (Tjärnemo, 2001), it can be expected that retailers rather try to build their image by means of their own brands. The retailers also have brands for the organic products, which are also carrying the label of the association for control of organic production, KRAV. Together with the marketing efforts of the big supermarkets, this label has played an important role in the market expansion. Many consumers' food choices take place at the point of purchase, and the grocery store is crucial as a marketing place of organic products. Despite the centralisation of decisions in the supermarket chains, managers in the large grocery stores are the ones who decide the variety of the assortment in the fruit- and vegetable departments. The managers and staff also have daily contacts with the costumers and can easily observe new trends and needs from the consumer.

Studies of the consumer of organic products have focused on a hypothetical consumer who is a heavy-user with well-defined characteristics. For the market to grow it is necessary to go behind the motives for purchase and look at different consumers and different attributes. The aim of this paper is to explore the role of the consumers' preferences and of the food store in the marketing of organic products, of which vegetables are the main focus of interest.

Materials and methods

The data material draws from various studies. While our interest is primarily in vegetables, one comparison has been made with meat. The first study is a quantitative study by use of conjoint analysis of (41+145) carrot and (43) meat consumers. Conjoint analysis relies on the ability of respondents to make judgements about different stimuli. These represent some predetermined combinations of attributes, which are judged by respondents in an attempt to estimate how important each of the attributes is. This method was supplemented by a qualitative study of the same consumers stating their associations to different labels concerning these food products (Erneholm, 2004; Ekelund & Tjärnemo, 2004). This part consisted of a written questionnaire of consumers' own associations to the concepts: *organically or conventionally grown, grown in Sweden* and *imported*.

Another study consists of in-store-interviews with consumers and with fruit and vegetable managers in supermarkets (Tjärnemo & Ekelund, 2004). In the consumer study, sixteen consumers were interviewed while they were shopping for fresh fruit and vegetables in a major grocery store in central Malmö. Interviewees were chosen as they put fruit or vegetables in their shopping basket. The idea was to choose a comparable number of consumers who *bought* and who *did not buy* any organic fruit and vegetables at that particular time of shopping. The interviewees were asked how they decided what product to buy.

In the study of fruit and vegetable managers, representatives of twelve big outlets, affiliated to the same retailer chain in southern Sweden were interviewed by means of an open questionnaire with general questions concerning both conventional and organic fruit and vegetables. One aim was to get an insight into how the interviewees perceived the development and the future of their fruit and vegetable department and to what degree the managers perceived organically grown as an important part of the range of fruit and vegetables. The in-store-interviews, with consumers as well as store representatives, were tape-recorded and transcribed. For the analyses Perspective Text Analysis – PTA (Helmersson, 1992; Helmersson & Mattsson, 2001) was used. PTA takes as a point of departure that the way a person expresses his or her ideas and thoughts by means of language reflects the person's view of the world.

Results

In our experiment, we let consumers rank different stimuli, consisting of two different kinds of production method and origin – organically and conventionally grown, and Swedish and imported, respectively – each with four different price levels. The value of the utility of each of the stimuli was calculated as the utility of production method, of origin (Swedish or imported) and of price. The results show that the respondents have greater utility of origin than of production method, with price being the most important attribute. In most cases the respondents preferred organic products before conventional products, and products produced in Sweden before imported products. To carrot consumers origin was twice as important as production method, and to consumers of ground beef origin was four times as important as production method.

The second part of this study consisted of a written questionnaire of consumers' own associations to the concepts: organically or conventionally grown, grown in Sweden and imported. Their associations were then grouped into different categories:

- Quality in general/ taste
- Chemicals/poison/safety
- Local/less transportation
- Environment
- Health
- Price

The consumers associated to the environment in different ways, both directly (Environment) and indirectly through the relationship to Transportation and Local production. Also the category Chemicals/poison/safety, as well as Health; can be associated to the environmental argument. The results showed that *Swedish* and *Organic* gave positive associations that were very similar. Swedish vegetables were considered being of high quality in various aspects and were also connected to local production and short transportation distances. The main difference was the price, as organic was considered expensive. Imported vegetables had a negative image with a quarter of the consumers associating them with chemicals, and a fifth with long transportation. Nearly a third expressed doubts about safety or negative opinions of quality of imports. The ground beef-respondents associated the concept produced in Sweden with quality, controlled and free from disease, while imported meat was associated with disease, infection and unsafe. It could be added that when the same questions were put to a sample of 21 Italian students in Alnarp, the result was very similar in that they considered Italian food superior to imports, with the possible exception of Swedish salmon (which was most probably of Norwegian origin).

In the study at the store level, there were differences according to the consumers' behaviour. If we compare the two groups of consumers, we can see that those who bought organic fruit and vegetables seem to have a rather self-centred, health-related approach when choosing what fruit and vegetables to buy in general, while those who *did not buy* organic fruit and vegetables seem to be more social and meal-oriented. Both groups considered quality factors, such as freshness and keeping qualities, as important when buying fruit and vegetables. A difference between the two groups was that the non-buyers perceived the grocery store as a source of inspiration. While the first group had a completely positive view of organically grown fruit and vegetables, the second group expressed a conflict between what they perceived as a considerate (organic) choice (i.e. something one ought to buy) and what they perceived as unmet intrinsic and extrinsic food qualities of organic fruit and vegetables. This second group of consumers also expressed doubts and uncertainty about organic production.

The fruit and vegetable managers were more coherent in their perceptions concerning organic fruit and vegetables. The result of the text analysis showed that the managers perceived organic fruit and vegetables as "a marginal range of products from both a store profit and a consumer demand point of view". They perceived the handling and display of organic fruit and vegetables as "critical for the sales". The fruit and vegetable managers perceived consumers' interest in organic fruit and vegetable as "varied and characterised by low involvement". They mentioned many factors, such as lower prices, increased and continuous supply, concerted action taken by the whole food supply chain and higher consumer demand, as prerequisites for their own grocery stores to take action, by means of providing increased shelf space and marketing activities, to stimulate the sales of organic fruit and vegetable.

Discussion

From the in-store study the consumers who bought organic products had a health-oriented buying strategy, while those consumers who did not buy organic fruit and vegetables were more socially and meal-oriented, who perceived the grocery store as a source of inspiration, and for that reason the store could play a significant role by providing a broad supply of high quality organic fruit and vegetables and marketing activities that push the consumers to choose the organic alternatives. A conclusion from our consumer studies is that origin, Swedish, is a more important attribute than production method, Organic. Swedish is simply good enough. From a marketing perspective, the concept Swedish is a sales argument, which raises interesting questions concerning the increase in imported organic food on the Swedish market. It is also very interesting to note that the supermarkets are promoting an increasing and expanding range of their own private labels, where one idea is that the origin of the product is of little interest. There is, thus, a discrepancy between the interests of the consumer and of the supermarkets, since origin is valued higher than production method and that the same marketing arguments seem to be valid for the organic and the Swedish products in the eyes of the consumers.

Conclusions

While there is an interest in organic products among a group of consumers there is a lack of motivation on behalf of the retailers to invest time and interest in these products. There is also reason to believe that increased marketing efforts in the supermarkets would expand the market for organic food in general and fruit and vegetables, being impulse products, in particular

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Acknowledgements

This project was funded by the Swedish Board of Agriculture. Data collected by Jenny Nettersand and Fredrik Fernqvist has been used in the studies.

Organic marketing initiatives and rural development – lessons learned for the organic industry

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Abstract

Remarkable growth in organic production throughout Europe has provided new business opportunities for companies marketing organic products. Mostly they are small and their resources are limited. However, they have succeeded to find operational strategies, which are successful even in rural and remote areas. Earlier the high demand and low competitive situation helped many organic marketing initiatives (OMIs) to develop their operational concept. More lately markets have grown and the strategies need to be more customer oriented. Just being organic is not enough any more. Some of the determining factors for OMI success are supply policy, logistic and processing policy. Many OMIs are afraid of being dependent on one sales channel. Even though most of the sales volume goes through supermarket sales, especially in Nordic countries and UK, many still want to develop their direct sales and regional sales. The personal characteristics of the founders or managers are critical to get the owners and farmers to commit to the OMIs business vision. Organic values should be transmitted through the whole chain to consumers. Consumers need to know the advantages of organic products and they need to have trust in the actors.

Keywords: Organic marketing, success, marketing organisations

Introduction

In fifteen EU countries the organic production areas have grown annually on average 26 percent during the time period 1993-2001 (Hamm & Gronefeld, 2004). In food business this kind of growth is exceptional and creates new business opportunities for many. The main driver has been the consumers' very positive attitudes toward organic products. Organic products are considered natural, clean, safe and a healthy option in food choice (Bähr et al, 2004). The pull effect has got extra strength from each food related scandal published in media.

Organic production was very limited in the early 90's, which is seen also in the number of organisations marketing organic products. In the beginning availability of good quality organic products was the main problem for many marketers to diversify their functions. The example of the successful pioneers encouraged others to convert into organics and as the availability got better, a lot of new marketing organisations were established in late 90's. In many countries labelling systems and EU-funding and different public support systems strengthened this development. Organic action plans in several countries were introduced to support the growth of organic farming not only because of the high consumer demand but as well because it is considered as an environmentally friendly production method. This is motivated by issues like biodiversity, animal welfare and water pollution (especially ground waters).

This article is based on the results of the 'Organic Marketing Initiatives and Rural Development' (OMIaRD) research project, which has provided a publication series consisting

7 volumes (see more information http://www.irs.aber.ac.uk/omiard). The objective of the whole project has been to study development of organic markets, organisations operating in the sector and consumer motivation as well as the barriers to buy. In this short presentation we focus on organisations, which are mainly selling organic products. We call them OMIs according to the following definition: “An OMI is an organisation of actors (privately or cooperatively owned) involving participation of organic producers which aims to improve the strategic marketing position of the products by adding value to the raw product through processing or marketing”. This means that our findings do not cover the whole organic business sector. There are plenty of very small businesses which are typically family based and under our minimum turnover borderline (100 000 €). In addition, there are large conventional companies, which have just taken some organic product lines into their selection and the organic business does not play a major strategic importance for these firms. Our OMIs got at least 25 % of their turnover from organic sales.

The aim of this paper is to give short overview of the OMIs surveyed through out Europe. We try to summarise their strategically important success factors. Our extensive amount of data gives us relevant information of the development stages of the OMI and the meaning of the competitive situation. The results of our consumer studies give extra value for organic industries.

Material and methods

The whole OMIaRD project consists of a remarkable amount of different types of data (market data, expert information, OMI surveys, expert and manager interviews, network analysis, consumer focus groups and laddering interviews). A short overview for the data relevant for our presentation is given in Figure 1.

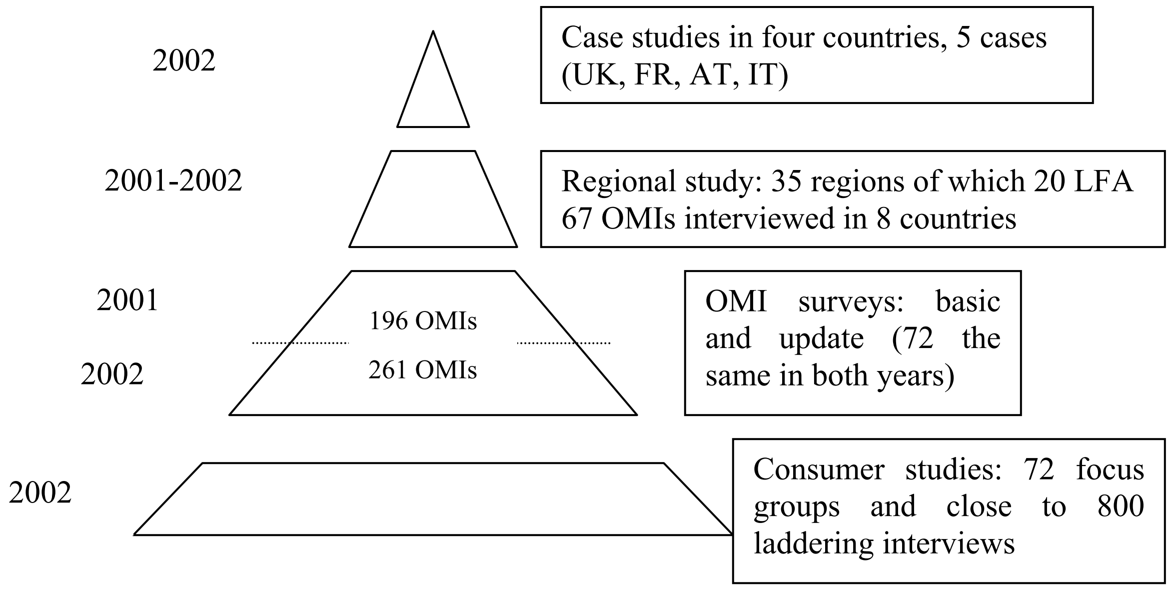

Figure 1. Overview to the data collection in OMIaRD, those related closest to OMI operations.

OMI surveys were done in 19 countries in order to investigate the basic information of marketing organisations. Such characteristics like founders, age of the organisation, size (turnover, personnel), products sold, sales channels and areas, and mission statements were analysed. A much more profound study was conducted on regional level. In all partner countries interesting areas were identified. These were at the same time representative of the organic sector in the country. So selection criteria included both regional aspects and internal OMI factors. From those 35 regions 67 OMIs were identified into a comprehensive business analysis. By using a standard framework questionnaire all the relevant business areas (4P's) complemented with personnel and history perspectives were discussed with the business managers. Finally four case study areas were included in the study. Research teams of both local and international researchers looked more in depth the businesses and interviewed close to 30 stakeholders in each area, both internal and external ones. Networking and rural development context were special focuses in this phase (Midmore et al, 2004).

Consumer studies are another main source of information to look at the organic market development. Almost 800 laddering interviews in partner countries gave a profound picture of consumer motivation in different market conditions and cultural base. Purchase barriers are issues which need to be tackled in order to get the market growth continue. Among other issues in 72 focus group discussions consumers had a possibility to take the position of the manager of our case study firms (vegetable box scheme model, meat company, mountain cheese producer and two pasta makers).

Results and discussion

A typical OMI doesn't exist. The business circumstances and country market structures are so versatile, that it seems to be that very different kind of innovative business ideas can survive and succeed. The size of organic markets is still limited and many market structures has established during the last ten years. It can be noticed that still most of the OMIs are small and their resources to take risk, invest, put own money on marketing activities are limited. The size and young age affects also to their possibilities to get into bigger sales channels. Closeness of potential markets has affected their business orientation. If direct sales are not an option, export can be. Even though many of our OMIs in the regional study are located in rural areas and even in LFA areas, the location is not a determining factor for OMI success.

In our study there seems to be some factors which have explanatory power for OMI success or failure. First of all we need to pick up the personal characteristics of the OMI founder or managers. There seems to be a remarkable amount of very strong personalities, quite often pioneers in the organic movement or otherwise very active persons in organic networks. As Sylvander states: "There is, on the one hand, the model of the inspired and charismatic founder who impresses all around and, on the other, the demographic group led by an inspiring founder. The essential feature is not so much the founder's management style, but the strength and the originality of the projects and the competences required to carry them out" (Sylvander & Kristensen, 2004).

Another highly discriminatory factor seems to be the supply policy of the OMI. Internal cohesion and the willingness to comply whit the OMI objectives need to be high. As well as the availability of raw materials can be a bottleneck in fast growing markets, the OMI should have special competencies to get also other reliable partners than just its own member farmers. The loyalty of the suppliers is critical.

Many of our OMIs are founded by farmers and their involvement is important. The starting motivation can have been just to get their organic products sold as organic and with good premium price. This causes sometimes conflicting interests between farmers and OMI managers. The willingness to invest to the OMI can be limited, if the main focus is in the organic farming itself. However, our results show that processing and logistic policy is another discriminating factor for success. Business in a larger scale implies that the managers need to solve all the difficult problems of logistics, including raw material collection, optimal storage conditions, sorting, grading, and distribution. In addition product development and processing gives the added value, which is important in customers' acceptance. Many OMIs have multiple and very demanding skills in this respect. Some others have outsourced these functions successfully.

Looking at the history and development stages of the OMIs analysed, shows how the development can be compared nicely to the product cycle theory. After a strong growth period organisations reach a phase in which the whole strategy of the organisation need to be redirected. Sometimes the original personnel are not enough any more, supply is not enough to fulfil the demand, or facilities, technology or computer solutions are inadequate. These kinds of strategic turning points have shown to be difficult for the OMIs. Flexibility and commitment to the new vision is requested of the owners. Quite often financing new investments contains a lot of risk. The new competences diverge from the original and the control pulls away from farmers. In an overall market growth situation these steps are easier to take than nowadays, when the growth has reached certain maturity and competition is harder. Just providing an organic alternative is not enough for customers anymore. The customers expect that the product concept (including service) suits perfectly to customer's own business concept.

Consumer studies clearly bring out the same issue. Consumers' willingness to pay extra price depends on their perception about the organic product. What do they know about it? What do they believe about the benefits of organic production and how do they perceive the difference between organic and conventional alternatives. This means that OMIs need to be able to mediate the organic values through the whole food-chain. The ethical objectives of OMIs should be seen in the whole concept. Economic objectives are also important but not enough.

Conclusion

Organic Marketing Initiatives have been and still are important for the expansion of organic food production. All though often neglected in the policy development of the EU smaller organic firms can play an important role as facilitator and organizer of distribution and value added products from local organic farms. A role that is very important for the continuous transition to organic farming principles.

The study of the many OMI's has also uncovered the fragile elements of such initiative. In the cases where the initiative is carried by one person, the manager, it is very crucial that the initiative seek to strengthen the internal network and communication. In remote areas – where a number of these initiatives are situated – the positive effect of the OMI on the local community can be of great importance for the area.

These positive effects of the OMI's can be promoted by national and European policymakers. Especially in connection with the development of the new EU instruments to promote rural areas, there seem to be potentials in tailored instruments like the OMI's, as they can have very positive environmental, social and economic potentials.

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Acknowledgements

This presentation is based on the findings of the "OMIaRD project". The authors gratefully thank all the contributors of the OMIaRD team of 10 partners in eight European countries. The project came true by the major finance of the Commission of the European Communities, under the European Union's Fifth Framework for Research and Technological Development Programme, for the project 'Organic Marketing Initiatives and Rural Development' QLK5-2000-01124. Finally, we must acknowledge of collaboration of the hundreds of individuals, businesses and organisations, which have provided the huge amount of information, sometimes even confidential in its nature, for us to analyse.

Characteristics, goals and motivations among organic dairy farmers in relation to time of conversion

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Abstract

This study explores organic farmers' characteristics, farming goals and conversion motives grouped by year of conversion (three groups). A survey was undertaken among organic dairy farmers in Norway in 2003. The new organic producers (converted in 2000 or later) were younger and less educated than the earliest entrants (the "old guard") who converted in 1995 or earlier. The frequency of activities like vegetable growing and poultry farming among the old guard was high. The newcomer herds were fed more concentrates and had a higher milk production intensity, showed a higher incidence of veterinary treatments and less frequent use of alternative medicine than the herds of the two earlier converting groups. For all groups of farmers, the highest ranked goals were sustainable and environment-friendly farming and the production of high quality food. Newcomers more often mentioned goals related to profit and leisure time. On average, the most frequently mentioned motives for conversion were food quality and professional challenges. The old guard were more strongly motivated by food quality and soil fertility/pollution issues than the others, whereas financial reasons were relatively more important among the newcomers.

Keywords: farming goal, motive for conversion, animal health, feeding, conventionalisation

Introduction

The area of land and number of farms under organic management in Norway has increased rapidly, as in many other countries worldwide. Most of the new players contributing to the growth in organic production must necessarily be conventional farmers converting to organics. Along with organic farming's popularity, some researchers have warned that the organic movement may be in danger of loosing its identity, with agribusiness involvement and abandoning of the more sustainable agronomic and marketing practices originally associated with organic agriculture (e.g., Guthman, 2004). This argument has been canonized as the "conventionalisation thesis".

Padel (2001) concluded that motives for conversion have changed from the earlier philosophical ideals and husbandry reasons towards an increasing focus on environmental and economic concerns, and the perception of organic farming as a professional challenge. The importance of subsidies for farmers' decisions to convert has not been studied in detail, and there has been little direct research about the goals of organic farmers.

This study aims to fill parts of these gaps by providing empirical information about Norwegian organic farmers' personal as well as farm characteristics, farming goals, and motives for conversion, grouped by year of conversion. The study is restricted to dairy farming since it is the dominating form of organic livestock production in Norway.

Materials and methods

The data reported here were collected as part of a larger questionnaire among Norwegian farmers. This paper examines data from the organic dairy farmers. The Norwegian Agricultural Authority has a register of farmers receiving support payments. Reproduction, feeding and production records are registered in the Norwegian Dairy Herd Recording System. The Norwegian Cattle Health Services register dairy cow health parameters. These data sets were merged with the questionnaire data.

The questionnaire was sent out in January 2003 to all 245 registered organic dairy farmers, and 161 (66%) farmers responded. The survey questions were related to among others: (1) farm and farmer characteristics; (2) farmers' goals and motives for conversion; and (3) livestock disease management strategies, included their use of alternative medicine.

The year in which the farm's first field(s) was certified as organic was presupposed to be the year of conversion to organic farming. Respondents were categorized into three groups: (1) those who had farmed organically since 1995 or earlier (early converters, the "old guard"); (2) those who were certified in the years 1996 to 1999 (mid converters); and (3) those who started farming organically in 2000 or later (late converters, the newcomers).

Data were examined using descriptive statistical analyses. Mean values obtained in different groups for metric variables were compared by t-tests, omitting an observation if it had a missing value. Chi-square statistics were generated for comparisons of frequencies of categorical data.

Results and discussion

Personal characteristics and farm production practices of the three groups are reported in Table 1.

Table 1. Farmer characteristics and production practices grouped by year of conversion.

	Early conv. (1)	Mid conv. (2)	Late conv. (3)	All	Significant difference[1]
Number of respondents	45	68	48	161	
Farmer characteristic					
Age of farmer (years)	50.5	48.4	42.8	47.2	**1-3, 2-3**
Farming experience (years)	23.3	24.9	18.7	22.6	1-3, **2-3**
Univ./college education (% of farmers)	53.7	38.2	31.3	40.1	1-3
Agricultural education (% of farmers)	82.5	77.9	68.1	76.1	
Land management					
Farmland (ha)	29.2	28.9	33.0	30.2	
Grassland (ha)	24.5	25.3	28.2	25.9	
Grain (% of farms)	53.3	35.3	47.9	44.1	1-2
Other crops (% of farms)[2]	55.6	22.1	22.9	31.7	**1-2, 1-3**
Livestock management					
Number of dairy cows	16.6	16.4	17.4	16.7	
Milk yield per cow (kg year-1)	4830	5073	5398	5110	1-3
Concentrates (FUm cow-1)	819	836	1006	885	1-3, 2-3
Other mammals (% of farms)[3]	51.1	36.8	33.3	39.8	1-3
Poultry (% of farms)[4]	40.0	13.2	12.5	20.5	**1-2, 1-3**
Animal health					
No. of disease treatments/100 cows	32.7	39.4	53.0	41.9	1-3
Use of alternative medicine (% of farmers)	77.5	66.7	43.5	62.5	**1-3**, 2-3

"Early converters" = conversion in 1995 or earlier, "Mid conv." = 1996-1999, "Late conv." = 2000 or later.

[1] Significant differences are in italics (P<0.10), normal (P<0.05) or bold (P<0.01), based on t-tests for metric variables and chi-square tests for categorical variables.

[2] Percentage of farmers having 0.2 ha or more of potatoes, vegetables, fruit or berries.

[3] Farms having at least two other animals (suckler cows, sheep, goats, pigs, horses).

[4] Farms having hens, chicken, turkeys, ducks or geese.

The average organic dairy farmer was 47.2 years old and had 22.6 years of farm experience. Late entrants were significantly younger and had less farming experience than the two earlier groups. More than 40% of the respondents had some college or university education. Early entrants had a significantly higher educational level than the late entrants.

The average farm had close to 17 dairy cows and 30 ha of farmland. The farm size measures were quite similar across the groups. On average, 85% of the farmland was used to produce grass. More early entrants than farmers in the mid group produced grain. A greater number of the old guard farmers, compared to the mid and late entrants, cultivated "other crops" and kept poultry, however, usually on a very small scale. They also tended to more mixed livestock farming than the later groups. These findings indicate that a substantial part of the old guard follow the organic ideals of mixed farming and self-sufficiency.

Supply of concentrates per cow was quite similar between the two earliest groups, while the new producers' cows were fed more concentrate. The higher concentrate feeding intensity was associated with a higher milk yield per cow. The late entrants' average milk yield of 5398 kg per cow was low compared to the overall average of 6190 kg in Norwegian dairy herds.

The newcomer herds showed the highest level of registered disease treatments per cow. A vital question is however if the registered disease treatments actually mirror the true number of diseases in the herd. The farmer's threshold for veterinary treatment of diseases influences the resulting treatment rate. Further, alternative treatments are incompletely reported to the Cattle Health Services, and the earliest groups had a significantly higher user frequency of alternative medicine.

Table 2. Percentage of farmers rating various goals and motives as important grouped by year of conversion.

	Early conv. (1)	Mid conv. (2)	Late conv. (3)	All	Significant difference[1]
Farming goals					
Sustainable and environment-friendly	88.9	83.8	68.8	80.8	1-3, 2-3
farming	80.0	77.9	75.0	77.6	
Producing high quality food	51.1	60.3	58.3	57.1	
Reliable and stable income	62.2	50.0	54.2	54.7	
Time for family, living quality for children	46.7	47.1	37.5	44.1	
Independency, self employment	40.0	30.9	39.6	36.9	
Work with animals/crops	28.9	44.1	27.1	34.8	2-3
Improve the farm for the next generation	17.8	17.7	37.5	23.6	1-3, 2-3
Have sufficient leisure time	13.3	23.5	27.1	21.7	
Reduce debt, become free of debt	13.3	19.1	25.0	19.3	
Continue to be a farmer	6.7	10.3	22.9	13.0	1-3, 2-3
Maximize profit	11.1	8.8	4.2	8.1	
Social contacts	6.7	0.0	2.1	2.5	1-2
Increase equity	0.0	0.0	0.0	0.0	
Higher private consumption					
Motives					
Food quality	62.2	45.6	41.7	49.1	1-2, 1-3

Professional challenges	33.3	47.1	45.8	42.9	
Soil fertility, pollution problems	51.1	35.3	27.1	37.3	1-2, 1-3
Ideology, philosophy	40.0	35.3	25.0	33.5	
Health risks (pesticides etc.)	24.4	36.8	33.3	32.3	
Animal welfare	22.2	32.4	33.3	29.8	
Profitability	11.1	22.1	37.5	23.6	**1-3**, 2-3
Organic farming payments	6.7	10.3	35.4	16.8	**1-3, 2-3**
Natural conditions (soil, climate, etc.)	8.9	7.4	10.4	8.7	
Income stability	2.2	4.4	2.1	3.1	

[1] Significant differences are in italics (P<0.10), normal (P<0.05) or bold (P<0.01), based on the chi-square tests.

From a list of 14 farming goals, the respondents were asked to select up to five goals as most important for them. In the same way, from a list of 10 motives for conversion to organic farming, the respondents were asked to select up to three motives as most important for them. Table 2 shows the percentage of farmers rating various goals and motives as important.

The highest ranked goal in general was ”sustainable and environment-friendly farming”. The goal ”producing high quality food” followed close behind. The goals of converters to organic farming have changed over time. Nearly 70% of the late entrants had ”sustainable and environment-friendly farming” as an important goal, while the rate was close to 90% in the old guard. A higher frequency of the late entrants found ”have sufficient leisure time” important. Profit maximization ranked very low in the early and mid group, while it was mentioned more frequently among the newcomers. Even though goals of profit and leisure time had become more important, environmental and food quality goals were the most frequently stated goals among the new organic producers, as well.

On average, the most important motives for conversion were ”food quality” and ”professional challenges”. Among the old guard, ”food quality”, ”soil fertility, pollution problems” and ”ideology, philosophy” appeared most frequently, whereas ”professional challenges” and ”food quality” were ranked highest in the later groups. A significantly higher frequency of the late entrants than respondents in the earlier groups mentioned ”profitability” and the ”organic farming payments” as important motives. However, the traditional environmental, food quality and philosophical concerns were more widely present as motives for conversion. ”Food quality” and ”soil fertility, pollution problems” motives appeared more frequently among the old guard. Our findings are quite similar to previous studies reviewed in Padel (2001).

Conclusions

Trends towards more pragmatic forms of organic production were identified. The old guard tended to have a more diverse enterprise mix. Newcomers’ dairy herds had higher inputs of concentrates, achieved higher milk yields, and had a higher incidence of veterinary treatments. Few of the new producers used alternative medicine. Among the late entrants, a considerable share seemed to convert because of the prospects of more profitable farming and the additional organic farming payments rather than because of an ideological commitment to organic farming. The degree of intensification is however still rather low, and the greater part of the herds, had a moderate or even low milk production per cow. Although financial considerations have become quite important for a considerable number of the late entrants’ decision to go organic, environmental, food quality, and philosophical concerns were still more widely present as goals and motives. A potential challenge seems to be the farmers who go organic just for the subsidies, without any commitment to the organic ideals.

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Acknowledgements

The Research Council of Norway, grant 151264/110, provided financial support for this research. The authors thank the farmers participating in the survey for their cooperation and willingness to answer the questionnaire.

Prospect for organic farming in Denmark

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Abstract

Concerns about the impact of modern agriculture on the environment have led to public support for the development of organic farming during the last 10-15 years. Besides generating environmental benefits and supplying food, organic farming is supposed to be "multifunctional", such as providing rural amenities and promoting rural development. In Denmark, conversion into organic production has increased rapidly through the 1990s. Nevertheless, despite increased consumption of organic products in Denmark (in fact, Denmark has the highest organic share in consumption), drastic increases in organic production has led to surplus supply of organic products, especially milk.

In this paper we use a dynamic general equilibrium model specifically developed for forecasting the Danish economy towards 2022 to explore the future development of the organic production in Denmark. Several policy scenarios aiming at benefiting organic production are analysed and the strength and weakness of these policy scenarios are discussed.

Keywords: forecasting, computable general equilibrium (CGE), applied general equilibrium (AGE), modelling

Introduction

This paper is a short description of the work undertaken under a research project financed by the Danish Research Centre for Organic Farming. The aim of the project was to develop a dynamic general equilibrium model for the Danish economy with specific attention to organic farming, and to utilize the model for forecasting the future time path for organic production and analyse various policy simulations. This presentation will focus on the forecast and policy analysis.

Background

During the period 1989 to 1994 organic land almost tripled in size (from 5,500 to 16,400 hectares) and the total land farmed according to organic principles doubled (from 9.600 to 21.100 hectares). From 1994 to 1999 there was a huge interest in converting even more land into organic farming and certified organic land increased from 16,400 in 1994 to 147,000 hectares in 2003. Since 1999, land under conversion has fallen with the effect of levelling out the total organic land (organic and converted) to 166,000 hectares in 2003.

The predominant organic production is organic milk production. Around 10 percent of total milk production in Denmark is produced organically, thus representing not only a large production share in organic terms but also compared to conventional production.

The Danish organic food market is characterised by very high organic market shares. Purchase data reveal that this is the case, especially for organic dairy products, cereals and vegetables (in that order). Milk has the highest organic share and consumption of organic milk constitutes 27.5% of total milk sales and 34% of total sales of organic food. Milk and oats have the highest organic shares and the lowest price premiums as compared to their conventional counterparts. On average, more than half of all organic products are purchased by heavy users.

The correspondence between production and consumption was close in the first half of the 1990s. But from the end of the 1990s growth in consumption has levelled off while production has continued to increase at rapid speed, a development that has resulted in a situation where approximately 60 percent of organic milk production has not been sold as organic products from the year 2000 and onwards.

As of 2001, there have been several changes to the contracts between ARLA (the market leader of milk in Denmark) and the milk producers, some of which have been adopted intentionally for lowering the economic benefit to the organic milk producers so as to achieve a better balance in the organic milk market. This has resulted in a slight downward trend in production from its peak level in 2001. Therefore, a downward trend can be expected in the future, due to the mismatch between supply and demand for organic products.

This surplus production situation is not an isolated Danish phenomenon. The Dairy Industry Newsletter in 2003 estimated that some 40 percent of the total organic milk production in the EU is in surplus. The problem is the largest in Denmark, Austria and the UK (60, 50 and 50 percent surplus, respectively).

The model applied

The applied general equilibrium model describes the Danish economy by 68 industries that produce 76 commodities, which can be used for either consumption or production. Each industry maximises its profits, whereas each household maximises its utility. The government sector consumes goods, invests in capital, collects taxes, subsidises production, makes transfers to households, accumulates debt, and pays interest. All agents are assumed to be price takers, with producers operating in competitive markets and earning zero economic profit. In equilibrium, demand equals supply for each type of domestically produced commodity and primary factor of production.

Each primary agricultural sector/processing industry has been split into two separate activities in the model: one producing organic products, and the other producing conventional products. In total 18 organic industries produces 19 organic products. The substitution nests in private consumption have also been altered to emphasise the pair-wise substitution between organic and conventional products.

The model links successive years through a specification of physical capital accumulation and investment, financial asset accumulation, lagged adjustment process in the labour market and finally through dynamic land allocation that ensures that economic return to land in conventional and organic production is equalised in the longer run while it can differ in the short run.

Structural forecast for the Danish economy and analysis targeting organic

The purpose of creating a structural forecast of the Danish economy is twofold. First it is used to forecast the future of the Danish economy and its structural development. Second, this forecast serves as the benchmark against which subsequent policy scenarios can be measured.

The starting point for forecasting the Danish economy is a database reflecting the Danish economy in the year 2002. The forecast period covers the period of 2003 to 2022. Such a forecast requires: exogenous assumption on key macroeconomic indicators (for the period from 2003 to 2006, these are supplied by the Danish Economic Council; thereafter we assume average yearly growth rates); exogenous assumption on changes in preferences of households and the production technologies of industries; inclusion of known policy changes in the entire forecast period such as changes in the minimum acreage requirement and the reform of the EU Common Agricultural Policy (Agenda 2000 and the latest 2003 reform). Furthermore, we also assume that the market for organic milk will be balanced within the first eight years of the simulation.

The forecasts provide a microeconomic picture that is consistent with the macroeconomic scenario. These forecasts may be of interest to decision makers in business and policy. Also, they serve as a realistic base case, from which answers to traditional “what if” questions, such as the environmental taxation, changed regulation or technical change, can be answered.

In the baseline, domestic consumption of organic products experience relative high yearly growth at the beginning of the period, due to falling prices caused by the tendency toward equilibrium in the market for organic milk. In the long run, growth levels off at a yearly rate between 0 and 1.6, depending on the products.

Despite increases in consumption, a 22 percent accumulated fall in the amount of land used for organic production is calculated. This sharp decrease is explained by the above mentioned required balance in the market for fresh organic milk and the fact that organic milk initially accounts for more than 60 percent of the total organic agricultural production. That is, the initial large market disequilibrium in this important market explains the result.

For organic agriculture, the most important shock in the baseline is the assumption that the market for organic fresh milk will be balanced during the period 2003-2010. This requirement results in negative annual growth rates for organic milk production and the closely related production of roughage. Also, the price of organic milk and hence the land rental will fall as a result of the reduced demand for milk. Lower land rental leads to lower unit costs in the other organic enterprises and hence they have the potential to expand production. Cereal production is hardly affected in the first couple of years even though cereals are an important input into the dairy sector. The reason is that lower cereal prices benefit the pig and poultry sectors, resulting in a positive impact on cereal production.

Towards the end of the forecast period, all organic products exhibits annual growth rates between 0.2-3.0 percent. These growth rates do not have any significant impact on the development in organic land since growth of this magnitude is accommodated by technological progress.

Five scenarios analysing political intervention that changes relative competitiveness of organic farming have been studied, including productivity growth through adopting new machinery (especially weed-killing robots); strengthening the regulation underlying organic farming by banning the usage of conventional fodder and manure; subsidizing organic land; taxing pesticide and fertiliser uses in conventional farming and finally increased willingness to pay for organic products.

Measuring the impact by organic land productivity growth only exhibits modest increase of 0.5 percent, as compared to the baseline even though the productivity growth has large positive effects on horticultural production. The reason is that productivity growth leads to lower production cost and thus increased demand, but productivity growth also has the effect that the same production volume can be produced on less land. The combined effect results in this modest effect on organic land.

Strengthening the requirement for organic production has the effect of increasing the cost in crop production and leads to increases in the price of organic manure. In organic livestock sectors, unit costs are increased through the requirement of all fodder being organic but also give rise to increased earnings through higher price of manure produced. The combined effects of these forces are modest measured by both production and land.

Subsidising organic land use leads to improved profitability and thus stimulates the interest in converting into organic production. But subsidies also lead to a substitution effect between land and other inputs, thereby leading to a lower total production per hectare in organic production. The environmental impact of subsidies is modest, due to land moving into a cleaner production. This is because conventional production actually increases its usage of unwanted input, as the subsidies lead to general increase of land rentals and thus stimulates a substitution effect favouring other inputs in conventional production. The latter effect is relatively small but nevertheless interesting.

Taxing unwanted input in conventional production also changes the relative profitability between conventional and organic production, favouring organic production. Applying the taxes such that results in somewhat the same size of organic land as compared to the subsidy scenario, results in reduced usage of unwanted inputs that are much larger, as compared to the subsidy scenario.

Changed consumer preferences towards organic products have a direct positive impact on the organic production measured both by size of the organic land and by effectiveness in production. A preference change also leads to an efficient organic production. Comparing to other scenarios, this does not affect welfare negatively since it is the choice of consumers.

Conclusion

This paper has explored the future prospects for organic farming in Denmark using a dynamic applied general equilibrium model of the Danish economy. The forecast reveals steady growth in the consumption of organic products, but in spite of this, the area of land used according to organic principles is expected to fall by some 22 percent. This is the consequence of the present disequilibrium in the organic milk market that is expected to disappear in the longer run.

Several policy scenarios were analysed. If the political aim is the size of the organic sectors measured by size of land, subsidies are effective; whereas if it is the reduction in the use of pesticides and fertilizers in agriculture, taxing those inputs are the most effective strategy.

Productivity growth or strengthening the regulation underlying organic production had only marginal effects on organic land, while productivity potentially could have sizeable effects on production and consumption. Increased willingness to pay for organic products have a direct positive impact on the organic production as measured both by size of the organic land and by the effectiveness in production.

Pathogenic Yersinia and Listeria monocytogenes in organic pork production

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Abstract

The microbiological safety of organic food has been under some debate, because knowledge of microbial hazards in organic farming, animal production in particular, is scarce. There is some evidence that differences in pig husbandry, farming and production systems can affect the on farm prevalence of foodborne pathogens such as *Yersinia* and *Listeria* that can cause serious illness in humans. The goal of this study is to determine the prevalence of pathogenic *Yersinia* and *Listeria monocytogenes* in organic pork production and assess risks in different steps of the pork production chain. A total of 1940 faecal, pluck, carcass swab and meat samples were examined for *Listeria monocytogenes, Yersinia enterocolitica* and *Yersinia pseudotuberculosis* to assess microbiological safety of organic pork production compared to conventional. Information gained from this study is used to create a more advanced model for the pathogen risks in pork production chain, including special features of organic farming.

Keywords: *Listeria monocytogenes*, pathogenic *Yersinia*, pork, prevalence, risk assessment

Introduction

Yersinia enterocolitica, Yersinia pseudotuberculosis and *Listeria monocytogenes* are foodborne pathogens that can cause serious illness in humans. *Yersinia* is the third most common enteropathogen reported in humans in Finland, after *Campylobacter* and *Salmonella*. In 2003, the number of reported human yersiniosis cases was 647, of which 174 were caused by *Y. pseudotuberculosis* and 473 by *Y. enterocolitica* (Holmström et al, 2003). *L. monocytogenes* possesses a threat especially for people in high-risk groups such as pregnant women, neonates, immunosuppressed persons and elderly people, but also healthy young people can be infected (Farber & Peterkin, 1991; Miettinen et al, 1999). In 2003, a total of 41 *L. monocytogenes* cases were reported in Finland, of which over 50% were 65 year-olds or older (Holmström et al, 2003).

Pathogenic *Yersinia* and *L. monocytogenes* are commonly found in pig tonsils. In previous papers the prevalence of *Y. enterocolitica*, *Y. pseudotuberculosis* and *L. monocytogenes* in fattening pig tonsils have been 36-65%, 4% and 22%, respectively (Asplund et al, 1990; Fredriksson-Ahomaa et al, 2000; Korte et al, 2002; Niskanen et al, 2002; Autio et al, 2004). Both genera (*Yersinia* and *Listeria*) are able to multiply during cold storage and therefore cause a threat in a modern distribution chain of foods.

The microbiological safety of organic food has been under some debate, because knowledge of microbial hazards in organic farming, animal production in particular, is scarce (Bourn & Prescott, 2002). In general, consumers expect the microbiological quality of organic products to be higher compared to that of conventionally grown (Williams & Hammit, 2001). There is some evidence that differences in pig husbandry, farming and production systems can affect the prevalence of pathogens such as *Yersinia* and *Listeria*. In previous studies the prevalence of *L. monocytogenes* was found to be higher in pigs raised on silage or wet feed than in pigs fed with dry feed, and lower in specific pathogen free herds (SPF) than non-SPF herds (Skovgaard & Norrung, 1989; Buncic, 1991; Belœil et al, 2003). The prevalence of *Y. enterocolitica* has been shown to be higher in specialized slaughter pig production than in conventional farrow-to-finish production (Skjerve et al, 1998). It is possible that organic and conventional pig production are similar factors causing differences in microbial status between the two systems.

Risk assessment modelling is a novel tool for decision making in complex systems (Nauta et al, 2000). A quantitative model can pool together large amount of data and provide a simulation framework for different scenarios and control measures. Department of Food and Environmental Hygiene of University of Helsinki and National Veterinary and Food Research Institute have started a research project in co-operation with the Finnish Association for Organic Farming to assess the microbial food safety risks concerning organic versus conventional pork production.

Progress of the project

Altogether 15 farms, 5 organic and 10 conventional, from South-Western Finland were selected for the study. Samples were collected during summer 2003 to winter 2005. In every farm, ca 25 pigs were sampled for *L. monocytogenes* and pathogenic *Yersinia* at farm and slaughterhouse. At the farm rectal swabs from pigs and at slaughterhouse samples from intestinal content, pluck, tonsils and carcass were collected. The farm and slaughterhouse samples were taken from the same individuals to allow detailed studies of contamination over production chain. In addition 155 meat samples from meat cutting plants were collected to assess the occurrence of *Yersinia* and *L. monocytogenes* in organically and conventionally produced meat. Meat samples were collected from the batches that included sample pigs. The total of 1940 microbiological samples were examined with conventional cultivation methods using modified ISO protocol (1996) for *L. monocytogenes*, and modified NCFA method (1996) for *Yersinia*. The remaining analyses of samples should be completed in the summer 2005. In addition, data on possible risk factors were gathered from the farms to assess possible routes of contamination of pigs. Statistic methods will be used to analyse the prevalence data and data on possible risk factors. The information on microbiological tests, on-farm questionnaire and observation results are further used to construct a probability model to describe the probability of infection of *L. monocytogenes* and pathogenic *Yersinia* on farm and the transition probability to slaughterhouse. The project should be completed and results reported at the end of the year 2005.

Conclusions

In this project, the information got on the prevalence of *L. monocytogenes* and pathogenic *Yersinia* of organic pig farms, contamination routes of the pigs on farm and contamination of the carcasses and meat in food processing can help to evaluate the microbiological safety of organic pork compared to the conventional system. The risk model constructed in this project can be used for the evaluation of the different interventions available for the reduction of the risk for consumers caused by *L. monocytogenes, Y. enterocolitica* or *Y. pseudotuberculosis*.

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Acknowledgements

This project was funded by Ministry of Agriculture and Forestry, Finland. We thank slaughterhouses, meat cutting plants and farmers for co-operation in this project.

Contamination of lettuce with *E. coli* from the use of animal manure as fertilizer

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Abstract

In organic agriculture animal manure is commonly used as fertilizer for the production of vegetables. Since manure may harbour pathogenic bacteria such as *Salmonella spp*., *E. coli* O157:H7 and other Shiga-toxin producing E. coli, Yersinia spp. and Campylobacter spp., questions have been raised of their bacteriological safety. A few surveys have shown that both indicator organisms and pathogens may be isolated from organic vegetables, but if such vegetables are of poorer bacteriological quality than conventionally produced vegetables remains to be seen. However, there are studies that have shown that pathogens may be transmitted from manure-amended soil to the plants and that the bacteria may be internalized into lettuce tissue. In contrast, other studies indicate that such transmission does not take place. In conclusion, there are several factors that influence the transmission of pathogens and indicators from manure to vegetables and more research is needed in this field.

Keywords: Animal manure, lettuce, *E. coli*, pathogens

Introduction

Manure is commonly applied as fertilizer to fields used for vegetable production in both conventional and organic agricultural systems with increased used in the latter. Application of untreated manure may represent a risk of contamination of the vegetables; as such manure may harbour pathogenic bacteria such as *Salmonella spp*., *Listeria monocytogenes*, *Escherichia coli* O157:H7 and other Shiga-toxin producing bacteria that may contaminate soil, irrigation water and the plants. However, the fact that the pathogenic bacteria often are present in low concentration makes it necessary to look for surrogates when examining food stuffs for the presence of potential pathogenic bacteria. Because *E. coli* is always present in faecal material and has the intestines as its only reservoir, it is normally used as an indicator of faecal contamination. Thus, the presence of *E. coli* on plants such as lettuce may suggest that faecal contamination has taken place and that faecal pathogens may be present.

This paper focuses on transmission of *E. coli*, used as an indicator, and pathogenic bacteria from manure to product.

Presence of indicator organisms and pathogenic bacteria in organic vegetables

There have only been a few studies investigating the presence of indicator organisms and pathogenic bacteria in organic vegetables. Although the results from these studies show that the bacteriological quality generally is good, indicator organisms, such as *E. coli*, and pathogens, such as *Listeria monocytogenes*, have been detected (Loncarevic et al, 2005; McMahon and Wilson 2001; Sagoo et al, 2001). There has been one outbreak of food borne disease that could be directly linked to the consumption of organically produced vegetables (Tschäpe et al, 1995). In a nursery school in Germany several people (children and adults) became ill after eating sandwiches that were made with organic parsley that were contaminated with Shiga-toxin producing *Citrobacter freundii*. There is, however, no evidence that organically produced vegetables are of poorer bacteriological quality than conventionally produced vegetables.

Transmission of bacteria from manure to lettuce

In the production of lettuce, manure is commonly applied before sowing seeds or transplanting into the field. Different types of manure, such as manure-based composts, firm manure and slurry may be used and theoretically these different manure types could influence the hygienic quality of the lettuce. Several studies have investigated the potential for transmission of pathogenic bacteria and indicator organisms from manure to lettuce using different approaches (Dong et al, 2003; Islam et al, 2004a; Islam et al, 2004b; Johannessen et al, 2004; Johannessen et al, 2005; Natvig et al, 2002; Solomon et al, 2002; Warriner et al, 2003). Results from Solomon et al, (2002) indicated that *E. coli* O157:H7 was transmitted from the soil via plant roots to the lettuce seedling leaves when seeds were sown in contaminated soil. In contrast, an experiment by Johannessen et al, (2005) where transmission of *E. coli* O157:H7 through the roots to the plants were studied, the bacterium was not detected in any of the samples of the plant. In the last-mentioned study seedlings were transplanted into soil that was fertilized with manure that was contaminated with *E. coli* O157:H7. This suggests that the time of introduction of contamination is important. Another direct transmission route from manure-amended soil to plant is through splashes of soil either from heavy rainfall or water spreaders. Application of manure after the plants have come up or after transplanting of seedlings may also lead to contamination of the plants and are not recommended. However, there are also other factors that are important in the transmission of indicator organisms and pathogens from the use of animal manure as fertilizer. The type and concentration of bacteria are important. It has been shown that different bacteria have different potential for the colonization of plants (Dong et al, 2003). The climate plays a role and also the type of vegetable is of importance. Gagliardi and Karns (2002) showed that *E. coli* O157:H7 persisted for a longer period of time with cover crops. The same trend was observed by Islam et al, (2004a) who found *E. coli* O157:H7 persisted for a longer time in soil covered with parsley plants than in soil from lettuce plots, which were bare after the lettuce were harvested.

Conclusion

The potential for lettuce to become contaminated with indicator organisms and pathogenic bacteria from the use of animal manure seems to be relatively small. However, more research is needed in the field of transmission routes of pathogens in vegetables production.

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Changes in soil characteristics and product quality under the influence of long-term organic farming

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Abstract

Conversion form conventional farming to organic production farming method results in changes in soil characteristics and product yield. The aim of the research is to assess changes in quality of soil and wheat yield under the influence of long-time organic production conditions. The analyses were carried out at the farm of the LUA Centre of Agroecology during the period of 1997 - 2004. Different crop rotations were applied at the farm. In the first crop rotation plants were fertilised with organic fertilizers, while in the second crops were grown without the use of organic fertilizers. The analyses show that soil characteristics deteriorate in the fields of both crop rotations during the period of investigation. In the first crop rotation, the content of organic carbon decreased from 1,64 to 1,23 %, that of phosphorus from 231,4 to 184,5 mg kg^{-1} and that of potassium from 217,0 to 168,5 mg kg^{-1}. Respectively, in the second crop rotation the content of organic carbon decreased from 1,47 to 1,14 %, that of phosphorus from 145,4 to 101,2 mg kg^{-1}, that of potassium from 155,1 to 105,6 mg kg^{-1}. The yield of winter wheat Širvinta-1 under organic farming conditions in Lithuania was high (mean 4,4 t/ha) and the quality according to different parameters corresponded to first - third classes quality requirements. The mean content of proteins during the period of investigation was 12,0 %, that of wet gluten was 20,08 %, sedimentation was 30,63 cm^3. The differences of yield and quality during different years may be explained by meteorological conditions.

Keywords: organic farming, wheat, soil quality.

Introduction

Organic production areas expand every year in Lithuania. The implementation of requirements of the new farming system requires new type of knowledge and experience. Under different conditions, the results of foreign scientists may not always be transferable and applicable to our farms, thus it was necessary to carry out the investigations of the new system under local conditions. Comparative investigation of different farming systems carried out at the Lithuanian University of Agriculture allowed to evaluate qualitative and quantitative differences and peculiarities of their formation in different farming systems, as well as to highlight the main problems of organic production (Rutkoviene et al, 2003). In 1997 the Centre of Agroecology was established in LUA, where field trials of organic farming are carried out and organic farming monitoring is done. The aim of the research is to assess changes in quality of soil and wheat yield under the influence of long-term organic farming.

Materials and methods

The analyses were carried out at the farm of the LUA Centre of Agroecology during the period of 1997- 2004. The farm is situated in the zone of Lithuanian central plain. In the farm *Endohypogleyi _Eutric Planosols -. PLE-gln-w* medium clay loam soils prevail. Analysing of granuliometric compozition of organic farm was estimated, that in the soil prevailing fraction are fine sand (0,25 – 0,05), coarse dust (0,05 – 0,01) and silt soil(<0,001). According to the Fere triangle in all fields of farm granuliometric composition of soil is this medium loam. The investigations were carried out in phosphorus, potassium and humus rich soils that were close to neutral or neutral. The farm converted to organic farming in 1997 in the area of 25 hectares. Two different crop rotations were implemented in the farm. The first crop rotation consisted of winter wheat, spring crops + under crop, perennial grasses of first year use, perennial grasses of second year use. Perennial grasses of second year use were cut, the soil was shaved, organic fertilizers were shaken, cultivated and winter wheat was sown. The second crop rotation consisted of winter wheat, summer crop, legume crop for seeds or for green manure, spring crops + under crop, perennial grasses of first year use, perennial grasses of second year use. Nitrogen content was adjusted by growing legume crop, fields of the first crop rotation additionally fertilized with organic fertilizers. Soil sample was taken in autumn after harvesting 4 times repeatedly from the stationary observation sites installed in the crop rotation fields.
Indicators such as organic carbon, mobile phosphorus and potassium, total nitrogen, pH were determined in the soil. Chemical analyses were carried out at Lithuanian Agrochemical Research Centre. The variety of wheat grown was Širvinta-1. Samples of wheat grain were taken from the field. Chemical grain analyses were carried out at the chemical laboratories of LUA, LIA and UAB Ustukių mill. Protein, wet gluten and sedimentation were determined using the method of close infrared spectroscopy with computer analyser Infratec. Grain quality was determined in accordance with the requirements of the standard LST 1542:2002. Flour quality assessment was made using Farinnograph of Bradenber in accordance with the requirements of the standard LST-1696:2001. The program Statistica was used for processing the data of investigations.

Results

Data of changes in soil characteristics is presented in Figure 1 and Figure 2.

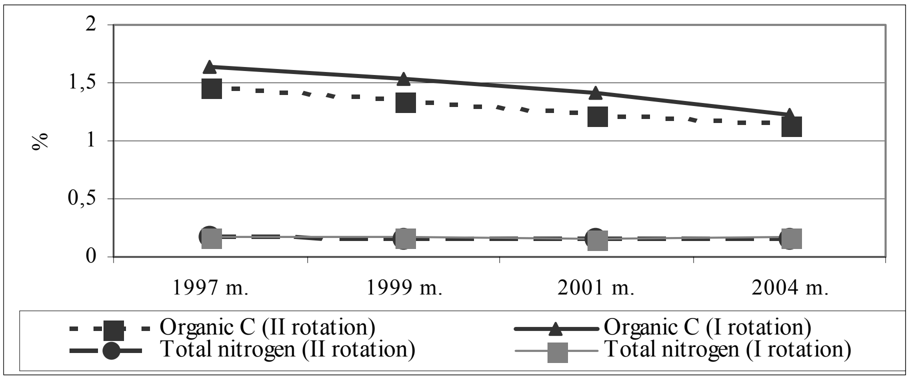

Figure 1. Influence of long-term farming on the changes of organic C and total N of soil.

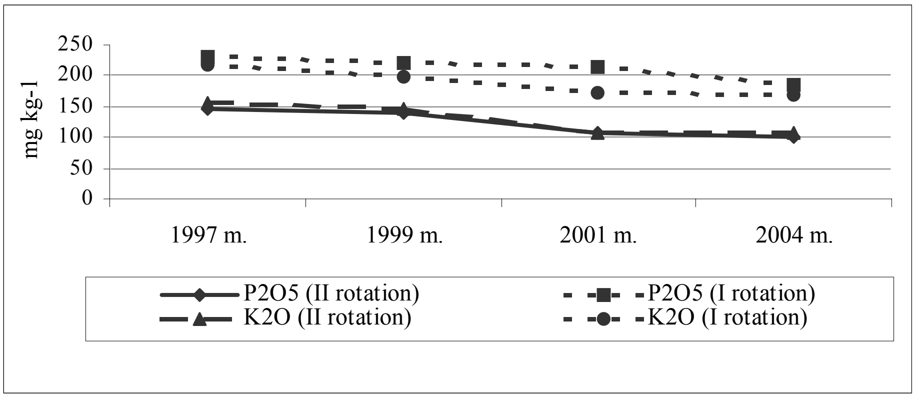

Figure 2. Influence of long-term farming on the changes of mobile phosphorus and potassium in the soil.

Soil characteristics deteriorate during the period of investigation. In the first crop rotation, the content of organic carbon decreased by 0.41 %, that of mobile phosphorus by 46,9 mg kg^{-1} and that of mobile potassium by 48,5 mg kg^{-1}, however general nitrogen content remained almost unchanged. In the second crop rotation the content of organic carbon decreased by 0.33 proc., that of mobile phosphorus by 44,2mg kg^{-1} and that of potassium by 49,5 mg kg^{-1}. pH in the first crop rotation was 6,3-6,7 and in the second it was neutral 7,0-7,2.
The calculation of nutrient balance shows it negative in both crop rotations. Higher content of nitrogen, phosphorus and potassium were taken from the first crop rotation field together with the yield than from the second due to the lower yield of the second crop rotation. Despite different agrochemical characteristics determined in the first and the second crop rotations (higher in the first crop rotation fields), the trends of changes under organic farming term are very similar.
Grain yield of organic winter wheat Širvinta-1 and their quality indicators reflecting their suitability for processing are presented in Table 1.

Table 1. Influence of organic farming term on winter wheat grain yield and quality.

Index	1998	2002	2003	2004		Mean	Standard devitation
	I rotation	I rotation	II rotation	I rotation	II rotation		
Proteins, %	11,82	11,74	12,64	11,81	11,78	12,00	0,43
Wet gluten, %	19,31	20,30	21,11	19,59	18,33	20,08	0,80
Sedimentation, cm^3	27,54	37,52	36,66	20,81	20,0	30,63	7,95
Yield, t ha^{-1}	4,6	4,0	4,5	4,5	4,0	4,4	0,27

Grain yield was high in both crop rotation fields under organic farming conditions in Lithuania (4,0-4,6t/h) and was stable during years of investigations, however the trends of deterioration in soil characteristics was observed.
Wheat grain quality was assessed in accordance with three criteria complex provided by the standard requirements and assuring the quality of bakery products. Protein content of investigated grain, which is one of the main quality indicators, was on mean 12,0 % and complied with the quality requirements of second class each year. According to gluten content organic grain complied with the quality requirements of third class. Sedimentation indicator, which characterizes protein content and quality in

complex, was marked by the biggest variation. Sedimentation indicator values changed in a wide range of values, however each year complied with first or second-class requirements. Dough quality analyses carried out using Farinograph show direct and strong correlation between the value of proteins and wet gluten indicators and that of valorimeter (r = 0,72, 0,83), describing the quality of dough. The comparison of quality indicators of yearly wheat grain yield reveals that there is no clear trend of quality indicators change subject to term of farming years. In 1998 and 2004 grain were characterized by lower quality. This may be explained by meteorological conditions as small number of sunny days and low temperatures during vegetation period resulted in lower grain quality indicators. Grain quality, as it is known, is determined not only by growing and meteorological conditions but also by the genetic structure of the variety. Our analyses of quality of eleven varieties of winter wheat grown under the same organic farming conditions show that protein content varied from 8,3 % (variety Baltimor) to 11,81 % (variety Širvinta-1). Sedimentation and gluten indicators between different varieties of wheat grain were also higher than between wheat grain of the same variety grown in different years.

Discussion

Research on the influence of long-time organic farming allowed assessing the impact of various factors on the quality of organic wheat. It was determined that in our case the impact of variety and meteorological conditions on the mentioned factors was higher than that of the term of organic farming. The investigations carried out by foreign scientists also show that farming influence is evident after longer organic farming duration (Mader et al, 2002).

Conclusion

The investigations carried out demonstrate that during 8 years of organic farming deterioration trends of soil agrochemical characteristics (such as organic carbon, mobile phosphorus and potassium) are observed in all the trail fields. Dependence of yield and quality changes under duration of organic farming year was not determined. It is necessary to continue the investigations and to assess the influence of longer organic term farming on soil characteristics and product quality.

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Organic food and health – status and perspectives

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Abstract

In a recent study it was investigated, through a well-controlled animal feeding experiment, whether conventional and organic food products showed differences in animal physiology of a type and magnitude that could indicate that organic products would affect humans differently. The primary, but still tentative conclusion from this study was that the most significant effects on rats was observed on health aspects that have rarely been assessed in prior studies: Immune status, sleep/activity pattern, accumulation of adipose tissue, liver function, and vitamin E status, while a large number of markers of "traditional" nutritional value showed no differences. Although the results of the present study could not directly be applied to organic and conventional production systems the observed differences were all in favour of the organic treatment, and thus pointed in the direction of potential health benefits when eating organically grown rather than conventionally grown food. However, this study like other studies related to the issue suffers from the fact that only one replication per food produce was used in the animal studies. Therefore the size of the effects could not be evaluated with respect to replication variation, which could have been determined by establishment of field trials. In addition, it was not possible to correlate the responses of the animals to the analysed diet composition due to the limited number of replicates, whereby the explanations of the effects were limited. Thus, it is of outmost concern that future investigations on the effect of organic food in relation to human health and well-being should be based on well-defined and controlled food produce system with replications.

Keywords: health, immunity, vitamin E, cultivation methods, animal models

Introduction

Many consumers perceive that organic foods in general are of better quality, i.e. have a better taste, and are healthier and more nutritious than foods produced using conventional cultivation methods. The consumption of organic foods has increased regularly during the last decade, particularly in Western countries (Schifferstein & Ophuis, 1998; Mann, 2003). However, according to a Danish knowledge-synthesis reviewing the existing scientific literature, evidence that can definitely support or refute such perception is not available in the scientific literature (O'Doherty Jensen et al, 2001).

The present study was conducted using a well-controlled rat-feeding experiment comparing three iso-energetic and iso-nitrogeneous diets composed of vegetables and a high content of rapeseed oil (13 %), produced according to each of three different cultivation systems ("Organically", "Minimally" and "Conventionally"). The purpose of the study was to investigate whether a difference in growing conditions of the feed plants would affect any of a range of physiological responses using a rat model, being characterized as non-insulin dependent diabetes mellitus, type II diabetes and non-obese.

Materials and methods

The experiment was performed with 36 rats that were fed on three diets consisting of potatoes, carrots, peas, green kale, apples and rapeseed oil. The difference between the three diets was the three combinations of cultivation strategies used to grow the used ingredients:

- "Organically": low input of fertiliser through animal manure and without pesticides
- "Minimally fertilised": low input of fertiliser primarily through animal manure and with pesticides
- "Conventionally": high input of mineral fertiliser and with pesticides

Each ingredient type was cultivated according to standard practice for the crop in terms of e.g. levels fertilizer and timing of pesticide applications. For each crop all treatments were carried out on the same or adjacent experimental fields, which were divided according to the three cultivation strategies, so that the cultivation took place in similar soils and under similar climatic conditions, and the ingredients were harvested and treated at the same time.
The three experimental diets had exactly the same formulation (300.0 g kg^{-1} potato, 50.0 g kg^{-1} carrot, 472.4 g kg^{-1} pea, 10.0 g kg^{-1} green kale, 10.0 g kg^{-1} apple, 130.0 g kg^{-1} rapeseed oil, 6.4 g kg^{-1} DL-methionine, 12.5 g kg^{-1} CaCO3, 0.7 g kg–1 salt, and 8.0 g kg^{-1} vitamin/mineral mixture), and the diets were iso-energetic (gross energy 21.2 ± 0.14 MJ kg^{-1} DM, metabolizable energy 18.0 ± 0.14 MJ kg^{-1} DM) and iso-nitrogeneous (crude protein 160.7 ± 0.2 g kg^{-1}), and contained in addition the following main nutrients (mean ± SD): dry matter 966.7 ± 5.0 g kg^{-1}, HCl-fat 156.5 ± 1.6 g kg^{-1}, ash 41.4 ± 0.5 g kg^{-1}, crude fiber 56.3 ± 1.6 g kg^{-1}, dietary fiber 179.3 ± 2.1 g kg^{-1}, calcium 6.8 ± 0.1 g kg^{-1}, total phosphorus 3.4 ± 0.1 g kg^{-1}, lysine 10. 8 ± 0.2 g kg^{-1}, and methionine + cystine 9. 7 ± 0.4 g kg^{-1}. The pesticide level was determined by the Regional Veterinary and Food Control Authority Copenhagen, Danish Veterinary and Food Administration, and was found to be below the detection limit.

The rats received the same diets throughout their entire life and the measurements of their health status started after weaning of their first litter (age, 19 weeks; weight, 212 g). The following measurements were used to assess rats' health status:

- Clinical health and disease
- utilisation of nutrients
- energy metabolism
- physical activity
- functions of organs and intestine
- post mortem evaluation of organs
- analyses of biomarkers and nutritional status in blood and tissues
- analyses of immune response

Results

Analyses of the primary nutrients showed no differences between the three diets. However, with regard to the analyzed contents of vitamins and acids, differences among the three diets

appeared as the content of vitamin E and C18:2 were lower, and the C18:1 higher in the "minimally fertilised" than the other dietary treatments.
The rats thrived on all three diets, only showed minor differences with respect to utilisation of energy and nutrients. Even though the rats were genetically disposed for diabetes, there was no visual sign of this disease among the rats. The rats had only a slight increase in weight after eating the diets for 25 weeks. However, the data showed a tendency towards a lower weight and a lower content of adipose tissue in the rats that were fed on the organic diet as compared to the other diets.
Concurrently with the measurements of energy utilisation, the physical activity of the rats was measured using infrared sensors. Rats are active at night, and there were no differences between the dietary groups with respect to activity at night. However, during daytime, when the rats are supposed to rest, the data indicated that rats fed on the organic diet were more relaxed (less active) than rats feed on the other diets.
Rapeseed oil comprised 25 % of the energy content of the diets, and due to the observed dietary differences, inclusion of the rapeseed oil caused some differences in the fatty acid composition of the serum and the tissue of the three dietary groups of rats. Also, the vitamin E content was lower in blood plasma from rats that received the minimally fertilised diet. The content of vitamin E in the "organically" and the "conventional" diet was similar. Yet, there was a higher content of vitamin E in the blood of the rats that were fed the "organically" diet. This could be health beneficial as vitamin E is an antioxidant protecting the cells from oxidative injury. There were no differences in the vitamin E content of liver and adipose fat tissue between rats from the three dietary groups.
Immune status of the rats was measured as the total content of immunoglobulins in the blood serum. The results showed that rats fed on organic and minimally fertilised diets had a higher content of immunoglobulin G (IgG) than rats fed on the conventionally grown diet. There were no differences in the serum contents of immunoglobulins A and M. At present, no explanations are available with regard to the lower content of IgG in the rats that were offered the conventionally grown diet. Yet, it is noteworthy that the conventional diet had a higher content of the secondary metabolite falcarindiol than the other diets. Carrots are the source of falcarindiol and other closely related polyacetylenes, such as falcarinol, in the diets with falcarinol clearly being the most bioactive of the carrot polyacetylenes having for example immune stimulating properties (Hansen et al, 1986). However, as the physiological effects of falcarindiol, are expected to be qualitatively similar but quantitatively less than for falcarinol (Kobæk-Larsen et al, 2005), it cannot be excluded that falcarindiol may interact with falcarinol in an antagonistic manner thereby affecting its bioactivity. This could explain the lower content of IgG in the rats that were offered the conventionally grown diet, as the content of falcarinol was not significantly different in the three diets. Further, it cannot be excluded that falcarindiol by it self can have an inhibitory effect on initiation of the immune response (Seon et al, 2002).

Conclusion

Even though most of the measured variables showed no differences between the experimental diets, and that the results of the study could not directly be applied to organic and conventional production systems, the actual recorded differences were all in favour of the "organically" diet contrasted with the "conventionally" diet, and thus pointed in direction of potential health benefits when eating organically grown rather than conventionally grown food. Future research is needed to provide more information on the effects of organically grown compared to conventionally grown food products, with respect to nutritional quality and health promoting properties, with special emphasis on both the systematic and random variation between different systems of food produce. Special emphasis should be given to explore links and explain overall relationships between the nutritional quality and biomarkers of health.

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Acknowledgement

This study was a part of the project "Organic food and health – a multigeneration animal experiment", which was financed by The Danish Research Centre for Organic Farming (DARCOF), Tjele, Denmark, through the research program "Research in organic farming 2000-2005 (DARCOF II).

Farming systems and nutritional quality of cereals

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Organic cultivation systems and food quality

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Abstract

Concerns about inter-relationships between diet and health have entered the debate about food quality and whether organically produced food is of higher quality than conventionally produced food. Mechanisms that can affect establishment of product quality in different cultivating systems are discussed on the basis of relevant literature and recent research.

Introduction

Agriculture has developed to provide a gradually stronger increase in food supply to the increasing global population. For that reason agronomists have mostly focused on enhancing bulk yield during the past century. A number of reports since the 1960s point to the fact that chronic diseases have increased. One reason for this may be the adoption of a Western lifestyle, creating dietary problems such as imbalances between nutrients. Another reason may be that the nutritional qualities of our basic foodstuffs have declined. Nutritional value seems to drop in direct relationship to the increase in bulk production, especially at high growth rates and yields.

Accordingly, public concern about food quality has intensified and has prompted the debate about the integrity and safety of food. Many consumers have the perception that organic food is healthier than conventional food. Animal feeding trials have consistently demonstrated improved health in animals fed organically produced food compared to those fed conventionally produced food. Observed benefits include improvements in growth rate, reproductive health, recovery from illness and general health in those animals fed organically produced feed.

It has not been confirmed that converting to organic fertilisers and ceasing pesticide use will increase food quality. Each cultivation system is unique and is a function of land use history, local conditions and management. Factors such as soil physical and chemical properties, soil flora and fauna activity and the biological diversity of the site and its surroundings also affect the chemical composition of the crop and thereby its resistance to disease and the quality of the produce. Field trials reported in the literature illustrate this complexity.

To improve our knowledge about how cultivation systems can affect the quality of food produce, it is important to determine the kinds of mechanisms that are involved in changing processes in the cultivation system. In the following section, some of these mechanisms and processes are discussed.

Light energy/carbon partitioning vs. food quality

Quality values distinguish between species depending on genetically-determined differences. The quality target for crop production is to reach the best possible composition of compounds or groups of compounds that are important in nutrition and consumer health. These compounds are created in primary and secondary synthesis pathways in plants, and the carbons they consist of are obtained through photosynthesis. Plants can affect their composition of primary and secondary compounds by regulating the partitioning of carbons to the different pathways.

The main question for quality establishment in crops is how they use the light energy they absorb to produce biomass, as well as non-biomass related compounds. An altogether too powerful stimulation of biomass production in a plant may lead to a reduction in the functioning of other processes and consequently the chemical and nutritional composition of the plant. The model is expressed as the growth-differentiation balance hypothesis (GDBH).

The basic principles of GDBH are that both growth and differentiation require photosynthates, and are negatively correlated, and that the balance is dependent on the relative availability of resources. This means that the chemical composition of plants depends on resource factors such as light and mineral nutrients, and factors that influence allocation of photosynthates between growth and differentiation. The latter include abiotic and biotic stresses. The quality of crop products can be modified by the incidence of stress during the crop life cycle.

Claims that organic cultivation systems produce food of enhanced healthy value are based on three assumptions. These can be expressed as follows. (1) Elimination of pesticides may

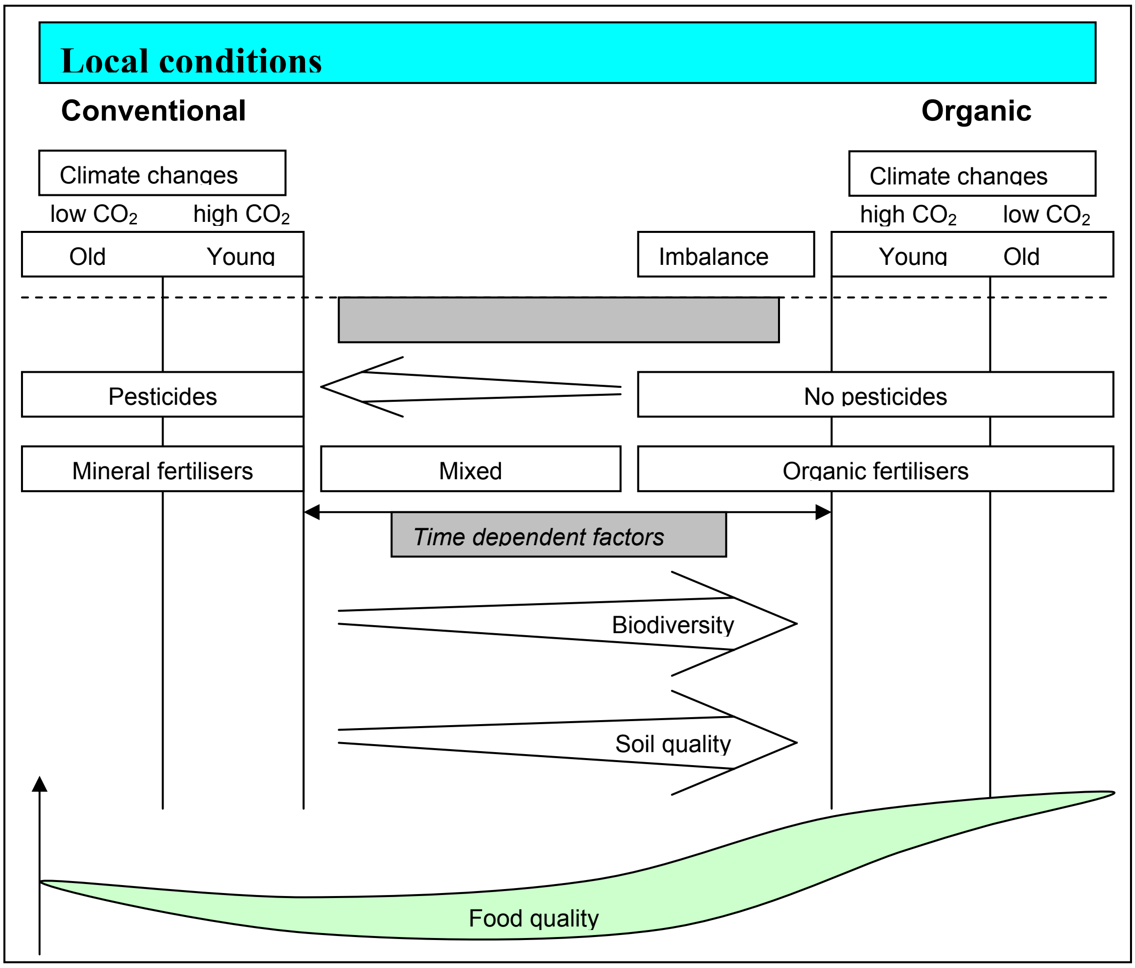

Figure 1. Factors involved in the development of cultivation systems that affect the quality of the produce.

enhance soil biological activity, as well as increasing the risk for attacks by herbivores and pathogens. To protect itself against attacks by the latter organisms, plants produce protective organic substances that are believed to be health-promoting, and therefore may produce food of higher quality. (2) Use of organic fertilisers increases organic matter inputs to the soil and thereby enhances soil organic matter quantity. This may have a beneficial effect on soil quality and thereby enhance quality of the produce. (3) Crops grown with organic fertilisers receive a more well-balanced mineral nutrient supply.

Pesticides and biodiversity

Environmental contamination and pesticide use affect the quality of plant products by directly affecting the plant and its metabolism or by changing biodiversity. Sublethal doses of herbicides have long been known to be capable of affecting the growth and metabolism of a crop. Herbicides in low doses can reduce ascorbic acid content and alter concentrations of amino acids, carbohydrates and organic acids. Inducing resistance to herbicides can alter a range of mechanisms in plant cells and thereby alter the amount and composition of minerals and fatty acids, amongst other things.

Pesticides have been shown to have endocrinal and/or carcinogenic effects. Use of pesticides implies a risk for accumulation of residues in the produce. In 2002, 43% of all fruit and vegetables tested in Sweden were found to contain pesticide residues. The levels found were generally low, but 4.3% of fruit and vegetables exceeded the maximum residue limit. Organic produce is usually found to contain no pesticide residues, and is thus healthier in this respect.

One of the main organic farming principles is to improve pest control by increasing multi-functionality on field, farm and landscape level. Elimination of pesticides may have a favourable effect on biodiversity and ecosystem services. Intercropping and addition of organic amendments are other factors that may increase biodiversity. Organic farming has mostly a positive effect on biodiversity. However, the effect differs depending on landscape context, whereby a mosaic landscape increases biodiversity in both organic and conventional farms. Increased biodiversity may prevent crops from being attacked by herbivores and pathogens and therefore these crops do not need to produce protective substances. This can lead to an improvement in produce quality, as we should be aware that these compounds may be toxic. Thus, we should observe caution when introducing measures that greatly increase the production of plant defence compounds in crops.

Organic amendments such as composts can suppress plant diseases. Increases in total microbial activity and biomass may be associated with enhanced disease suppression. This effect can be caused by production of fungitoxic compounds such as organic acids or ammonia or enhanced antagonism or induction of resistance.

Local conditions and long-term effects

The essential mineral elements are made available to humans by the activity of soil micro-organisms and plants. These elements are obtained from soils and, in turn, from the parent materials from which soils are derived. Differences arise in soil quality attributes as a result of farming practices, and these affect mineral availability. Soil quality can be defined as the soil's fitness to support crop growth without resulting in soil degradation or otherwise harming the environment. In addition to parent material and topography, soil organic matter

(SOM) is considered to be a key attribute of soil quality. Introducing organic amendments into the crop rotation provides an increase in SOM quality and other soil quality attributes, such as soil aggregation, fertility and microbial activity. The abundance of different microbial groups and total biomass is generally increased by organic manure relative to unfertilised and N-fertilised soil. A change in the composition and activity of the rhizosphere microflora affects uptake of a number of mineral nutrients, which affects the mineral status of plants and thus their resistance to disease.

Another known global environmental problem is the increase in carbon dioxide, which is raising the temperature of the earth. One effect of the increase in the amount of carbon dioxide is its effect on the chemical composition of plants. According to evidence, the mineral content of a number of products has decreased since the beginning of the 20^{th} century. This means that the ability of the plant to absorb minerals, or the ability of the cultivation system to deliver minerals, has not kept pace with the increased production capacity brought about by the increase in carbon dioxide. The end result is that the mineral content of plants is diluted and the proportion of minerals and energy in food is declining, which could lead to mineral deficiencies. These may occur regardless of whether a field is in organic production or long-term conventional production.

Fertilisers

In addition to the factors mentioned above, organic fertilisers directly affect the composition and availability of mineral nutrients. The mineral nutrient demand of plants can easily be met using mineral fertilisers. When organic fertilisers are used, one must be aware of the mineral composition of the source of the fertiliser. Continuous use of only one type of organic fertiliser may cause mineral imbalances in both soil and plants in the short-term. However, over longer periods soil quality attributes may be improved by an increase in the mineral buffering capacity of the soil.

Green manure has a more or less low content of sulphur that is dependent on the parent material. Crops with a high sulphur demand fertilised with only green manure may suffer from sulphur deficiency. This gives rise to growth retardation and starch accumulation. In crops such as leek and white cabbage, sulphur deficiency decreases the content of sulphur-containing secondary compounds. As these may have a health-promoting effect, the continuous use of green manure may decrease product quality instead of increasing it.

Nitrogen in organic fertilisers exists usually in organic form and/or as ammonium. This may change the uptake balance between different cations and anions. It has been observed that organically produced food contains higher chloride levels and accumulates minerals that are taken up as anions compared to conventionally produced food. This indicates that crops take up more ammonium than nitrite in organic cultivation systems and that this changes the mineral status and other quality attributes of the produce.

Conclusion

Elimination of pesticides and mineral fertilisers is one step towards increased food quality, but it could have negative effects in the initial stages. Over time and with the adoption of multi-functionality enhancing measures such as increased biodiversity and mixtures of organic amendments, the quality of organically produced food will increase, although it will probably be affected by environmental changes caused by human activity.

Organic fertilisers for greenhouse vegetables

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Abstract

Greenhouse vegetables (i.e. tomato, cucumber, sweet pepper) exhibit a large and continuous nutritional demand. In organic cultivation, it is not possible to supply all the nutrients needed in one application at the beginning of each planting. Mushroom compost, fish-meal or fish-silage are all potential organic fertilisers to supply plants with nutritents throughout the season. Applying these fertilisers at adequate rates will ensure comparative yields to conventional cultivation of greenhouse vegetables.

Keywords: organic fertilisers, greenhouses vegetables, fish products, mushroom compost

Introduction

Organic production relies solely on organic fertilisers to supply the necessary nutrients to plants. Greenhouse vegetables i.e. tomato, cucumber and sweet pepper have a high nutritional demand and fertiliser must be applied regularly throughout the growing season in order to fulfil their needs. Because organic fertilisers are less concentrated than inorganic ones a larger volume of them has to be applied to supply the same amount of nutrients to plants. This will make the cost of fertilisation higher because the cost per amount of pure nutrients is higher and more amount of labour is needed to apply them. In order to keep down costs of fertilisation, it is of importance to choose fertilisers carefully which give the right amount and balance of nutrients and to develop methods to spread them fast and accurate.

Mushroom compost is a nutritious waste product from conventional mushroom production available in abundant amounts at a low price. It has been used with good results as a soil amender and fertiliser in Iceland for a number of years and is accepted as a source of nutrients in certified organic production with certain restrictions. Preliminary trials have shown that it can serve well as a fertiliser in cultivation of tomato (Gunnlaugsson 1997, 1998). Apart from being very nutritious, mushroom compost also has beneficial effects on soil structure as it contains abundant amount of un-decomposed organic material.

Fish products such as fish-meal and fish-silage are rich in nutrients and can thus serve as fertiliser to plants. As the nutrients are more concentrated in these materials than in mushroom compost it is possible to fulfil the needs of plants for nutrients by applying fairly low volumes and they are available at a reasonable price, at least in Iceland. In this article experiments with the three above mentioned organic fertilisers for greenhouse cultivation of cucumber are described.

Materials and methods

Cucumbers where grown in a 216 m^2 greenhouse on raised beds (8.00 x 1.00 x 0.30 m) which where filled with a commercial soil mix of Icelandic peat (48%), fresh mushroom compost (40%) and Hekla-pumice (12%), mushroom compost thus functioning as a base fertilizer for the plants. Two plantings where performed with cv. 'Mustang' and cv. 'Ventura' respectively. The plants where trained to high wire system with plant density of 2.4

plants/m^2. The first crop, cv. 'Mustang' was sown on March 20th and planted on April 17th. Harvesting period lasted for 8 weeks (May 17th – June 30th). The second crop, cv. 'Ventura' was sown on June 3rd and planted July 1st. The harvesting period lasted for 12 weeks, from July 25th-October 20th. Temperature was set at 22°C during the day and 19°C at night with ventilation at 24°C. At daytime, carbon-dioxide was supplied at a concentration of 700 ppm when the vents where closed and 340 ppm when they where open. Irrigation with water took place 4 times a day, in 3-5 min cycles through a drip-tape.

There are large differences in the nutrient content of each fertiliser used in the experiment (Table 1). Mushroom compost is very high in potassium but low in nitrogen and very low in phosphorus compared to the other fertilisers. Fish-meal has a very high content of nitrogen and phosphorus but a moderate content of potassium. Nutritional values for fish-silage are considerably lower than for fish-meal, especially phosphorus.

Table 1 – Content of nitrogen, phosphorus and potassium in the organic fertilisers used in the experiment.

	Total N g/kg	Available N g/kg	P g/kg	K g/kg
Mushroom compost (bulk density 462 g/l)	11.0	5.5	0.9	12.6
Fish-meal	96.0	76.8	39.4	5.6
Fish-silage	18.6	15.0	3.3	3.8

Table 2. Fertiliser application for cucumber and estimated total amount of nitrogen, phosphorus and potassium given in the experiment by each fertiliser. The amounts given are per m2 greenhouse area.

	Mushroom compost	Fish-meal	Fish-silage
Base fertiliser, g/m^2 (soil mix with mushroom compost)	17,311	17,311	17,311
Additional fertiliser, g/m^2	17,736	1,039	2,439
Estimated total application of N, g/m^2	193	175	132
Estimated total application of P, g/m^2	32	57	24
Estimated total application of K, g/m^2	379	194	197

The weekly nutritional demand for cucumber was estimated to be 5.02 g N, 1.0 g P and 6.28 g K per m^2 greenhouse area giving a total demand of 136 g N, 27 g P and 170 g K per m^2 greenhouse area for the cultivation period in the experiments (27 weeks). Base fertilisation with mushroom compost was the same in all the beds, 17,311 g equal to 95 g N per m^2 greenhouse area (Table 2). Additional fertilisation with mushroom compost, fish-meal or fish-silage was started one month after planting. Because of the large differences in nutritional content of the fertilisers, it was decided that the doses given to the plants should fulfil their estimated need for nitrogen. Thus, 900 g mushroom compost, 65 g fish-meal and 335 g fish-silage per m^2 greenhouse area where applied on a weekly basis throughout the season. The total amount of each fertiliser applied is given in Table 2 as well as total estimated amount of nitrogen, phosphorus and potassium.

Results and discussion

Total saleable yield for both plantings (21 harvesting weeks) ranged from 30.3 - 36.9 kg/m^2 highest when applying mushroom compost, lowest when applying fish-silage (Table 3). Normal saleable yield for cucumber in Iceland is 40-45 kg/m^2/year in conventional cultivation for harvesting periods of 29 weeks giving a average of 1.5 kg/m^2/week. In this experiment the average saleable yield varied from 1.44 - 1.75 kg/m^2 which is highly comparable to conventional cultivation.

Table 3. Saleable yield of cucumber plants cv. 'Mustang' (1. planting), cv. 'Ventura' (2. planting) and total yield when fertilised with mushroom compost, fish-meal and fish-silage. Values are means $\pm$ SD.

Fertiliser	1. planting 'Mustang' kg/m^2	2. planting 'Ventura' kg/m^2	Total saleable yield kg/m^2
Mushroom compost	17.1+1.2	19.9+1.3	36.9+1.0
Fish-meal	20.1+1.2	15.5+2.5	35.6+3.1
Fish-silage	15.0+1.9	15.3+1.0	30.3+2.1

In the first planting the highest yield was obtained when applying fish-meal as additional fertiliser whereas the plants fertilised with fish-silage gave the lowest yield. The lower yields might be explained by the fact, that undiluted fish-silage was accidentally applied early in the season, causing temporary root death. In the second planting on the other hand, the fish-products gave considerably less yield than the mushroom compost which could partly be explained by the fact that mushroom compost has favourable physical properties. When the soil was examined at the end of the season it was clearly lighter and better aerated in beds fertilised with mushroom compost.

When comparing the nutritional demand of the plants and the amount of fertiliser given it is clear that in some cases to much fertiliser was applied (Table 2). It is therefore interesting to look at the actual nutrient status in the soil during the experiment. Nitrate is below target value except in the very beginning and the two latest measurements when fish-meal was applied as a top dressing (Figure 1). No signs of nitrate shortage where observed on the plants, therefore it is evident that the nitrogen released from the organic material was either taken up simultaneously by the plants or washed out. The potassium level was very high in the beginning of the season because of the high potassium levels in the mushroom compost but decreased steadily towards the end of the season when fish-meal and fish-silage where applied as additional fertilisers (Figure 1). On the other hand, very high values where measured when plants where fertilised with mushroom compost, again because of high concentration of potassium in the mushroom compost.

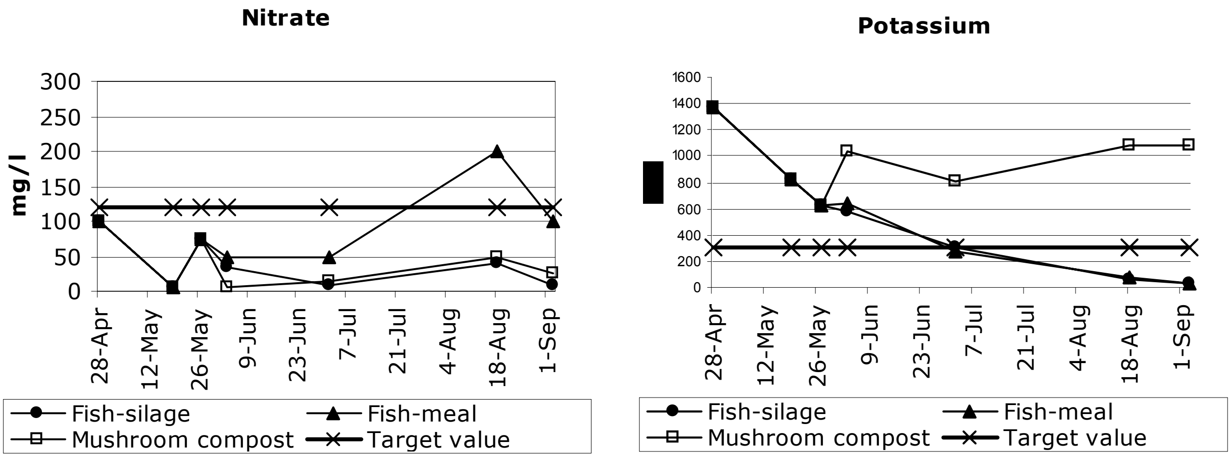

Figure 1. Level of nitrate and potassium in soil samples from cucumber beds fertilised with fish-silage, fish-meal and mushroom compost. Target values from Bjerggård and Hansen (1985).

Conclusions

The three different fertilizers used in the experiment have different nutritional values and physical properties. Mushroom compost contains high amount of relatively un-decomposed organic material giving the soil good physical properties. On the other hand a large amount of the material (20 kg/m^2/season) is needed to fulfil the demands of the plants for nitrogen resulting in excessive fertilisation with potassium. Fish meal is very rich in nitrogen and phosphorus and fish silage contains a relative high amount of nitrogen, but these materials do not contribute to preserve favourable physical properties of the soil. To give the plants optimum fertilisation and soil conditions it is probably best to apply these organic fertilisers as a mixture. In a subsequent experiment a mixture of mushroom compost and fish-silage proved to be a good alternative (Gunnlaugsson, manuscript).

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A rational growing system for organic production of greenhouse tomatoes

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Abstract

In order to increase the production of organic vegetables in Norway, a project was started to facilitate the transition from conventional to organic greenhouse production. A growing system based on ecological production principles was tested at Planteforsk Særheim Research Centre. Results showed that a growing system with limited beds, using 75 l/m^2 of an organic growth substrate and 24 l/m^2 locally available cattle slurry as additional fertilizer, resulted in a yield comparable to traditional greenhouse tomato production. Fertilizing three times a week with 0,5 l/m^2 cattle slurry in combination with sprinkler irrigation controlled by light integration showed to be equally effective as fertilizing using standard mineral nutrition. Results give rise to an economical production of organic greenhouse tomatoes.

Keywords: *Lycopersicon esculentum* Mill., liquid fertilizer, irrigation

Introduction

Production of organic greenhouse vegetables in Norway is still on a low level, in spite of an increasing demand for organic food products. At the moment, organic growers in Norway have too little knowledge on greenhouse production, while greenhouse growers have too little knowledge on organic production. In order to increase the production of organic vegetables, the Norwegian growers association initiated a project with the goal to develop an economical production of greenhouse tomato-, cucumber and lettuce based on ecological production principles. In this project, agronomical problems concerning the transition from conventional to organic greenhouse production should be solved. To achieve a stable and economical production, the main challenge was defined to be a proper use of growing media and organic fertilizers. The project is financed by the Norwegian Agricultural Authority and carried out at Planteforsk Særheim Research Centre.

The first step in the project was to choose a growing concept for ecologically grown greenhouse tomatoes following the standards set by the Norwegian Food Safety Authority. In order to avoid problems with soil borne pests and diseases and to reduce the risk of losses of plant nutrients, it was chosen to grow plants in limited beds. This system showed good results in earlier experiments in Sweden (Gäredal & Lundegårdh, 1998) and Finland and might quicken the transition from conventional to ecologic production.

One of the problems in organic crop production is to adjust the availability of nutrients to the nutritional needs of the plants. This concerns to a large extent crops with a long growing season, like greenhouse tomatoes. In many cases in organic crop production, a high amount of basic fertilizer is applied at the start of the crop, when plants are still small, assuming that nutrition will be available in time. In tomato production, this system has a high risk of loss of nutrients, will lead to imbalanced, vegetative plants at the start of the growing season and often leads to nutrient deficiency at the end of the growing season, thus reducing yield. It seems therefore more rational to apply a part of the nutrients during the growing season.

The main reason to change from soil to rockwool in greenhouse crops about 30 years ago was to avoid problems with soil borne pests and diseases. However a higher yield in crops growing on rockwool was also achieved using the knowledge that was developed on nutrient uptake and effects of irrigation techniques in the last 30 years. This knowledge is little used in organic production.

Materials and methods

Tomato seedlings (*Lycopersicon esculentum* Mill cv 'Cedrico'), 42 days old, grown in 1 l pots filled with peat ('Naturtorv'), were planted on the 6th of March 2003 in two greenhouse departments at Særheim Research Centre (58º 47'N, 5º 41'E). Tomatoes were grown at a density of 2,5 plants/m^2 in limited beds using the following growing media and fertilizers:

1. Standard peat bags (25 l/m^2) with added standard liquid inorganic fertilizer (750 l/m^2, EC= 2,0) using standard drip irrigation (Control treatment).
2. Standard peat bags (25 l/m^2) with basic dried chicken manure (2 kg/m^2) and added liquid seaweed extract (750 l/m^2, EC=0.5) using standard drip irrigation. Blood meal (15 g/m^2) was added seven times during the growing season
3. A mixture of peat and perlite (80/20 volume %, 75 l/m^2 in a tube with a diameter of 50 cm, cut in two) with basic dolomite meal (125 g/m^2) and added cattle slurry (0,5 l/m^2, 3 times a week, total of 24 l/m^2) using a can and sprinkler irrigation.
4. A commercial organic substrate ("Turvemulta", Biolan Oy, Finland, 75 l/m^2 in a tube with a diameter of 50 cm, cut in two) with basic dried chicken manure (2 kg/m^2) and added liquid seaweed extract (750 l/m^2, EC=0.5) using standard drip irrigation. Blood meal (15 g/m^2) was added seven times during the growing season.
5. A commercial organic substrate ("Turvemulta", Biolan Oy, Finland, 75 l/m^2 in a tube with a diameter of 50 cm, cut in two) with basic dried chicken manure (2 kg/m^2) and added cattle slurry (0,5 l/m^2, 3 times a week, total of 24 l/m^2) using a can and sprinkler irrigation.
6. A mixture of organic soil and perlite (80/20 volume %, 75 l/m^2 in a tube with a diameter of 50 cm, cut in two) with composted pig manure (8 kg/m^2) and added cattle slurry (0,5 l/m^2, 3 times a week, total of 24 l/m^2) using a can and sprinkler irrigation.

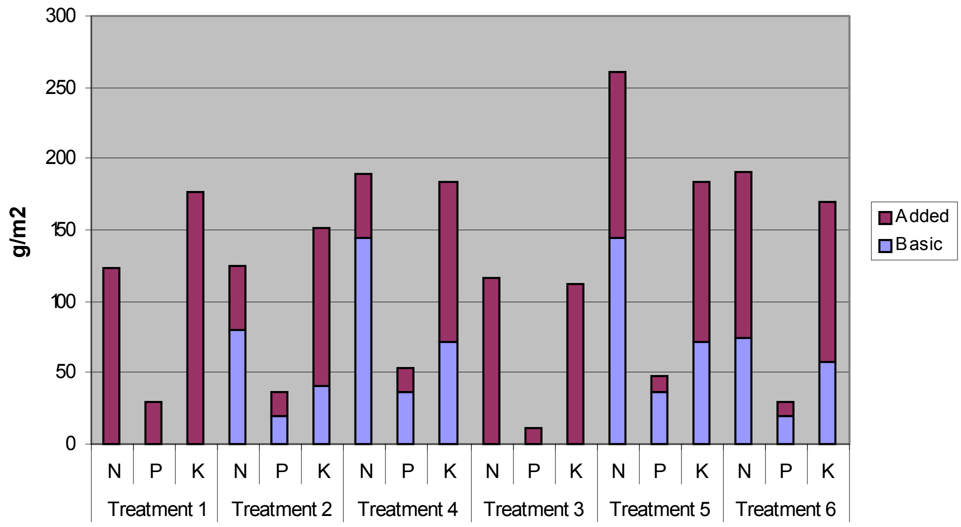
Plants were grown in accordance to standard commercial tomato production in Norway with respect to growing conditions and harvested until the 30th of October. Irrigation, with a fixed amount of 4 dl/m^2 each turn, was controlled by light integration (Verheul, 2001). Each treatment was repeated four times.

Results and discussion

Figure 1a shows the total amount of nitrogen (N), phosphorus (P) and potassium (K) in g/m^2 given for the different treatments during the growing season as basic and added fertilizer. The amount of basic N-fertilizer in relation to added fertilizer varied from 0 (treatments 1 and 3) to 76 % (treatment 4). Highest amounts of fertilizer were given in treatment 5. In Denmark, a nitrogen demand of 235 g N/m^2 is assumed in tomato (Nygaard Sørensen, 2005).

Figure 2 shows the first class and total yield of tomatoes in kg per m^2. Results show that it is possible to achieve almost the same yield with organic fertilizer when compared to inorganic fertilizer. For Norwegian standards, the yield level achieved with organic fertilizer was quite high. In practice, organic growers operate with a yield of 15-20 kg/m^2. The yield achieved with inorganic fertilizer was however somewhat lower than the average yield in commercial tomato production in Norway, which is 42 kg/m^2. The highest total yield using organic fertilizer was achieved in treatment 5, the treatment receiving highest amount of fertilizer using a commercial organic substrate and added cattle slurry. A high first class yield was also achieved using the 'local solution' with organic soil from Særheim, combined with cattle slurry, which is available in high amounts in this region. The relatively good yield for treatment 3 suggests that supply of cattle slurry three times a week during the growing season was highly effective for tomato production. Comparing treatment 4 and 5 shows that the use of cattle slurry gave a higher yield when compared to drip irrigation with the liquid seaweed extract, the last one also being much more expensive. Plants grown on standard peat bags receiving organic fertilizer showed reduced growth and production. The low volume caused a high concentration of nutrients in the growing medium, a hampered root development and a high amount of fruits with blossom end rot.

Subtracting the total amount of nitrogen, phosphorus and potassium with the amount left in the growing medium at the end of the experiment gives the amount of nutrients used during the growing season (Fig 1b). Results show that the use of organic nutrients was around the level of inorganic nutrients used. Since organic nutrients normally are less available for crop production when compared to inorganic nutrients, this indicates that the chosen growing system had been highly effective. Nitrogen use in treatments 1-6 was respectively 2.5, 3.7, 3.6, 2.5, 2.7 and 2.9 g per kg of tomatoes harvested. Thus, cattle slurry (treatment 3) showed an equally effective nitrogen use when compared to standard mineral nutrition (treatment 1). In commercial tomato production, a nitrogen use of 4.6 g per kg tomatoes is calculated (Hansson, 2005).



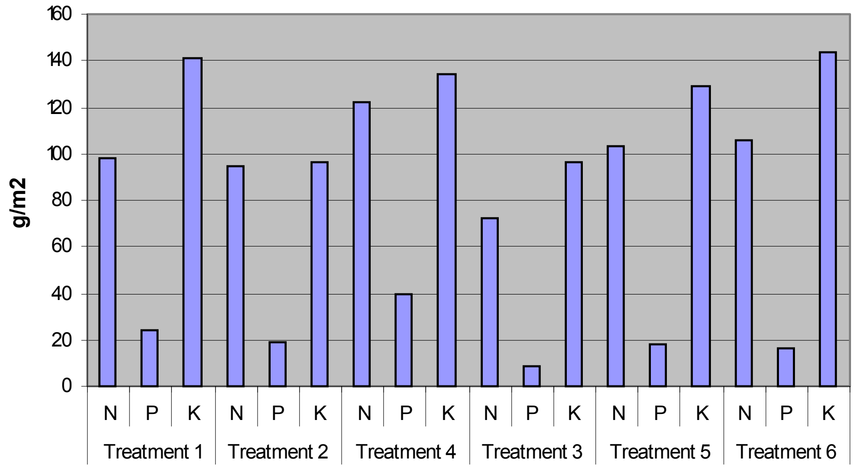


Figure 1. Total supply of basic and added fertilizer (a) and total use (b) of nitrogen (N), phosphorus (P) and potassium (K) in tomato for six different treatments during the growing season (2003).

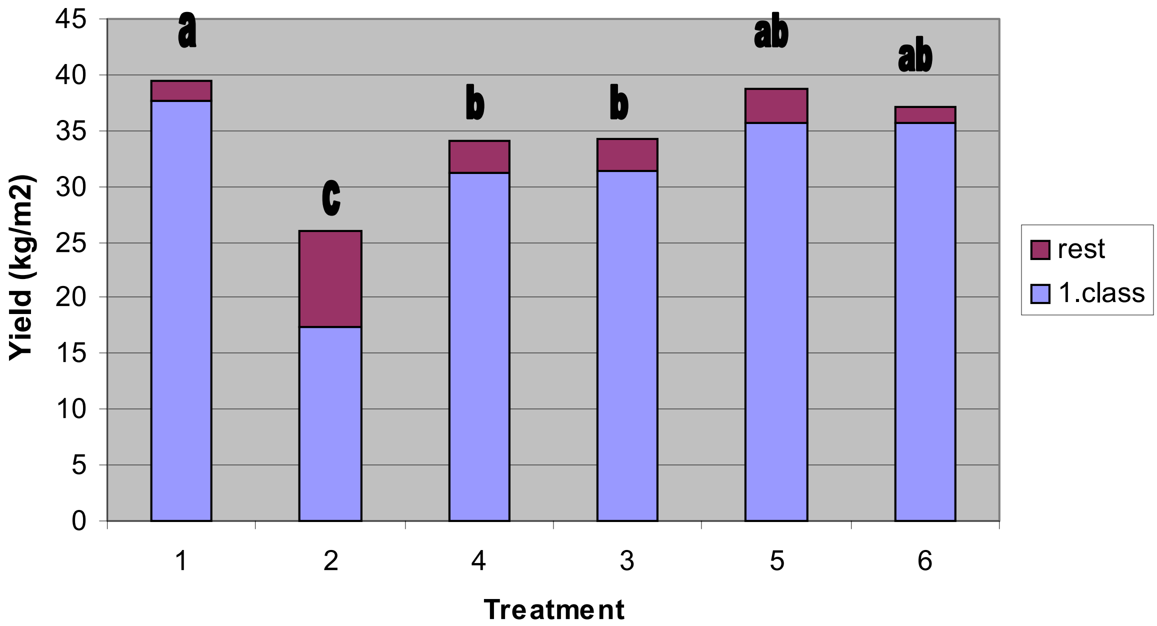


Figure 2. Total yield of tomatoes (cv 'Cedrico') for six different treatments in 2003. Treatment yields having the same letter are not significantly different ($p < 0.05$).

Conclusion

The rational growing concept in limited beds using 75 l/m^2 of an organic substrate combined with a regular (three times a week) supply of locally available cattle slurry (with a total of 24 l/m^2) using sprinkler irrigation regulated by light integration shows a high yield and gives rise to an economical production of ecological greenhouse tomatoes.

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Variety trials of broccoli in organic farms

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Abstract
There has been demand in variety trials since official experiments ceased in Finland at the beginning of the 1990-century. After since the variety testing has been done by farmers themselves or in different projects in connection with developing rural areas. One aim of the general project during years 2004-2006 is to unify variety testing practices in Finland. The aim of the organic variety trials on year 2004 was to find good varieties for organic broccoli production and varieties which stand covering cloths as long as possible nearly until harvest.

The organic broccoli farm trials went well and the randomisation could be done as in experimental farms. Good varieties for organic broccoli production could be selected among varieties. Some different growing seasons in addition to year 2004 is still needed. In the farm trials need of research personnel to do planting, harvest and observing was necessary to get strict results. The first years experience is supportive to continue variety and covering cloth timing farm trials in Finland. The unifying practises with all different project cooperative partners sound promising as well.

Keywords: variety trial, broccoli, organic farming

Introduction

Interest toward vegetable variety trials has been big among Finnish farmers because the growing conditions in Finland are different from middle Europe or south Scandinavia. Vegetable variety trials ceased in Finland officially 15 years ago. After since varieties has been tested by farmers themselves or as a part of different projects to develop rural areas. In the projects the information got, has been utilized only by project members and the results has been written for financiers. Some of the results have published in trade papers. In this project one of the aims is to collect different projects working with field vegetable variety trials from different areas of Finland together and unify practices. In the variety trials the example species are carrots for storing, iceberg lettuce and broccoli. The base elements to unifying are old official trial guidelines and Danish practical field trial convention discussed with Gitte Kjedsen Bjørn on summer 2004. Very important have also been discussions with Finnish advisers and farmers.

The aim of the organic variety trials was to find good varieties for organic broccoli production and varieties which stands covering cloths as long as possible until harvest.

Materials and methods

The growing work was done in two organic farms on 2004 in southern Finland about 115 km from Helsinki north. The farmers had their own habits to farm in the limits of organic farming rules and the research adapted to them. The tested varieties were ‘Alborada’ (Bejo Zaaden, standard), ‘Lucky’ (Bejo Zaaden), ‘Surveyor’ (Bejo Zaaden), ‘Monaco’ (Syngenta Seeds), ‘Montop’ (Syngenta Seeds), ‘Monterey’ (Syngenta Seeds), ‘Thriathlon’ (Sakata Seeds), ‘Milady’ (Seminis) and ‘Iron’ (Seminis). The seedling was grown in MTT Horticulture research greenhouses for three and half weeks. The seeds were untreated conventionally produced seeds because there were not available organically produced seeds from broccoli for professional vegetable growers. The special licence for the use of conventional seeds was given by the states authority.

The field experiments were conducted on Vehnämäki organic farm in Hauho and Lepaa koulutila in Häme polytechnic University of Applied Sciences, Horticulture Lepaa, Hattula. In Hauho the soil type was fine sand rich in organic matter and pH 6.8. In Hattula soil type was loam clay rich in organic matter and pH 6.9. The fertiliser was composted broiler manure. Total nitrogen added was 170 kg N per hectare before planting. The plant spacing was 50 cm between and 40 cm within the rows in four replicates. There was two planting times (two experiments) because some of the seeds were delayed. Planting was made in Hauho on 1 June and 22 June and, in Hattula 2 and 18 to 21 June. Covering cloth was used in Hauho from 1 June to 9 July and in Hattula 2 June to 6 July. The plant protection was made with covering cloth and Chinese cabbage as a trap-crop. Irrigation was made if needed in Hattula, because the clubroot decease attacked in the end of cultivation. Weeding was made by harrowing and had. Harvest was done by hand from first experiment in Hauho on 21 July to 4 August, Hattula 23 July to 5 August and experiment two in Hauho 16 to 30 August, in Hattula 17 to 20 August. The yield was weighted and quality of broccoli head was observed.

Results and discussion

The weather in Finland was rainy and rather cold during the growing season. Broccoli grew well. The growing time was 51 to 63 days from planting. The earliest was ‘Montop’ and then came ‘Lucky’ (55 days). In the second experiment ‘Alborada’ had 63 days growing time and the others had 60 days in both experiments. The growth was very uniform and the harvest could be done at once or some varieties twice. The quantity and quality was good except some variety had ‘cat eyes’ or holes in the stem. The broccoli heads were convex, compact, dark green and the buds were small. ‘Lucky’ had ‘cat eyes’, the colour of head was spotted. ‘Triathlon’ had some ‘cat eyes’ also, but not as much as ‘Lucky’. ‘Surveyor’ had biggest buds and the weight of head was big. ‘Alborada’ had a lot of lateral shoots. The stem was good in ‘Alborada’, ‘Monterey’, ‘Iron’, ‘Lucky’, ‘Milady’ and ‘Montop’. In Hattula there were no holes in stems at all in ‘Alborada’ and in Hauho only some was observed. There were big holes in the ‘Triathlon’, ‘Monaco’ and ‘Surveyor’ stems and that is why their quality was poorer than others.

Total yield of broccoli (Figures 1 and 2) ‘Alborada’, ‘Monaco’ and ‘Triathlon’ in first experiment, was in Hauho more than 18 t/ha and in Hattula more than 12 t/ha. In the second experiment the yield were lower due the late planting time. The covering cloth kept warm near the growth and the small climate was favourable to broccoli. The cloth was taken off because of weeding but in Aaland they used the cloth until the end of growing. They had a cooperation organic broccoli variety trial in Aaland experimental station.

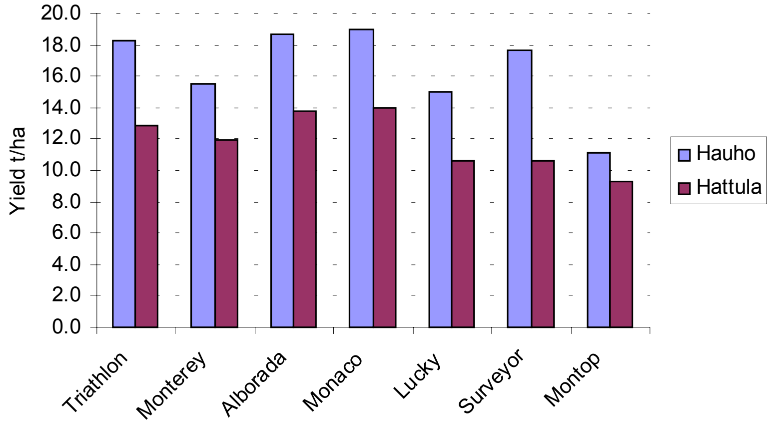

Figure 1. Total yield (t/ha) of broccoli in organic variety trials in Hauho and Hattula Finland in experiment 1 planted on 1 to 3 June 2004.

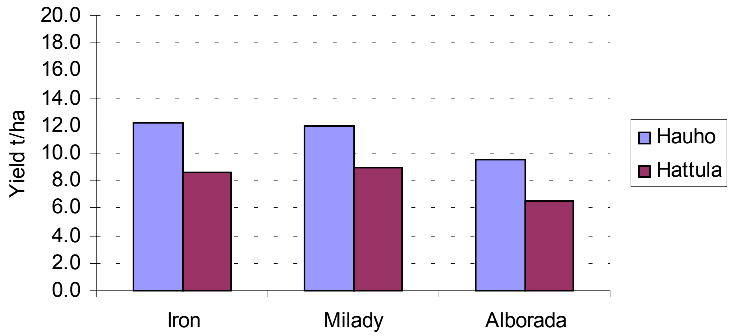

Figure 2. Total yield (t/ha) of broccoli in organic variety trials in Hauho and Hattula Finland in experiment 2 planted on 18 to 22 June 2004.

Conclusions

The organic broccoli farm trials went well and the randomisation could be done as in experimental farms. Good varieties for organic broccoli production could be selected among varieties. Different growing seasons is still needed to get reliable results. In the farm trials need of research personnel to do planting, harvest and observing was necessary to get strict results. The first years experience is supportive to continue variety farm trials in Finland. The unifying practises with all different project cooperative partners sound promising as well.

Acknowledgements

This project is funded by Ministry of Agriculture and Forestry of Finland. The authors wish to thank organic farmers Antti and Kalevi Vehnämäki and Lepaa Koulutila who gave us space and time for the trials.

Control of potato late blight by caraway oil in organic farming

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Abstract

One of the most severe threats to organic potato production in Finland is potato late blight (*Phytophthora infestans, P.i.*), because there are currently no compounds available for its direct control. Caraway (*Carum carvi*) seeds contain biologically active essential oils, which have shown potential in controlling *P.i.* An attempt is being made to develop a *P.i.* control strategy for organic farming based on caraway oil. In addition, knowledge is sought on the interactions among the essential oil-based anti-fungal agents, the plants sprayed with them and the *P.i.* pathogen. The economic feasibility of controlling *P.i.* with caraway oil will be also surveyed. Caraway essential oil delayed the onset of *P.i.* for about 10-14 days under field conditions. The efficacy of the oil is based on the prevention of *P.i.* spore production and growth already at a low oil concentration. In contrast to previous findings, caraway oil had some systemic effect on potato plants. Formulation decreased volatilisation of the caraway oil and changed its adhesiveness to spores, but efficacy against *P.i.* was not improved in greenhouse tests.

Keywords: plant protection, *Phytophthora infestans*, potato growth, caraway essential oil, carvone

Introduction

A new sexually reproducing potato late blight (*Phytophthora infestans, P.i.*) population characterised by early oospore-derived epidemics is one of the most severe threats to organic potato production (Fry et al, 1993; Lehtinen & Hannukkala, 2004). The first symptoms of the new *P.i.* are apparent in the field about one month earlier than was the case ten years ago. Currently control is based on crop management practices that delay the onset of epidemics. These include methods such as: using only healthy seed, implementing crop rotation, taking care of sanitation during composting (Zwankhuizen et al, 1998), increased aeration in potato stands by wider row spacing (Karalus 1998; Glass et al, 2001) and favouring varieties with early tuber formation capacity and reasonable tolerance to leaf and tuber blight (Karalus & Rauber, 1997). However, blight management based on cultural practices alone results in considerable yield losses even under a moderate disease pressure. In Finland there are no compounds available for direct blight control in organic production.

Different plant and compost extracts have been studied for their efficacy against foliar pathogens of vegetables and ornamental plants, including *P.i.* on tomato and potato. The overall results of these studies have been variable but on several occasions a reasonable delay in onset of a blight epidemic has been achieved, resulting in higher yield compared with an untreated crop (Jackel et al, 1995; Schmitt, 1996; Blaeser et al, 1999). One of the successful examples is crude steam distillate from the herb, *Ocimum gratissimum* on the pathogen *Phytophthora palmivora* on cocoa pods (Awuah, 1994).

Caraway products are used as sprouting inhibitors, and they also considerably reduce losses caused by storage fungi (Bång, 1995a, 1995b, 1999). However, very limited published data on the efficacy of caraway oil based extracts against P.i. are available.

The aim of the research is to develop a *P.i.* control strategy for organic farming based on caraway oil. We also want to obtain knowledge about the interactions among the essential oil-based anti-fungal agents, the plants sprayed with them and the *P.i.* pathogen.

Materials and methods

The research includes several experiments started in 2000, some of which are still continuing. During the initial stage laboratory, greenhouse and field experiments were carried out to study the effects of caraway oil on *P.i.* Possibilities for different oil extraction methods were also investigated. The aims of the second stage of the research were to improve the efficacy of caraway oil through oil formulation, and to reveal its mode of action on the pathogen and potato plant.

Results and discussion

Caraway essential oil delayed the onset of late blight for about 10-14 days under field conditions (Hannukkala et al, 2002; Keskitalo, 2002). The control activity of the oil is based on the prevention of late blight sporangia production and growth already at a low oil concentration. In contrast to previous findings, caraway oil had some systemic effect on potato plants. Formulation decreased volatilisation of the caraway oil and changed its adhesiveness to spores, but efficacy against *P.i.* was not improved in greenhouse tests.

Conclusions

It is possible to delay the onset of *P.i.* for 14 days by using caraway oil. The aims of the ongoing studies are to find ways to delay it further. This improves the economic feasibility to control *P.i.* with caraway oil. Use of caraway oil in combination with other plant-based extracts is being studied.

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Acknowledgements

These projects are funded by the Finnish Ministry of Agriculture and Forestry.

The ecology of the cultivation system
Green manure as a multifunctional "tool" in vegetable production

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Fresh vegetables are important 'ambassadors' for organic food in the marketplace and thus they are also of great significance for the entire development of Swedish organic farming. It is expected that the demand for organic vegetables will continue to increase in line with the increase in consumer awareness regarding the importance of food composition for health.

Objectives
The overall aim of the project was to develop locally adapted vegetable production systems by using green manure as a multifunctional `tool` for integrated management of plant nutrients, pests, weeds and product quality.

The specific objectives of the project were to evaluate how different **forms and application** methods of green manures influence the following functions in cultivation systems:

- Plant nutrient supply
- Plant protection
- Product quality
- Agronomic and economic performance

We have investigated five forms and application methods using green manure, i.e. five cultivation systems: 1.Direct incorporation of green manures in spring season, 2.Intercropping of the green manure and the cash crop, 3.Use of fermented green manure (slurry), 4.Use of composted green manure, 5.Use of green manures as a mulch

The project involves researchers, extension officers, post-graduate students, growers with experience and knowledge of organic farming, as well as Nordic and international collaboration. It was structured in four work packages (WP), each headed by one partner.

WP 1 Plant nutrient supply
The objectives of this WP was to: 1.Investigate how soil biota is affected by fertilisation with organic fertilisers, 2.Determine differences in nitrogen efficiency between various forms of green manure, 3.Investigate ecosystem services and possibilities to reduce competition in inter-cropping systems

Soil biota and organic fertilizers
Short- and long-term effects on soil microbial life when using green manure as a fertilizer has been studied in field experiments. Results show that long-term green manuring effects the soil microbial community structure, but similar to those of other organic amendments such as farmyard manure and sawdust. Green manuring increases the abundance of different microbial groups and total microbial biomass compared to N-fertilized soil. The abundance of mycorrhiza is lower in green-manured soil compared to farmyard-manured soil. The enzymatic activities vary in response to the green manuring. The activities of protease and

arylsulfatase are comparable to the mineral fertilized treatment, whereas the phosphatase activity increases. Analyses from the short-term experiment are on going.

In addition a field experiment for studying the soil food web with isotope technique was conducted. Red clover labelled with ^{13}C was used as green manure in one treatment. In a second treatment the growing crop of leek was labelled with ^{13}C. The increased ^{13}C isotope concentration from the green manure and from the growing crop is followed throw the food web. This will give information on which organisms that derive their nourishment, directly or indirectly, from the living plant material and which depend on the dead organic matter. The analysis of ^{13}C-content is done with mass spectrometry. The first results show that the labelling method works fine. In the treatment with labelled green manure we found high ^{13}C-content in some soil animal groups such as fly larvae, diplopods and certain collembola. This indicates that these groups consume the green manure directly, or indirectly through microorganisms. Other animals, such as some collembola and mite species had low levels, which indicate that they are associated with other food sources such as the growing crop or old organic matter. The analyses will now continue with more soil animals and microorganisms.

Nitrogen efficiency
The nitrogen efficiency using red clover as green manure crop and leek as cash crop was studied in four of the investigated cultivation systems. Beside direct incorporation three levels of slurry, compost and mulch was used in a field experiment. The nitrogen efficiency as a measurement of nitrogen losses between harvest of the red clover crop and time of fertilization, was 78 and 46 % for fermented and composted red clover respectively and 92 % when using red clover as a mulch. The uptake of nitrogen in the leek crop as percentage of total nitrogen input was between 5 and 10 % for the red clover based fertilizers compared to 20 % in the control treatment with a mineral fertilizer. However, not all of the fertilizer nitrogen was accessible to the leek crop during the cropping period. Uptake of accessible nitrogen was 30 % in the treatment with direct incorporation of the red clover, 30-50 % when using fermented and 40-60 % when using composted red clover, between 50 and 80 % when using red clover as a mulch and 25 % in the treatment with mineral nitrogen. The amount of mineral nitrogen left in the soil profile after leek harvest was high in the treatment with mineral fertilizers and in the treatment with the highest input of fermented red clover, 164 and 105 kg ha^{-1} respectively compared to between 30 and 50 kg ha^{-1} in the other treatments. Due to low nitrogen uptake the difference in yield between treatments was low. The leek yield in comparison to harvested red clover acreage was highest in the treatment with direct incorporation and in the treatments with the lowest input of fermented red clover and mulch.

Ecosystem services
Arbuscular mycorrhiza develop symbioses with plant roots, which improves plant uptake of nutrients and enhances their power of resistance. Through the mycorrhiza, inter-cropped plants may therefore each utilise nutrients such as nitrogen that the other has taken up. In the intercropped plants we did not find any indications on an altered presence of mycorrhiza due to the different treatments.

Field studies of symbiotic nitrogen fixation were carried out in co-cropped cabbage-red clover using the acetylene reduction assay as a measure of nitrogen fixation. Results shown that fertilisation appears to stimulate nitrogen fixation, which can be due to the fact that with more available nutrients, more leaves can be formed and produce a greater photosynthetically active area, which can supply the nitrogen fixing nodules with energy. Pruning decreased nitrogen fixation immediately but plants recovered later. Controls containing no cabbage, only clover, behaved in a similar manner but with maximum values double those above.

Reducing competition in intercropping systems
To ways of reducing competition in intercropping systems were examined; choice of understorey species and root cutting. The most promising understorey species, of the ten tested, were Burnet and Birdfoot trefoil. In an inter-cropping system with white cabbage using these species the total cabbage yield was between 50 and 65 % of the yield in a mono-cropping system, the percentage saleable yield somewhat lower. By cutting the roots of the understorey species the total yield was increased to between 70 and 75 % and, as root cutting increased the saleable yield with a higher percentage, the saleable yield to around 70 % of the yield in the mono-cropping system.

WP 2 Plant Protection
The aim of this WP was to evaluate the use of green manure in short-term and long-term pest management strategies. Apart from the nutritional aspects as included in WP1, the integration of green manure in a cropping system may affect several processes in insect pest populations, such as: 1. The attraction value of the field to pest organisms and their natural enemies, 2.The egg-laying behaviour and residence time of insect pest females and thus indirectly the egg-laying rate, 3.The long-term survival/mortality rate of juvenile pest insects, through conservation of natural enemies.

In this WP we have studied the effects of intercropping on the different stages of the lifecycle of the Turnip root fly, Delia floralis Fall. (Diptera: Anthomyiidae).

During 2003 and 2004, a field trial with white cabbage and an intercrop of red clover was performed. Egg laying was monitored throughout the season with the aim to estimate the effect of intercropping on egg laying and to study the behaviour of the egg laying females. By studying the egg laying near the border between parcels of intercropping and monoculture, an attempt was made to understand the scale at which flies makes their choice. This can be important for the future design of intercropping fields. A border effect was detected in 2004.

A more diverse field can provide more habitats for natural enemies of the turnip root fly. This includes both parasitoids (e.g. *Trybliographa rapae, Aleochara bilineata* and *A. bipustulata*), and predators (e.g. *Bembidion spp*). The effect of natural enemies was studied in the field experiment with an egg predation study where eggs were placed in the field and recollected for examination of predation rates. This result of this study is still under analysis.

To study the overall predation effect from egg to pupa, an experiment was carried out were barriers were placed around plants to exclude natural enemies. Here a possible effect of predation was found, but there were no difference in effect size between intercropping and monoculture plots.

In a greenhouse experiment the interactions between feeding larvae and plant responses to intercropping and insect attack was examined. Different numbers of eggs were inoculated on plants of white cabbage grown in monoculture and varying densities of red clover. Plants responded to intercropping and insect attack by growth effects and changes of the glycosinolate content of roots and leaves. Pupae weights were lower when larvae had been feeding on plants growing in intercropping.

WP 3 Product quality
The aim of this WP was to evaluate the effects of the different green manure cultivation systems on the quality of the edible part of the crop. In the different green manure systems, nitrogen was added in different forms and was, hence, decomposed in different ways through changes in the soil micro flora and micro fauna which, in turn, affects several physiological processes related to the quality of the crops.

The levels of alkyl cystein sulfoxides and glucosinolates were related to the total sulphur content of leek and white cabbage respectively, but unrelated to the yield. Higher levels of cystein sulfoxides in leek and glucosinolates in cabbage were found when mineral fertilizers were used, compared to in the system where green manure was used as a mulch and in the unfertilized control. The level of ascorbic acid in white cabbage was unrelated to fertilizer regime. In leek, the relationship between ascorbic acid and alkyl cystein sulfoxides was strongly correlated to potassium level and the relationship between nitrogen, potassium and sulphur.

WP 4 Agronomic and economic performance
The aim of this WP was to evaluate the cultivation system from an agronomic and economic perspective with the help of the method participatory research. Participatory research is a learning and adaptation process in which farmers, advisors and researchers work together on a mutual interest. In this WP, we evaluated in a practical context and from a practical viewpoint the cultivation systems that were studied from a scientific viewpoint in the other work packages. The participatory research group consisted of six growers, geographically distributed over the entire country, and one researcher, advisor and facilitator.

The work of the group has followed the theoretical procedure within participatory research; initial phase, search phase, planning phase, experimental phase and presentation phase.

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Effects of mineral fertilizers on quality of organic vegetables and its assessments by different methods

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Mulches and pheromones - plant protection tools for organic black currant production

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Abstract

Different mulches have been studied in organic currant production since 1997 at MTT Ecological Production in Mikkeli. In 1998-2000, three mulch materials (black plastic, green mass and Tassu sapling shield) were studied in a field trial on black currant (*Ribes nigrum* L.). Mulches were compared with bare soil. Mulches, especially black plastic, suppressed weeds effectively. Mostly due to the suppressed weed population the currant bushes grew vigorously; in bare soil growth was negligible. Since green mass mulch decomposes fast on the soil surface, it can be recommended mainly as an additional fertilizer.

Lepidopterous pests *Synanthedon tipuliformis, Euhyponomeutoides albithoracellus* and *Lampronia capitella* are difficult to control even by chemicals. Therefore pheromone-based management was studied in 1999-2003. Disruption resulted in satisfactory control of low populations of *E. albithoracellus* when *Archips podana* pheromone was used, and poorer control of a high population of *S. tipuliformis*. The efficiency of different trap models for *L. capitella* was tested, but field experiments are still required to evaluate the efficiency of mass trapping.

Keywords: *Ribes*, mulch, pheromone, weed control, pest control

Introduction

In 2004, organic black currant covered 396 ha in Finland, which is 18.7 % of the total black currant cultivation area (KTTK, 2004). Interest in organic currant production has increased every year, but methods for organic currant plant protection, especially pest control, are still lacking.

Weeds and pests cause the most severe problems both in conventional and organic currant cultivation, but weed and pest control methods are not alike. Covering the soil with different mulches can strongly influence crop growth and soil properties (e.g. nitrogen content, soil moisture, soil temperature). According to many investigations, mulching suppresses weeds and affects soil temperature, soil moisture and nutrients in the soil (Shearman et al., 1979, Bristow, 1998, Larsson, 1994). Weeds can strongly compete with young currant bushes, which is why weed control is often the main reason for mulching.

The currant shoot borer *Lampronia capitella* (Cl.), currant bud moth *Euhyponomeutoides albithoracellus* (Tengström) and currant clearwing moth *Synanthedon tipuliformis* (Cl.) are serious pests of currant. As larvae live sheltered inside buds and twigs, their chemical control is difficult. Monitoring by pheromone traps facilitate the timing of sprays against adults, but in organic production reliable and acceptable control methods are lacking (Tuovinen et al., 2003). More effective measures are needed and therefore attempts to develop pheromone-based methods were initiated in 1999-2003.

The aim of our studies was to investigate the weed control aspects of mulching and the significance on the growth and development of young currant bushes to find alternatives for black plastic. Another aim was to develop new pest control methods for organic as well as conventional currant production.

Mulch experiment

One-year-old black currant bushes (three plants per plot, replicated four times) were planted in October 1998. The preceding crop was two-year green manure grass (alfalfa-timothy-meadow fescue). Black plastic (thickness 0.05 mm, width 1.2 m) was applied along the rows before planting. In mid-June the following year green mass mulch (grass and red clover mixture, layer thickness 10 cm) and Tassu sapling shields (made of waste paper and peat, thickness 4 mm, Ø 40 cm) were applied. Bare soil served as a control. Weeds were estimated once in 1999 and twice in 2000. The height, width and growth of the bushes were measured after each growing period.

Weed control

Mulching controlled weeds quite effectively during the experiment. Black plastic was the most effective treatment (Figure 1). Tassu shields lasted throughout the experiment, but wind and small animals (birds, rabbits) carried them away, which was a little problematic. Green mulch had to be applied every year because it decomposed very quickly.

Growth of currant bushes

Bushes grew more rapidly in black plastic mulch than in other mulches. Growth was lowest in bare soil. In 2000, two years after planting, the average annual growth of a single currant bush was 10.4 m for bare soil, 14.6 m for Tassu shield, 16.0 m for green mulch and 24.5 m for black plastic and the average height of bushes 80 cm, 91 cm, 95 cm and 108 cm, respectively. New shoot growth was highest in green mulch and lowest in bare soil.

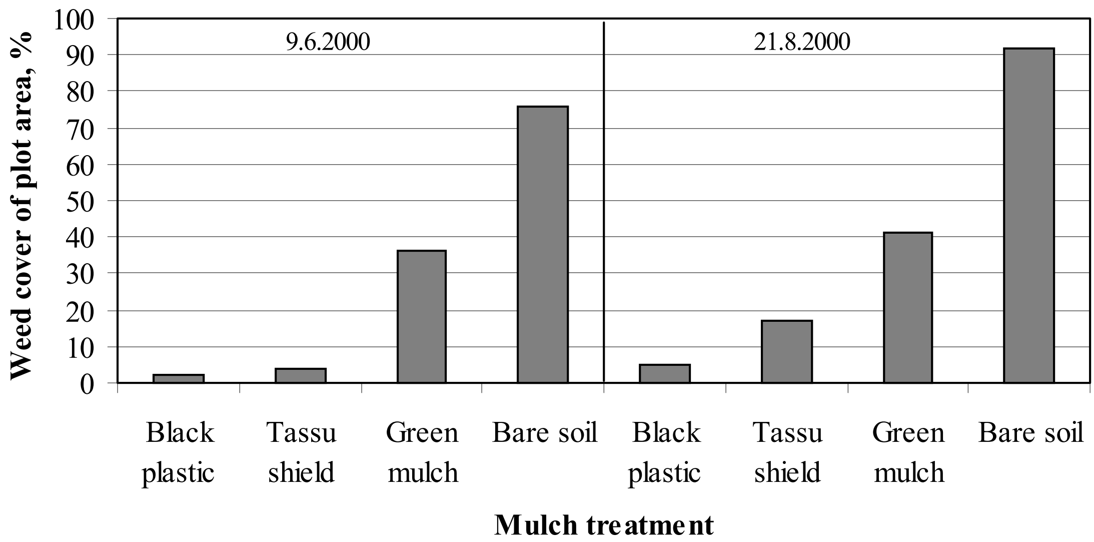

Figure 1. Average weed cover of plot area (%) in mulch treatments and in bare soil in June and August 2000.

Pheromone experiments

Disruption

Two types of disruption dispensers were used: silicon dispensers (Miniket, Enno Mõttus, Estonia), ca. 400/ha, attached to branches, and ceramic dispensers (N.P.P., France), ca. 25/ha, attached to poles. Pheromones were obtained from E. Mõttus and N.P.P. *Archips podana* (Scop.) pheromone lure (*E11-14Ac* + *Z11-14Ac*, 1/1) was used for E. albithoracellus and a specific pheromone lure for *S. tipuliformis*, (*E,Z)-2,13-18Ac*. Most experiments were carried out in small organic fields. To evaluate the disruption effect, standard monitoring traps were used, and injured buds (*E. albithoracellus*) or injuries inside twigs (*S. tipuliformis*) were recorded. The results of *E. albithoracellus* are promising and support further development of disruption techniques (Table 1). The results of *S. tipuliformis* were disappointing. As the experimental fields comprised only part of a bigger currant area, it is concluded that the whole area should be treated for reliable evaluation of the method. In addition, the initial population was obviously too high in the study area.

Table 1. Examples of disruption trials of *E. albithoracellus* using two different methods. Monitoring trap catches from the middle of the area, injury percentages are counted as injured buds in the following winter.

		Disruption block		**Control block**	
Field / Year	**Method**	Catch/trap	Injury, %	Catch/trap	Injury, %
d / 1999	Miniket Silicon	0	0.0	7	0.0
e / 1999	Miniket Silicon	0	0.0	0	0.0
f / 1999	Miniket Silicon	0	1.0	15	0.0
f / 2003	N.P.P. Ceram	0	0.1	36	3.1
g / 2003	N.P.P. Ceram	4	0.3	43	1.8
i / 2003	N.P.P. Ceram	71	1.3	16	1.4

Mass trapping

For mass trapping of *L. capitella*, three sticky and four water trap models were compared with the standard delta monitoring trap in 2003. The sticky traps were made of open horizontal plastic cylinders (length 20 and 40 cm, Ø 10 cm) or delta-type Atrakon-AP traps lined with glue paper and pheromone dispensers placed inside the traps. The water traps were made of open water containers (Ø 8, 10, 16 or 20 cm), pheromone dispensers hanging near the water surface. Detergent (1%) was added and a plastic rain cover was placed above the traps. The traps were placed 50 cm above ground in the row spaces. All traps were equipped with a Miniket dispenser loaded with *L. capitella* pheromone (*Z,Z)-9,11-14OH + (Z,Z)-9,11-14Ac + (Z,Z)-9,11-14Ald* (4/3/1) (Löfstedt et al., 2004). Four trap models were tested in each of the four trials by placing traps at random in squares ca. 5 m apart in five or six replicates. Moths were counted four times during the flying period. Catches of different trap types are presented as relative catches by replicate so that all traps can be compared in one scheme (Figure 2).

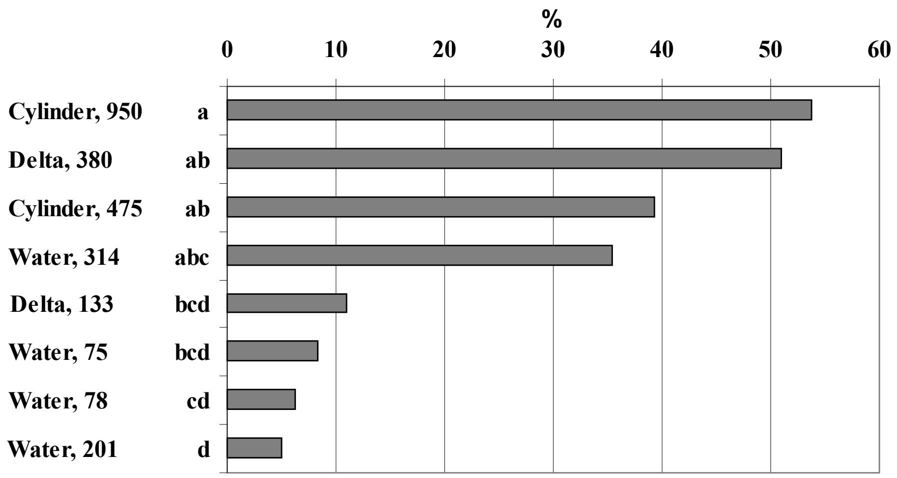

Figure 2. Results of *L. capitella* mass trapping experiments in 2003. Relative catches of trap models, trapping area in cm^2. Different letters indicate significant differences (Kruskal-Wallis, P=0.05).

Conclusion

The best weed control and growth were achieved by plastic mulch. Plastic is a resistant material, but difficult to remove from the field. Many organic currant growers favour organic materials (e.g. woodchips) instead of plastic. Tassu shields controlled weeds well, but the shape and the size of the shields were not suitable for currant bushes as such, and the price was high. Green mulch degrades too fast, allowing weeds to grow through the mulch layer.

The results of disruption of *E. albithoracellus* encourage further development and identification of the true pheromone blend. Disruption should be tested also for *L. capitella* as the mass trapping is obviously not effective enough in larger fields. Disruption trials of *S. tipuliformis* confirmed that this technique may not be effective in high-population conditions and in unisolated fields. In future, currant pest pheromones will have an important role if efforts to develop these techniques continue.

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Learning from a long-term crop rotation experiment

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Abstract

A crop rotation experiment was established in 1996/97 at three locations representing different soil types and climates. Three factors were tested: i) crop rotation with different proportions of N2-fixing crops, ii) with and without a catch crop, and iii) with and without animal manure. A green manure crop increased yields in the following cereal crops, but at the rotational level, total yields were larger in crop rotations without a green manure crop. There were positive effects of animal manure and catch crops on yield. However, except for the coarse sandy soil, the yield effects of catch crops and animal manure decreased over time when a grass-clover green manure was included in the rotation. The problems with perennial weeds increased over time depending on crop rotation and use of catch crops. This stresses the importance of considering long-term effects in the evaluation of crop management measures.

Keywords: Crop rotation, cereals, nutrients, weeds, management

Introduction

Crop production in organic farming systems relies to a large extent on soil fertility for nutrient supply. The soil fertility must be maintained via choice of crop rotation and (green) manuring practices. Fertility building by such means requires a long-term integrated approach, rather than the short-term and targeted solutions common in conventional agriculture. The control of perennial weeds is another area, which requires a long-term perspective, since there are interactions with the soil fertility and with crop management. Enhanced soil fertility has been found to increase crop yields in organic farming (Olesen et al, 2002). However, higher soil fertility may also increase the negative environmental impacts, including nitrate leaching and nitrous oxide emissions. It follows that, for studies of management effects in organic cropping systems and their environmental impacts, long-term cropping experiments are indispensable.

Materials and methods

A crop rotation experiment was established in 1997 at three locations in Denmark representing different soil types and climates: a coarse sand at Jyndevad, a loamy sand at Foulum and a sandy loam at Flakkebjerg. Average precipitation was 964, 704 and 626 mm at Jyndevad, Foulum and Flakkebjerg, respectively (Olesen et al, 2000). The following experimental factors were included in a factorial design with two replicates and all crops in the rotations were represented every year: i) crop rotation, with different proportions of N_2-fixing crops, ii) with (+CC) and without catch crop (-CC), and iii) with (+M) and without animal manure (-M) applied as slurry. Different four-year crop rotations were compared in the experiment, and two courses of the rotations were completed in 2004. Results from two different crop rotations are presented here, rotation 2 (R2: spring barley undersown with grass-clover – grass-clover – winter cereal – pulse crop) and rotation 4 (R4, 1st course: spring oat – winter wheat – winter cereal – pulse crop, and R4, 2nd course: spring barley – pulse crop

– winter cereal – spring oat). Cereal and pulse crops were harvested at maturity. All straw and grass-clover production was incorporated or left on the soil. The +M treatments received anaerobically stored slurry at rates, where the NH_4-N application corresponded to 40% of the N demand of the specific rotation according to a Danish national standard. The N demands of grass-clover, peas/barley and lupin/barley were set to nil.

Results

There were limited problems with pests, diseases, and annual weeds and increasing problems with perennial weeds during the two courses. The average yields in R2 decreased from the first to the second course at Jyndevad and Foulum (Table 1), primarily due a change in pulse crop species. At Flakkebjerg, the yields in R2 increased over time due to improved soil fertility. The average grain yields were higher in R2 compared with R4. However, the benefits from the green manure could not compensate for the average yield reduction caused by leaving 25% of the rotation out of production. As a rotational mean, including zero yield in the green manure crop, R2 yielded 14 to 18% less than R4.

Table 1. Mean grain yield of cereal and pulse crops and mean yield increase from catch crops and manure application (t DM/ha) in the two crop rotations for two courses of the rotations.

Course	Location	Rotation R2			Rotation R4		
		Mean	Yield increase		Mean	Yield increase	
		Yield	CC	Manure	Yield	CC	Manure
1st	Jyndevad	2.87	0.20	0.65			
(1998-2000)	Foulum	4.20	0.13	0.79	3.64	-0.23	1.01
	Flakkebjerg	3.34	0.06	0.50	3.06	0.21	0.90
2nd	Jyndevad	2.42	0.06	0.96			
(2001-2004)	Foulum	3.90	0.05	0.55	3.64	0.63	0.82
	Flakkebjerg	3.59	0.08	0.41	2.90	0.64	0.89

The use of catch crops in R2 increased yields in the first course at all locations, most at Jyndevad and the least at Flakkebjerg (Table 1). This difference between locations was probably due to large nitrate leaching losses from the sandy soil (Askegaard et al, 2005). In the second course of R2, the use of catch crops caused a yield decrease in the winter wheat following the grass-clover crop at Foulum and Flakkebjerg. However, at Flakkebjerg this yield decrease was nearly matched by a yield increase in the spring barley crop. Thus, as an average of R2, there was only a small effect of catch crop on yields. This result can probably be ascribed to a buffering effect of the clover in the grass-clover crop. A higher yield in the spring barley reduced the clover content in the grass-clover, which was established by undersowing it in the barley crop. This subsequently reduced the nitrogen supply to the following winter wheat.

The catch crops in R4 were clover-based and contributed to the N supply through N_2-fixation. The ploughing-in of clover catch crops prior to spring cereals increased yields in both the 1st and the 2nd course (Table 1). The negative effect of catch crops in the winter cereals in the 1st course of R4 derived from problems in the bi-cropping of winter cereals in a stand of clover. The method was changed in the 2nd course, which led to a positive effect of the catch crop on yields, also of the winter wheat.

Yields increased significantly after manure application in both R2 and R4, but the effect decreased from the 1st to the 2nd course at Foulum and Flakkebjerg (Table 1). This reduction probably resulted from the manure application affecting the proportion of clover in the grass-clover in R2 and the clover-dominated catch crops in R4. On the coarse sand at Jyndevad there was no such effect.

At Jyndevad, the infestation of couch grass (*E. repens*) quickly developed into a problem, whereas the infestation of *E. repens* developed slower at Flakkebjerg and to a much lesser extent at Foulum (Table 2). Stubble cultivations in the plots without catch crops were performed in autumn during most years at both Jyndevad and Flakkebjerg to control perennial weeds. This decreased *E. repens* infestations, but increased nitrate leaching significantly at Jyndevad from 30 kg N/ha in the +CC treatment to 130 kg N/ha in the –CC treatment (Askegaard et al, 2005). In spite of the high level of E. repens infestations in the +CC treatments at Jyndevad, the mean of cereal and pulse yields where higher in the +CC than in the –CC treatments in the second course of the rotation (Table 1), probably because of an improved nutrient supply. However, the yield benefit from catch crops at Jyndevad decreased from the first to the second course of the rotation, and this may be at least partly explained by the increase in *E. repens* infestations in the catch crop treatments. Manure affected *E. repens* differently at the two sites, giving increasing shoot densities in R2 at Flakkebjerg and decreases at Jyndevad (Table 2).

At Flakkebjerg, there was a lower infestation of thistles (*C. arvense*) in rotation 2 than in rotation 4, with least biomass in the crop the year after grass-clover (Table 2). There was a tendency for lower number of thistle shoots in the +CC treatment compared with the -CC treatment in rotation R4 (Table 2), in spite of the fact that stubble cultivations and row hoeing were carried out in the –CC and not in the +CC treatments. This most likely occurred because the nutrients retained in the topsoil by the catch crops benefited the crops, then which became more competitive against the thistles. Manure application reduced the thistle shoot density.

Table 2. Mean density of shoots of couch grass (*E. repens*) and thistles (*C. arvense*) and mean density increase from catch crops and manure application (no/m2) in the two crop rotations for two courses of the rotations.

Course	Location	Rotation R2			Rotation R4		
		Mean	Increase		Mean	Increase	
			CC	Manure		CC	Manure
E. repens							
1st (98-00)	Jyndevad	10.7	8.4	-7.7			
	Flakkebjerg	1.3	0.9	0.3	1.2	0.4	1.3
2nd (01-04)	Jyndevad	23.9	28.0	-12.9			
	Flakkebjerg	5.3	4.9	5.0	7.3	10.5	-1.3
C. arvense							
1st (99-00)	Flakkebjerg	0.6	-0.5	-0.5	1.3	-1.6	-0.2
2nd (01-04)	Flakkebjerg	1.1	0.5	-0.1	2.2	-1.5	-1.1

Discussion

The experiment has demonstrated that the long-term effects of different cropping systems are different from the short-term effects. These differences result from effects of the different cropping systems on soil fertility and on infestation with perennial weeds. Many of the effects were related to nutrient supply, in particular nitrogen supply. These effects depended on site conditions as influenced by soil type and climate. For the coarse sandy soil and the high rainfall at Jyndevad, nitrate leaching had a considerable effect on crop nitrogen supply and this was probably the main reason for the low yields at this site. The nitrate leaching was much less of a problem for the sandy loam and the lower rainfall at Flakkebjerg, where yields in some years instead were restricted by low summer rainfall.

The buffering effect of the grass-clover in rotation R2 resulted in smaller yield benefits from both catch crops and manure application in the 2nd compared with the 1st course of the experiment. This suggests that improving soil fertility via grass-clover green manure crops may not be the best way to improve crop yields. Instead the plant material from the grass-clover crops may be harvested and used in biogas digesters for renewable energy supply, and the digested slurry may be applied in a more targeted way to improve crop yields, possibly without loosing the yield benefits from growing catch crops.

Improved nutrient supply increased the crop competitiveness against E. repens. However, this was not sufficient to control this weed species, and stubble cultivations were necessary, in particular at the coarse sandy soil at Jyndevad. However, stubble cultivations in autumn increase the risk of nitrate leaching, which may further reduce crop nitrogen supply and reduce crop competitiveness. There is a need to break this vicious cycle, and growing catch crops may be a solution, if they can be effectively established after the stubble cultivations. An alternative is to perform the mechanical control of *E. repens* in spring prior to sowing, possibly by harvesting or burning the rhizomes.

Both the grass-clover green manure and the use of catch crops reduced the occurrence of *C. arvense*. These components of the crop rotation should therefore be considered in cases, where there is risk of infestation with C. arvense and possibly with other deep-rooted perennial weeds.

Conclusions

The yield effects of catch crops and manure changed from the first to the second course of the organic crop rotation experiment. This stresses the importance of considering long-term effects in the evaluation of crop management measures. The results of the crop rotation experiment demonstrate that crop management practices, including crop rotation design, should be tailored to the local site conditions. These site conditions not only include soil type and climate, but also the soil fertility and the specific weed problems.

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Acknowledgements

The Danish Ministry of Food, Agriculture and Fisheries financed this work, which was performed in the context of the Danish Centre for Organic Farming.

Subsoil loosening eliminated plough pan but had variable effect on crop yield

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Abstract

The effect of subsoil loosening to c. 35 cm depth was studied in an organic crop rotation experiment at Flakkebjerg (sandy loam) and Foulum (loamy sand). In each of the years 2000-2003 half of 4 plots per site was loosened in the autumn in a young grass-clover. Penetration resistance was recorded yearly. Detailed soil physical properties were determined for the Foulum site in 2003. Aboveground winter wheat growth was followed during the 2002/03 growing season using spectral reflectance measurements. Root growth was followed during the 2002/03 growing season at Foulum using the minirhizotron technique. Crop yield was determined every year in all treated plots. The Paraplow treatment effectively loosened the plough pan. Loosening in the grass-clover crop resulted in reduced growth. Apparently, this unintended effect of loosening had marked effects on the growth of the succeeding winter wheat crop. In wet years, yields were lowest in loosened and unmanured soil. In a dry year, loosening resulted in increased yield at Flakkebjerg. This appears to be an effect of the grass-clover crop that interferes with the results of loosening. Generally, our results suggest that under Danish conditions subsoil loosening can only be recommended in case of very severe subsoil compaction.

Keywords: Subsoil loosening, plough pan, soil structure, root growth, crop yield

Introduction

Subsoil compaction - especially in the form of plough pan compaction - is a widespread problem on Danish arable soils. Subsoil compaction may reduce crop yield and quality, increase negative environmental impacts (e.g. nitrogen leaching), and reduce soil workability and trafficability. The objective of this study was to investigate the effect of subsoil loosening in an organic crop rotation experiment where a root-hampering plough pan had been identified.

Materials and methods

The investigations were carried out in an organic crop rotation experiment at Flakkebjerg (sandy loam, 13% clay) and Foulum (loamy sand, 8% clay) (Olesen et al., 2000). At the initiation of the experiment in 1997, a root-hampering plough pan had been indentified at both Flakkebjerg and Foulum (Djurhuus & Olesen, 2000). We studied the effect of subsoil loosening to c. 35 cm depth using a Paraplow. In each of the years 2000-2003 half of 4 plots per site was loosened in the autumn in a young grass-clover (established undersown in spring barley in the spring). The grass-clover crop was ploughed under in the following autumn and winter wheat was established. After loosening there was thus a whole year without tillage, very limited traffic, and continuous crop growth. On-land ploughing was subsequently applied as primary tillage to counter plough pan reformation. The winter wheat crop was succeeded by lupin/barley and subsequently a spring barley undersown with grass-clover. Two different manure treatments were included in the experiment, with and without

application of slurry (50 kg NH_4-N/ha) to winter wheat and spring barley. The treatments were only carried out once in each plot, and therefore the number of treated plots per site increased from 4 in 2000 to 16 in 2003.
Penetration resistance 0-60 cm depth (Olsen, 1987) was recorded yearly in the treated plots in the years 2001 to 2004. Detailed measurements of soil physical properties (bulk density, and water content and air permeability at –100 hPa matric potential) were carried out at Foulum in 2003. Aboveground plant growth was followed during the 2002/03 growing season using spectral reflectance measurements according to Andersen et al. (2005). At Foulum, root growth was followed in winter wheat during the 2002/03 growing season using the minirhizotron technique described by Thorup-Kristensen (2001). Crop yield was determined every year in all treated plots.

Results

The Paraplow treatment effectively loosened the plough pan (Figure 1a). Subsoil loosening increased the volume fraction of coarse pores and air permeability (data not shown). This indicates increased saturated hydraulic conductivity. After 3½ years there was still a significant effect of loosening but not as pronounced as in the first couple of years after loosening (Figure 1b).

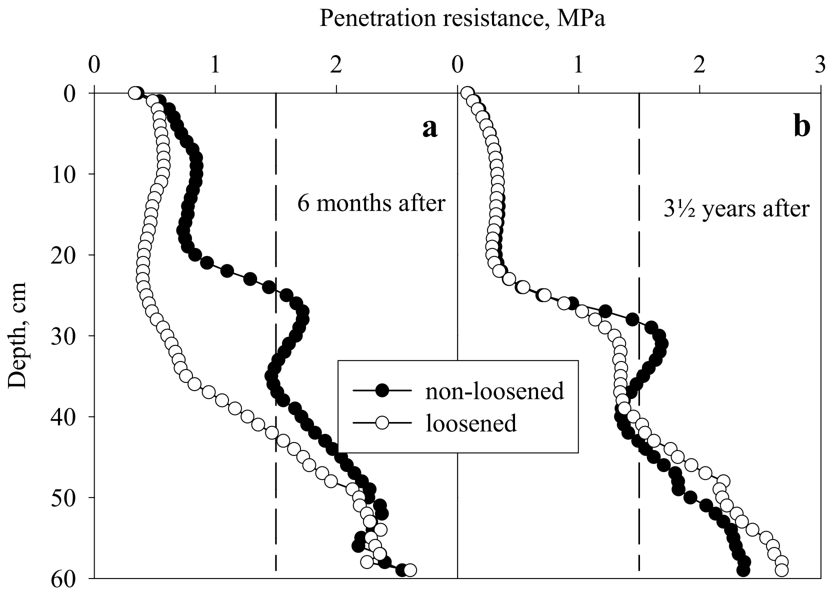

Figure 1. Penetration resistance at Foulum for loosened/non-loosened half-plots. Half-plots loosened September 2000. Measurements carried out 6 months (a) and 3½ years after loosening. Vertical broken line indicate critical limit for root growth (1.5 MPa).

The subsoil loosening was carried out without significant visual damage to the young grass-clover crop. However, reduced growth of the grass-clover crop was found in the following growing season. Especially the white clover appeared to be sensitive to soil loosening. Apparently, this unintended effect of the soil loosening had marked effects on the growth of the succeeding winter wheat crop. In winter wheat following grass-clover there was a tendency towards yield reduction in loosened and unmanured soil in 2002 and 2004 (Table 1). In contrast, there was a tendency to increased yield in loosened soil at Flakkebjerg in 2003 (with and without manure) and in 2004 (with manure).

Table 1. Effect of year, site, fertilization and loosening on winter wheat yields (85% dry matter)

Year	Site	Loosening	Grain yield (hkg/ha)	
			- manure	+ manure
2002	Foulum	No	42	58
		Yes	38	56
	Flakkebjerg	No	47	47
		Yes	40	46
2003	Foulum	No	55	66
		Yes	55	65
	Flakkebjerg	No	54	54
		Yes	57	56
2004	Foulum	No	48	58
		Yes	43	58
	Flakkebjerg	No	50	53
		Yes	50	57

Discussion

Plough pan re-formation was reduced during the first two years after loosening due to the use of on-land ploughing and other means of reducing soil re-compaction. A similar study on a Danish sandy loam showed that on-land ploughing is needed to inhibit plough pan re-formation (Munkholm et al., 2005a, b).

It seems that the residual nitrogen effect from the grass-clover crop has biased the effect of loosening according to the winter wheat yield results. The winter wheat crop relies heavily on the nitrogen supplied by the preceding grass-clover crop. A low residual nitrogen effect was expected under conditions where a low amount of nitrogen had been collected by the grass-clover crop (i.e. poor performance of the clover) and/or in case of high nitrogen leaching during the winter (i.e. wet winter climate). Further, a small residual nitrogen effect is expected to have the strongest impact without manure application. Our results were in accordance with this. The winters 2001/02 and 2003/04 were wet (i.e. high levels of nitrogen leaching) which may explain the observed low yield in loosened soil without manure application soil in 2002 and 2004. The winter 2002/03 was relatively dry (i.e. little nitrogen leaching) and relatively high yields were found without manure in 2003. Other studies in the crop rotation experiment have shown a generally lower level of nitrogen leaching at Flakkebjerg than at Foulum due to differences in soil texture and winter precipitation (Askegaard et al., 2005). The poorer performance without manure application (relative to manure application) at Foulum than at Flakkebjerg may be related to the difference in nitrogen leaching. Likewise, the relatively poorer performance of loosening at Foulum than at Flakkebjerg may reflect differences in nitrogen leaching and climate conditions.

The interfering residual effect of nitrogen from grass-clover was expected to decline strongly with time. Therefore, more or less unbiased results were expected for the succeeding crops in the rotation after winter wheat. The yield results showed no clear effect of loosening for the crops following winter wheat (lupin/spring barley and subsequently spring barley with grass-clover undersown) (data not shown). Subsoiling may cause mixed effects on the system of macropores. New cracks and pore space are produced at the same time, as the continuity of

the existing system of macropores (channels) is broken. The latter may significantly counteract the generally improved condition for root growth in the loosened soil layers.
Root and earthworm channels constitute effective pathways through compacted layers and significantly improve soil functions like aeration, infiltration and deep rooting.

Conclusions

Our results suggest that under Danish conditions subsoil loosening can only be recommended in case of very severe subsoil compaction. Biological amelioration may constitute a favourable alternative to mechanical subsoiling. Root and earthworm channels form effective pathways through compacted layers and significantly improve soil functions like aeration, infiltration and deep rooting.

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Acknowledgements

The Danish Ministry of Food, Agriculture and Fisheries financed this work, which was performed in the context of the Danish Research Centre for Organic Farming.

Pests and their natural enemies in the organic oilseed and turnip rape

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Abstract

The occurrence of the pests, their natural enemies – hymenopterous parasitoids and carabids were studied in the spring and winter oilseed and turnip rape crops on an organic farm in Estonia. The pests' abundance was low in both winter oilseed crops. *Meligethes aeneus* and *Ceutorhyncus assimilis* were found but plants showed no sign of damage. In the spring oilseed rape *M. aeneus* was a real pest in Estonian conditions. Four parasitoids of *M. aeneus* larvae (*Diospilus capito, Phradis morionellus, P. interstitialis* and *Tersilochus heterocerus*) and three of *C. assimilis* larvae (*Mesopolobus morys, Stenomalina gracilis* and *Trichomalus perfectus*) were found. Among carabids, the genus *Pterostichus* dominated, with *P. cupreus* being the most numerous species. The maximum abundance of carabids occurred at the time when *M. aeneus* larvae dropped to the soil for pupation and hence were vulnerable to predation by carabids. For organic production the winter oilseed crops should be preferred because of very low number of pests and the greater diversity and abundance of predators.

Keywords: spring and winter oilseed rape, pests, hymenopterous parasitoids, predators.

Introduction

In Estonia, the cultivation of oilseed rape (*Brassica napus* L., *Brassica rapa* L.) has expanded greatly in recent years and now exceeds 52, 770 ha. Only 49.7 ha were grown on an organic cropping system. This provides good potential for population growth of crucifer-specialist, phytophagous pests. In Europe, the most common pests of oilseed rape are *Meligethes aeneus* Fabr., *M. viridescens* Fabr., *Ceutorhynchus assimilis* Payk., *Ceutorhynchus pallidactylus* Panz., *C. napi* Gylh., *Dasineura brassicae* Winn., *Psylliodes chrysocephala* L. and *Phyllotreta nemorum*, *P. undulata* and *P. diademata* (Alford et al., 2003).

The management of pests on the European oilseed rape crop still relies heavily on chemical pesticides, most often applied routinely and prophylactically, often without regard to pest incidence (Williams, 2004). The pesticides also kill the natural agents of biological control, which would be a natural resource of great potential benefit to the farmer and the consumer (Williams & Murchie, 1995). Organic farming methods break up disease and pest cycles and there is an increase in crop diversity. Organic farming saves pests' natural enemies – parasitoids and predators. Parasitoids can control the pests. For example, larval ectoparasitoid *Trichomalus perfectus* Walker (Hymenoptera: Pteromalidae) of *C. assimilis* is widely distributed and particularly important (Murchie & Williams, 1998). Unlike parasitoids, predators are usually non-specific and their attacks on pests within oilseed rape fields tend to be fortuitous rather than targeted (Büchs, 2003a). In oilseed rape fields, the dominant predators are carabids, these having the greatest biomass in comparison with rove beetles and spiders (Goltermann, 1994). They are present all-year-round and able to suppress pest populations at an early stage (Büchs, 2003a). The occurrence of carabids is greatly influenced by the farming system, being greater in extensively-managed than in intensively-managed fields (Büchs, 2003b).

In Estonian conditions, the pests of oilseed rape and their natural enemies have been little studied. The present study aims to add to knowledge of rape pests and their natural enemies

on organic farming methods in Estonia and contributes to the project MASTER: MAnagement STrategies for European Rape pests (Williams et al., 2002).
The aim of this study was to identify the occurrence and phenology of winter and spring oilseed rape pests, their hymenopteran parasitoids and carabid predators in organic farming fields.

Materials and methods

The winter oilseed rape crop sampled was the variety "Hansen" (in 2001/2), the spring oilseed rape was the variety "Quantum" (in 2003) and the winter turnip rape was the variety "Prisma C" grown at converted organic farm Puki, Tartu County in 2003/4 (all crops were grown using the organic farming methods). In 2002 the oilseed crops were introduced to crop rotation. Insects were sampled using yellow water traps (for sampling flying insects) installed within the rape crops and pitfall traps (for sampling carabids). Traps were placed out at growth stage (GS) 61–62 (10–20% of flowers on main raceme open). Crop GS was assessed weekly according to the BBCH scale (Lancashire et al., 1991). The yellow water traps were positioned at the height of the crop canopy and raised weekly as necessary to keep pace with crop growth. The traps were emptied and insects collected once a week until harvest. The target phytophagous insects and carabids were identified to species. Parasitoids were identified to family, except those specialised on the target phytophagous insects, which were identified to species. Plant density, architecture and infestation and damage by pests were determined. Stems were dissected for *C. pallidactylus* mining damage. Pods were examined for the presence of live or dead *C. assimilis* and *D. brassicae* larvae, the exit holes of emerged *C. assimilis* larvae or those of its ectoparasitoids or pod shatter due to D. brassicae larvae.

Results and discussion

Pests. Abundance of pests was low in both winter oilseed crops (Fig. 1). Only two of the most important of the European pests were caught, *M. aeneus* and *C. assimilis*, but the plants showed no sign of damages by these pests. No *P. chrysocephala*, *C. pallidactylus, C. napi* or *D. brassicae* were caught and plants showed no sign of damage. At the GS 65–67 (50–70% of flowers were opened), *M. aeneus* and *C. assimilis* appeared in catches and remained the dominant species thereafter. Their numbers were greatest at GS 78–81 (80–100% of pods had reached final size) (Fig. 1) and indicated emergence of the new generation from the soil.

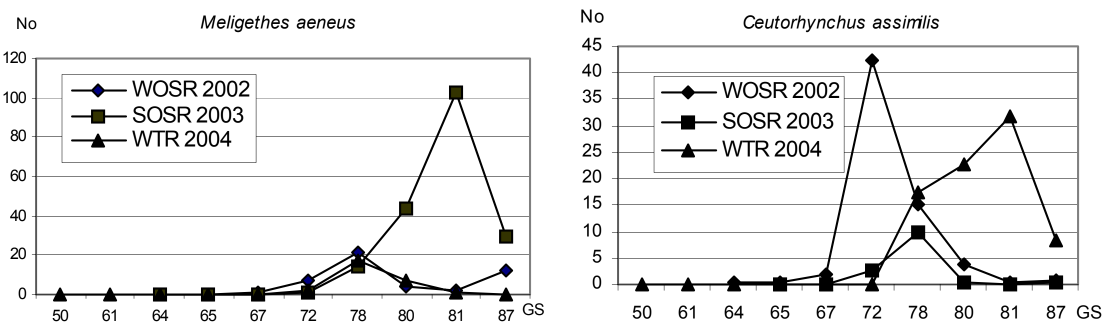

Figure 1. The mean numbers of *M. aeneus* and *C. assimilis* per yellow water trap caught at different growth stages (GS) of winter oilseed rape (WOSR), spring oilseed rape (SOSR) and winter turnip rape (WTR) in organic farming fields on the Puki Farm, Tartu County, Estonia, in 2002/4.

Although *C. assimilis* was abundant in the winter crops no larval damage to the pods was found, suggesting that the synchrony of this species with the crop GS was poor, and that it arrived at a sexually-immature stage or at a GS unsuitable for egg-laying. But in 2003 in the spring oilseed rape *M. aeneus* was the most abundant and real pest in Estonian conditions (Fig. 1). In the conventional and minimised fields of spring and winter oilseed rape the same tendency appeared in 2003 and 2004 (Veromann et al, 2004, Veromann et al, 2005).
Parasitoids. The numbers of parasitoids caught that attack the pests of oilseed rape was very low. Only one specimen of each of four species, namely, *Phradis morionellus* (Holmgren), which attacks *M. aeneus* larvae and *T. perfectus*, *Mesopolobus morys* (Walker) and *Stenomalina gracilis* (Walker) which attack *C. assimilis* larvae were found in winter oilseed rape, in 2002. In turnip rape only one specimen of *P. interstitialis* (Thomson) and 3 specimens of *P. morionellus* were found and no one was found in the spring oilseed rape. This paucity of parasitoids in our crop is somewhat surprising. *Diospilus capito*, *P. morionellus*, *P. interstitialis* and *T. heterocerus* have all been recorded in Finland (Hokkanen, 1989), at the northern distribution limit of oilseed rape cultivation, and *P. morionellus* is recognised as an abundant and effective regulator of its host in Scandinavia (Billqvist & Ekbom, 2001). In the favourable conditions the level of parasitism could reach to 100% (Herrström, 1964). The winter rape is offering hibernation places for parasitoids. Diverse flora in field margins is important presumption to promote parasitoids because adult parasitoids are exclusively dependent on floral and extra floral nectar, honeydew and pollen for food (Lewis et al, 1998).
Predators. In winter oilseed rape 25,134 specimens from 41 taxa of carabid, in spring rape 586 specimens from 21 taxa and in winter turnip rape 10,772 from 27 taxa were caught. The winter rape is offering good hibernation for carabids and therefore richer fauna. Dominant genera carabids were *Pterostichus, Amara, Agonum, Harpalus* and *Carabus*. In the winter crop fields *Pterostichus* dominated, with *P. cupreus* being the most numerous species. In the spring oilseed rape *Harpalus rufipes* dominated. *Pterostichus, Agonum* and *Harpalus* adults have a mixed plant and insect diet in different seasons. All carabid larvae are predators. Thiele (1977) has found that *Pterostichus melanarius* prefers a diet of animal food throughout the year whereas *Pterostichus cupreus* prefers it mainly in the summer. In the rape field carabids were most abundant in the period when the larvae of *M. aeneus* finished feeding on flowers and dropped down into soil for pupation. At that time they were prey objects for carabids.

Conclusions

In the Estonian conditions winter oilseed rape and turnip rape has still no serious pest problems. Only two of the most important of the European pests were caught, M. aeneus and *C. assimilis*, but they did not cause any significant damage to the winter oilseed rape and the turnip rape. In the spring oilseed rape only *M. aeneus* was pest. The occurrence of pests' natural enemies was established. *Meligethes aeneus* larval parasitoids: Phra*dis morionellus, P. interstitialis, Diospilus capito, Tersilochus heterocerus, Mesopolobus morys, Stenomalina gracilis* and *Trichomalus perfectus*, larval ectoparasitoids of *Ceutorhynchus assimilis* were found. Among predators carabid Pterostichus cupreus was the dominating species. Their higher abundance in the period when the larvae of *M. aeneus* finished feeding on flowers is indicate their role in the *M. aeneus* population regulation. Winter oilseed rape crop should be preferred in organic farms because there are still no serious pests and there is greater diversity and abundance of carabids.

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Acknowledgements

This research was supported by the grant no. 4993 and 5736 of the Estonian Science Foundation and the EU Framework 5 Project MASTER: MAnagement Strategies for European Rape pests (QLK5-CT-2001-01447).

Peculiarities of some legumes and cereals under organic farming system

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Abstract

A whole range of factors and their interactions influence organic farming. The experiments were aimed to estimate some elements of organic farming technologies. Different field studies were conducted on a loamy *Endocalcari-Epihypogleyic Cambisol* in Dotnuva. The effect of different legume/grass swards on the subsequent winter wheat crop was dependent on sward composition, and the highest grain yield was obtained after ploughed-in lucerne. Pre-crop of white clover and conventional drilling significantly affected wheat grain yield. Pea grain yield was dependent on soil tillage systems, and higher yield was in direct drilling treatment. Winter wheat grain yield of most varieties was above the expected level for organic farming, therefore protein content was too low for the top milling quality requirements, and leaf spot diseases caused some yield losses. Some positive impact of biological agents oksihumat and limnogumat was observed on Fusarium spp. and root rot diseases. The effectiveness of mechanical harrowing for the control of perennial weeds was low.

Keywords: disease control, legumes, weed control, winter wheat, varieties

Introduction

Organic farming is affected by many factors, such as management, climate and soils, all of which interact over time and space (Olesen, 1999). It is common knowledge that the basis for organic farming is crop rotation (Wijnands, 1999), however, individual elements are not less relevant. Legumes are of great importance in organic plant production both as catch crops in general and because of their biological nitrogen fixation (Younie, 2000). The most common legumes in crop rotations are perennial legumes and peas, and their influence on subsequent crops is very important. The choice of varieties in organic farming is the key element, because it is one of disease and of other abiotic and biotic stress prevention factors. Another highly pertinent element in organic farming is disease control. Biological disease control has become a significant component of plant disease management, but it is still questionable and the effect may vary from disease suppression to disease enhancement depending upon plant and environmental conditions. Weed control is one of the key factors for the successful production in organic farming. It has been noted that organic farming system is likely to have a wider weed species diversity (Boguzas et al., 2004). The use of mechanical weed control measures is one possible approach for optimising this factor. Organic farming is becoming increasingly popular in Lithuania, and two thirds of organic farms are involved in crop production, however the production volumes are low. As a result, the above-mentioned factors of organic farming are vital for management of farming. This paper describes some steps of organic crop management.

Materials and methods

Different field studies were conducted on a loamy *Endocalcari-Epihypogleyic Cambisol* in Dotnuva (55º24' N 23º50' E). Soil pH was neutral (7.3), humus content 2.1 %, available P 50-80 mg kg^{-1} and K 100-150 mg kg^{-1}.

Experiment 1. In the third year of use of different legume/grass swards, before ploughing we estimated plant residues and root mass and nitrogen content in them and their influence on subsequent winter wheat yield. *Experiment 2* was designed to assess alternative growing of white clover in a crop rotation and impact on cereal yield. *Experiment 3* was intended to evaluate pea grain yield formation in different soil tillage systems: conventional tillage (primary deep ploughing, pre-sowing cultivation with rotary harrow), reduced tillage (shallow ploughing in autumn, shallow pre-sowing cultivation) and direct drilling. *Experiment 4* was designed to estimate different winter wheat varieties under organic farming conditions. *Experiment 5* was intended to assess biological measures for disease reduction in winter wheat stands. The seeds were treated with biological preparation on the sowing day. *Fusarium spp*. and root rot severity were evaluated at tillering stage (BBCH 21-23). *Experiment 6* was carried out to evaluate the effectiveness of a flex-tine harrow. Wheat was harrowed once, twice and three times at different stages of cereal growth. The control treatment was not harrowed. The 1st harrowing was applied at the beginning of wheat tillering, the 2nd at the end of the wheat tillering, the 3rd at the booting stage of wheat. Weeds were recorded twice.

Results and discussion

The N content incorporated into the soil was dependent on sward composition. Higher nitrogen amount was incorporated into the soil with lucerne-based swards (Table 1). Winter wheat grain yield was low. This resulted from the growing conditions and the N-release to the succeeding crop. The highest winter wheat yield was obtained when it had been grown after ploughed-in lucerne-based swards.

Table 1.The effect of legume and legume/grass swards on the productivity of winter wheat

Treatments	N kg ha^{-1} from plant residues		Wheat grain yield, t ha^{-1}	
	2000	2002	2001	2003
Trifolium repens[1]	103.9	114.0	2.41	2.54
Trifolium pratense[2]	115.7	204.2	2.22	2.70
Medigaco sativa[3]	128.0	241.5	2.82	3.43
T. repens1 / grasses[5, 6]	120.3	176.8	1.61	2.53
T. repens1 M.sativa3 /grasses[4, 5]	175.5	252.0	1.80	2.33
Grasses[4, 5] / N_{240}	187.4	177.8	1.41	2.70
Grasses[4, 5] / N_0	96.5	94.7	2.18	1.71
LSD_{05}	-		0.322	0.424

[1]cv. Atoliai, [2]cv. Arimaiciai, [3]cv. Birute , [4]Lolium perenne cv. Sodre , [5]Phleum pratense cv. Gintaras II

Table 2. The impact of pre-crop and sowing method on cereal grain yield, t ha^{-1}

Wheat pre-crops + sowing method	Wheat (2003)	Triticale (2004)
Barley, conventional drilling (CD)	4.59	2.54
White clover, direct drilling (DD)	3.01	2.79
W. clover, barley cover crop, DD	2.45	2.94
White clover, green manure, CD	4.89	3.21
White clover, CD	5.07	2.70
LSD_{05}	0.406	0.448

In terms of grain yield, winter wheat undersown into growing white clover significantly lagged behind the conventionally sown wheat (Table 2). Winter wheat sown after ploughed in white clover yielded 300-480 kg grain ha^{-1} more than the wheat grown conventionally after barley (without clover). The yield of triticale was higher after wheat grown after pre-crops with white clover and slightly lower after wheat grown together with white clover.

Table 3. The effect of tillage on the grain yield of pea, 2004

Tillage system	Grain yield , t ha^{-1}
Conventional tillage	4.02
Reduced tillage	4.35
Direct drilling	4.69
LSD05	0.489

The highest grain yield of peas was recorded in the direct drilling treatment (Table 3). In the direct drilled experimental plots the number of lodged plants was very small. In the conventionally tilled plots almost all plants had lodged.

Table 4. Varietal effect on wheat grain yield and quality, 2004

Variety	Tillering coefficient	TWK, g	Protein content, %	Grain yield t ha^{-1}	Severity (BBCH 75-77) , %	
					Tan spot	Septoria leaf blotch
Sirvinta	3.8	52.0	12.6	6.96	10.8	4.3
Ada	3.8	40.0	12.3	7.49	12.8	4.5
Seda	3.7	52.8	12.2	7.61	9.0	3.1
Tauras	4.5	45.5	12.9	7.52	7.5	2.3
Alma	3.0	43.5	13.4	6.00	7.8	5.0
Milda	4.6	43.0	12.0	7.37	7.7	4.3
Lina	3.3	46.8	10.6	8.48	9.6	3.8
Bill	4.8	46.3	9.9	9.23	2.3	1.0
Lars	4.0	46.8	10.5	8.49	9.4	3.8
Zentos	2.6	45.0	10.3	8.39	9.8	2.8

Winter wheat established well and produced excellent yields (Table 4). Grain yield of most varieties was much above the expected level for organic farming. Protein content was generally too low to meet the top milling quality requirements, however some varieties were close to the top. According to quality indicators the variety Alma better met the requirements. Leaf spot diseases such as tan spot (*Drechslera tritici repentis*) and septoria leaf blotch (*Septoria tritici* and *Stagonospora nodorum complex*) prevailed in wheat stands and caused significant grain yield losses, therefore assessment of susceptibly of different varieties to these diseases on organic background is very important. During 2004, when the weather conditions were conducive to the development of leaf spot diseases, the varieties showed different susceptibility. The wheat variety 'Bill' was found to exhibit a higher resistance.
The efficacy of several biological control agents was studied in the winter wheat Ada during the autumn of 2004. *Fusarium spp.* infection level on seeds was partly reduced after the

application of oksihumat and lignohumat (Table 5). The following agents provided some control against root rot diseases during tillering.

Table 5. The effect of biological control agents on root rot diseases in winter wheat stands at tillering stage during the autumn of 2004

Treatment	Rate t^{-1}	*Fusarium spp.* infected seed (%)	Root rot diseases incidence %	Root rot diseases severity %
Untreated		13,5	71.7	23.9
Biochikol	1.5 l	11,0	51.7	25.6
Penergetic-p	200 g	9,0	55.0	22.2
Oksihumatas	0.05 %	6,5	51.1	15.6
Limnogumatas	100 ml (1.0 %)	6,0	55.0	18.3

Table 6. Effectiveness of mechanical weeding in the stand of winter wheat, 2004

Treatment	Number of weeds (plants m2) before harrowing	Number of weeds (plants m2) before harvesting	Effect of harrowing %	Grain yield t ha^{-1}
1 harrowing	32	18	43	5.62
2 harrowings	42	16	62	5.59
3 harrowings	36	12	67	5.71
Without harrowing	41	42	-5	5.53
LSD05				0.256

Results from both weed-count dates indicate that there was not much to gain by harrowing twice or three times, compared to harrowing only once or without harrowing (Table 6). The differences in the grain yield of wheat were insignificant in different treatments. The explanation for this is that wheat was grown after fallow, therefore weed incidence was low.

Conclusions

Lucerne-based swards showed the highest effect on subsequent winter wheat yield.
According to quality indicators the variety Alma better met the requirements of organic farming. More resistant to diseases was winter wheat 'Bill'.
Biological control agents oksihumat and lignohumat provided sufficient control of Fusarium spp. infection on seeds and partly suppressed root rot diseases during tillering.
The effectiveness of mechanical harrowing of winter wheat stand was not significant.
More comprehensive and longer investigations are necessary to draw clearer conclusions about the influence of many interacting factors in organic farming.

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Dynamics of N in white clover plants in production and environmental perspectives

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Abstract

To better understand N cycling in white clover (*Trifolium repens* L) stands under northern climate conditions, we studied how harvesting regime affected distribution of N among foliage, stolons and roots, growth and longevity of these plant organs, their ability to conserve N during the winter and the fate of N lost from the plant biomass. Field experiments were performed during four consecutive years with white clover plants (cv "Snowy"). Repeated leaf removal and subsequent re-growth came at the expense of stolon and root development and reduced the amount of total plant N produced by late autumn as compared to undisturbed plants. During the winter, root N was quite stable, apparently due to some root dormancy, while about 80 % of the leaf N present in the autumn was lost regardless of treatment. Short leaf lifespan (<100 days) suggested that leaves are not genetically programmed to survive the long Nordic winter. The losses of stolon N were intermediate, but harvesting decreased stolon longevity and increased N loss substantially. The amount of inorganic N in soil after snowmelt and mineralisation of white clover-derived N through spring were small, suggesting that leaching and gas emissions might be important N pathways. The N recovered in seepage water on the average corresponded to only 26% of lost leaf biomass N. Our investigation showed that moderate harvesting intensity, removal of herbage at the end of the growing season and use of winter-hardy cultivars appear to be effective measures to reduce the risk of off-season N loss from white clover biomass.

Keywords: nitrogen, white clover, lifespan, winter losses, leaves, stolons, roots

Introduction

White clover is an N rich plant with herbage N concentration typically ranging from 2.4 to 4.6 % of dry matter. It is relatively digestible by ruminants and decomposable in soil. It is quite well adapted to northern temperate climatic conditions, withstands grazing pressure fairly well and is a rather low-growing plant. Because of theses qualities, white clover is widely used in clover–grass leys and pastures and as green manure in organic farming, predominantly undersown in small grains.

A major challenge when using white clover, is to maximise N transfer to the subsequent growing season in order to minimise the risk of loosing a production resource much needed and the risk of environmental detriment due to off-season N losses (Janzen et al., 2003). This is important in organic farming, which relies on nutrient cycling and minimisation of external inputs for production and has environmental friendliness a high priority. Organic farming systems may show lower N losses than conventional farming systems, however, there is no conclusive evidence on this matter (De Neve et al., 2003). Occasionally, large losses may occur due to problems in synchronising mineralisation of organic N with plant demand.

In the present investigation on white clover, we studied (1) how harvesting regime affected plant N content in late autumn, plant biomass N conservation during the winter and plant N re-growth in the following spring, (2) growth and death of major plant parts throughout the year and (3) the fate of plant N lost during the winter. Moreover, we developed a method to distinguish between metabolically inactive and active plant roots.

Materials and methods

Experiments were performed during four consecutive years at Apelsvoll Research Centre in Southeast Norway (60°42'N, 10°51'E) where the climate is typical to inland Scandinavia. Summers are warm and somewhat dry (precipitation between 45 and 100 mm per month), and winters are relatively cold with snow-covered ground from mid November until the end of March. We also performed a two-year experiment at Holt Research Centre (69 °40'N, 18°56'E) on the northern Norwegian coast, where the climate is unstable.

In the study of plant N distribution and dynamics, white clover (cv. "Snowy") plants were established in the spring of 2001 and 2002 from stolon cuttings and planted in vertical PVC tubes that were dug into the field at Apelsvoll and Holt. During the growing season, the plants were totally stripped of leaves, harvested at 4 cm height or left undisturbed. The plants were sampled destructively in late autumn, the subsequent early spring and then after six weeks of spring re-growth. The material was sorted into leaves, stolons and roots for measurement of dry weight and N concentration. Soil inorganic N and N uptake in plant root simulator probes (PRS^{TM}; Canada) were also measured.

The growth and longevity of white clover (cv. "Snowy") plant parts were studied in 2002–2003 in a plot-root window experiment at Apelsvoll. The physical status of leaves, stolons and roots, both as unaffected and affected by harvesting, were monitored regularly by visual assessment of the colour of tagged leaves, stolon and root sections on a scale where, 1 = green (leaves, stolons) or white (roots), 2 = yellow (leaves) or browning has begun (stolons and roots), 3 = brown (leaves, stolons, roots) and 4 = dark brown or missing (assumed dead; leaves), dark brown and soft or light brown (stolons), or black or not visible (roots). For roots, we linked the visual assessment of colour and physical appearance to measurements of root metabolic activity. The roots were stained with 2, 3, 5-triphenyltetrazolium chloride (TTC) followed by root colour classification with an interactive scanner-based image analysis programme (WinRHIZO) (Sturite et al., 2005).

Recovery of N in seepage water was studied in a trial where in each of four years white clover (cv "Snowy" or "Milkanova") was sown in plywood boxes that were dug into the field at Apelsvoll. In 2000 and 2001 the plants were sown in a 2 cm slot between the box rim and a roof drain placed in each box. The drains were connected to 10 l plastic containers to collect water percolating through the above-ground plant biomass, which was carefully bent down into the roof drains in autumn. In 2002 and 2003 the plants were sown in vertical PVC tubes. In the autumn, half of the tubes were placed horizontally with the aboveground plant biomass threaded through holes in funnels made from plastic containers, while the tubes with soil and roots were left outside. These funnels were connected to the plastic containers for seepage water collection. In half of the boxes and tubes, plants were sampled destructively in late autumn and just after snowmelt in the spring for determination of dry matter and N concentration. Collected water was analysed for total-N, NH_4-N, NO_3-N.

Results

The harvesting negatively influenced total accumulation of N in white clover plants during the season of establishment, mainly by reducing N allocation to stolons and roots (Fig.1). During the winter, about 80 % of the leaf N present in autumn was lost independently of treatment. Loss of stolon N was on the average 40%. More stolon N was lost from defoliated (68%, Fig.

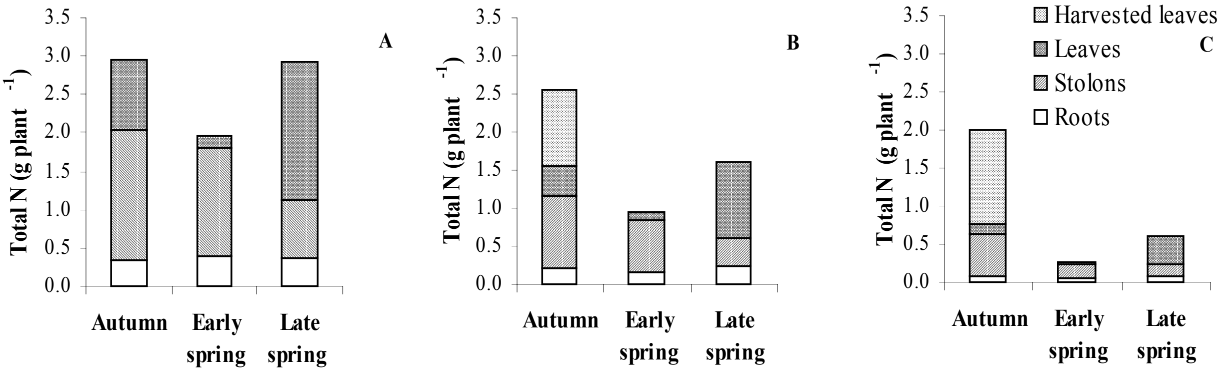

Figure 1. Total N content in white clover leaves, stolons and roots in autumn, early spring and late spring for non-defoliated plants (A), plants defoliated to 4 cm height (B) and plants stripped of the leaves down to the stolon basis (C). Means of two years and two sites.

1A) and harvested (27%, Fig. 1B) plants than from control plants (18%, Fig 1C). The root N was quite stable during the winter and the spring.

Total plant N re-growth in the spring was negatively influenced by harvesting in the previous year (Fig. 1), but relative plant N growth rate was similar for all treatments. The amount of inorganic N in soil after snowmelt and mineralisation of white clover-derived N during the spring was small, suggesting that leaching and gas emissions may have been important N pathways.

Our study of longevity showed that the leaves and petioles lived less than 100 days and were appreciably less winter hardy than stolons and roots (Fig 2). The lifespan of primary stolons ranged from 111 to over 677 days and was negatively affected by harvesting. The white clover roots lived between 27 and 621 days independently of treatment, but longevity depended on the time of root appearance. Measurements of root metabolic activity corresponded well with the visual assessment of root condition. In colour class one,
78% of the total root length was determined as active as compared to 63 % and 39 % in classes two and three.

In the experiment on N recovery, an average of only 26% of the foliage N losses was found in the seepage water. The content of N in the seepage water was very low until the late spring sampling (Fig. 3).

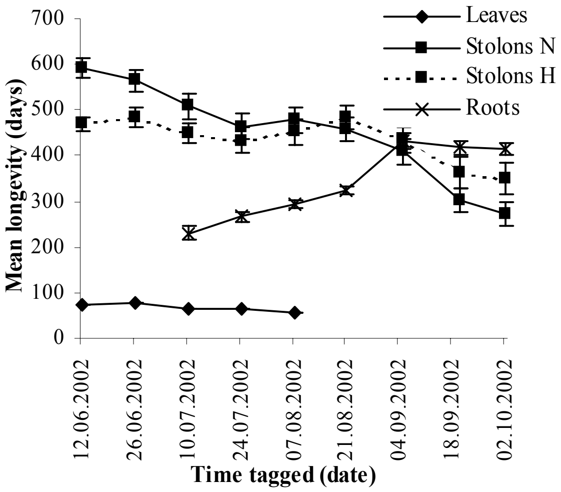

Figure 2. Mean longevity of white clover leaves, stolons and roots as dependent on time tagged in 2002. Letters N and H indicate non-harvested and harvested white clover plants, respectively, and bars indicate standard error.

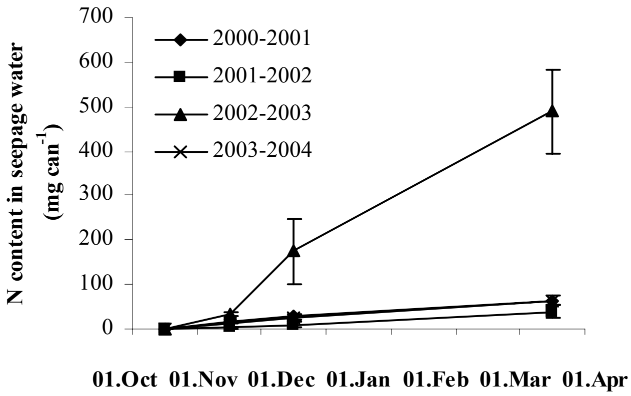

Figure 3. Content of total N in seepage water percolating through the aboveground plant biomass from the autumn till the spring. Bars indicate standard error.

Discussion

The leaves had a short lifespan, implying that the foliage is a source of readily plant-available N (Mueller and Thorup-Kristensen, 2001). However, our investigation showed that leaf N was largely lost from the plant biomass during the winter. It is likely that this readily degradable leaf N is at risk to further losses from the soil–plant system by nitrate leaching, surface run-off on frozen ground, emission of ammonia from residues located on the soil surface or by emission of nitrous oxide during nitrification and denitrification. Such losses are highly undesirable as organic plant production is frequently limited by N availability (Berry et al. 2002) and as they may lead to high N concentrations in drinking water, eutrophication of surface and marine waters (Carpenter et al., 1998), reduction in biological diversity of natural ecosystems receiving ammonia precipitation, and global warming and depletion of tropospheric ozone due to emission of nitrous oxide (Jensen and Hauggard-Nielsen, 2003). In our investigation, the small amount of inorganic N in soil after snowmelt and the small increase later on suggested that N from degraded herbage may have been lost. Moreover, the relatively low recovery rate of N in seepage water, suggested that gas emissions may have been an important N pathway.

Removal of herbage at the end of the growing season is an obvious measure to reduce the risk of off-season N losses where the herbage can be used as fodder, but is less feasible in stockless farming. The risk of loss may probably also be reduced by using winter-hardy cultivars that tend to reallocate resources before the onset of winter to stolons and roots, which in our investigation proved substantially more persistent than leaves. However, harvesting negatively affected both the stolon lifespan and the ability to conserve N during the winter.

Our investigation showed that off-season losses of white clover biomass N may occasionally be substantial, but the severity of such losses should not only be judged in isolation but also in a whole-system and a crop rotation perspective.

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Organic crop production and seed growing

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Abstract

In Latvia organic methods are used on 1200 organic farms with total area 48000 ha (in 2004). They cover 1.92 % of agricultural area. Cereals were grown on 5120 ha, oilseeds – 369 hectares and potatoes – 646 hectares. Field trials were carried out on organic farming fields at the Research Institute of Agriculture of the Latvia University of Agriculture (LUA). The influence of pre-crop, use of stable manure and time of harrowing on the yield of spring barley 'Sencis' were tested during 2003-2004. Depending on the variants the grain yield in the field trial varied from 1.56 to 3.85 t ha^{-1}. Data show that previous plants and stable manure influenced barley grain yields significantly. The highest yields in barley were obtained after red clover. Harrowing increased the yields of barley only after winter rye for green manure by using stable manure, but the time of harrowing had no influence on the yield of barley.

Keywords: spring barley, stable manure, harrowing, previous plants, crop production

Introduction

Agriculture as one of major industries of the national economy is closely connected with the development of the whole country, especially rural regions and food production. Therefore it should be viewed as an important factor of rural development and economic stability of the whole country (Report of Ministry of Agriculture, 2003).
Since he beginning of the 1990s, organic farming has rapidly developed in almost all European countries. In Europe almost 6,3 million hectares were managed organically by almost 170,000 farms (in 2003). In the European Union almost 5.7 million hectares were managed organically by more than 140 000 farms. This constituted 3.4 percent of the agriculture area and 3.2 percent of the farms in the EU (Willer&Yussefi, 2005).
Organic farming is a comparatively new direction of agriculture in Latvia. In Latvia organic methods are used on 1200 organic farms with total area 48000 ha (in 2004). They cover 1.92 % of agricultural area (Willer&Yussefi, 2005). Ministry of Agriculture plans to expand the area of agricultural land certified for organic farming from 1.92 % to more than 3 % in the year 2006. (Agenda of development of organic farming in Latvia, 2003).
In future is necessary to improve methods of providing of plant nutrients and limiting of weeds.
The aim of field trial was to investigate the influence of different agrotechnical measures: crop rotation, time of harrowing and using of stable manure on the spring barley grain yields and it quality in the organic farming.

Materials and methods

The three-factorial field trials were carried out on certified organic fields during 2003 and 2004. The factors: factor A – previous plants (red clover, winter rye for grain, bare fallow, bare fallow and green manure), factor B – time of harrowing (without harrowing, before shooting (EC 7, after Zadok), in the stage of clustering (EC 23), before shooting and in the stage of tillering (EC 7 and EC 23)), factor C – use of stable manure (without and stable

manure 60 t ha^{-1}). The depth of harrowing - 3 cm and direction of harrowing - across sowing direction.
The field trials were carried out on turf podsolic soil: pH_{KCl} – 6.75, P_2O_5 – 162 mg kg^{-1}, K_2O – 158 mg kg^{-1}, organic matter content – 32.5 g kg^{-1}, Ntotal – 1.1 g kg^{-1}. The content of nitrogen was determinated before sowing of barley in spring.
The object of research: spring barley 'Sencis'. The variety 'Sencis' is bred in Latvia (Stende BS) and is showed good results in field trials of variety testing for organic farming. Seed rate was 500 germinating seeds per m^2. Before sowing, grains were treated with 1.5 kg of ashes of foliage trees and 1.5 l of water per 100 kg of grain. Sowing date was 19.05.2003. and 30.04.2004. The number of replications was four, random plot layout, plot size - 42 m^{-2} and testing plot size – 26.18 m^{-2}. The harvest was done on 11.08.2004. and 10.08.2004.
After previous plant bare fallow + green manure, 15 t ha^{-1} (2004) and 17 t ha^{-1} (2003) of biomass of winter rye were incorporated in soil. The chemical content of winter rye biomass: dry matter 169.3 (2003) and 178.3 (2004) g kg^{-1}, P_2O_5 60 and 65 mg kg^{-1}, K_2O 254 and 302 mg kg^{-1}, total content of nitrogen 277 and 287 mg kg^{-1}. Winter rye was sown in autumn (10.09.2002. and 15.09.2003.) but incorporated in spring at the stage of tillering. In the trial, variants with stable manure were included (60 t ha^{-1}). The chemical content of stable manure: dry matter 169.7 (2003) and 387.7 (2004) g kg^{-1}, P2O5 64 and 88 mg kg^{-1}, K2O 97and 183 mg kg^{-1}, total content of nitrogen 238 and 377 mg kg^{-1}. The stable manure was incorporated in spring before sowing of barley.

Results and discussion

The rapid growth of organic farming in Latvia (fig. 1) has been fostered by the institutional developments and the adoption of the amendments to the Law on Agriculture in 2001, where the concept "organic farming" was defined and direct payments to organic farms were envisaged in the form of the state subsidies (Baraskina, 2003).

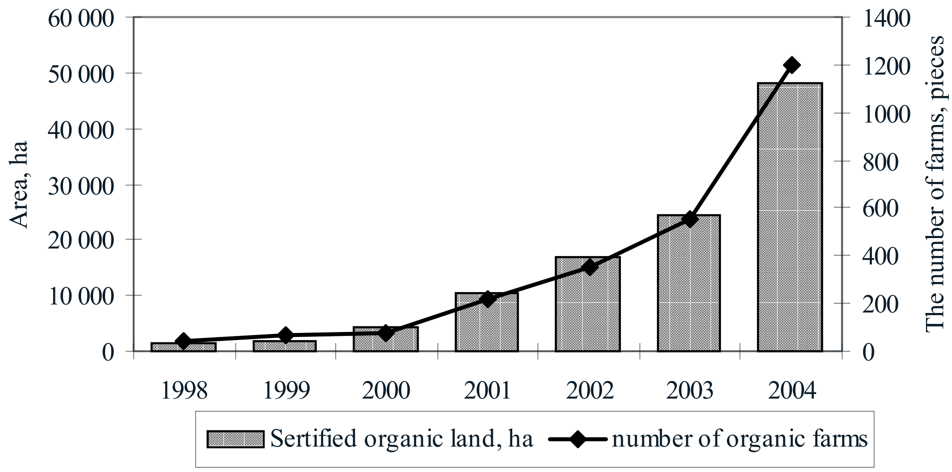

Figure 1. Development of land under organic management and of organic farms in the Latvia 1985 to 2004

Cereals were grown on 5120.52 ha or 85 % from all sowing from cereals, oilseed and potatoes (Table 1). Winter rye was most popular from winter cereals and was grown on 948.23 hectares or 15.5 % of area. Winter wheat was grown on 384.71 hectares. Winter barley was not widely grown - only 4.7 hectares. Oats had the greatest area (1795.73 hectares or 29.3 % from area) on organic farms with spring barley second (1155.90 ha and 18.8 %) and spring

wheat third (283.46 ha and 4.6 %). Buckwheat was popular both farms of transitation period and certificated organic farms.
Oilseeds were grown on 369.71 hectares or 6 % from all sowings. The most popular was spring oilseed rape – 202.63 hectares or 3.3 % of area. Spring turnip rape was grown on 89.39 hectares. 1 % of sowings were taken by oil radish.
Potatoes were grown on 646.70 hectares or 11 % from all sowings.

Table 1. Sowings of cereals, oilseeds and potatoes in Latvia, 2004.

	Sowings, ha				%
	1st transita-tion year	2nd transita-tion year	Certifi-cated organic farms	total	
Cereals total	765.42	1373.16	2981.94	5120.52	85
Spring wheat	70.86	149.05	63.55	283.46	4.6
Barley	125.85	428.43	601.62	1155.90	18.8
Oats	359.03	372.72	1063.98	1795.73	29.3
Spring triticale	32.83	60.6	87.19	180.62	2.9
Winter rye	79.87	191.68	676.68	948.23	15.5
Winter wheat	25.07	92.07	267.57	384.71	6.3
Winter barley	-	-	4.70	4.70	0.1
Buckwheat	71.91	78.61	216.65	367.17	6.0
Oilseeds total	45.93	95.72	228.06	369.71	6
Spring oilseed rape	40.81	52.97	108.85	202.63	3.3
Spring turnip rape	3.12	7.9	78.37	89.39	1.5
Winter oilseed rape	-	-	17.19	17.19	0.3
Oil radish	2.00	34.85	23.65	60.50	1.0
Potatoes total	50.91	113.5	482.29	646.70	11
Total: cereals, oilseeds, potatoes	-	-	-	6136.93	

The influence of pre-crop, use of stable manure and time of harrowing on the yield of spring barley 'Sencis' were tested during 2003-2004. Depending on the variants, the yields in the field trial varied from 1.56 to 3.85 t ha^{-1} (Fig 2).
Two-year trial results (Fig. 2) show that the highest grain yields were obtained after red clover (2.91 t ha^{-1} without using of stable manure and 3,33 t ha^{-1} in variants with stable manure) and bare fallow (2,97 and 3,46 t ha^{-1}).
The influence of previous plants on the spring barley yield was significant (p-value < 0.0001) and differed during years (p-value < 0.0001, η^2 = 46 % in 2003 and 82 % in 2004). In 2003 the highest yields were obtained after bare fallow + winter rye for green manure (on average 3.30 t ha^{-1}). In 2004 grain yields after this pre-plant was significantly lower – only 2,69 t ha^{-1}. The low grain yield after red clover (only 2.54 t ha^{-1}) can explain by sparsity and weedness in sowings. There were established perennial weeds *Elytrigia repens* (L.) *Nevski* and *Sonchus arvense* L.

The grain yields after bare fallow were high and similar in both testing year – 2.92 (2003) and 3.02 t ha^{-1} (2004) without using of stable manure and 3.39 – 3.53 t ha ($^{-1}$) after using of stable manure.

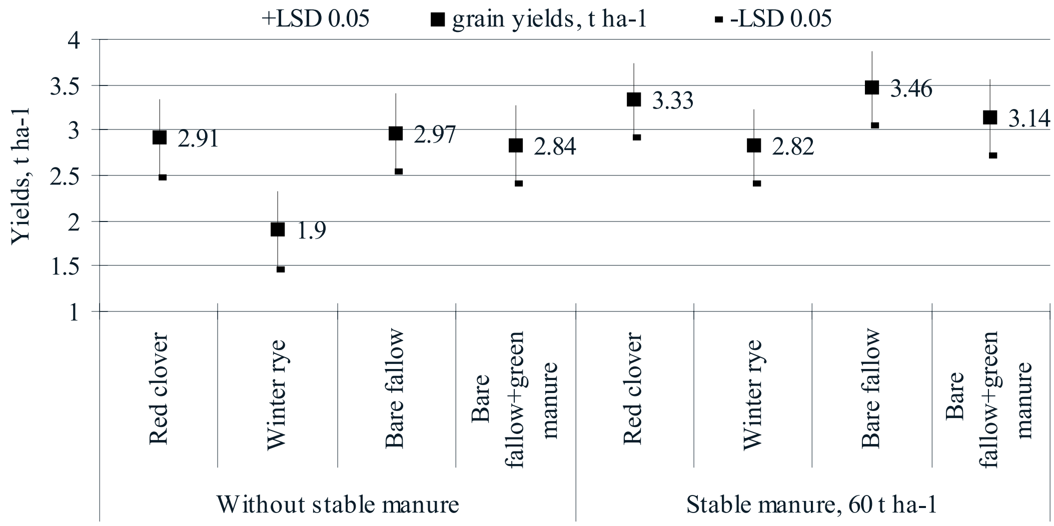

Figure 2. The grain yields of spring barley 'Sencis', during 2003-2004

The winter rye is typical soil impoverisher. Especially low grains yield after winter rye was obtained in 2004 – only 1.56 t ha^{-1}.
The influence of stable manure on spring barley yield was significant (p-value < 0.0001). Grain yields have increased by 0.47–0.99 t ha^{-1} (2003) and 0.33-0.87 t ha^{-1} (2004) on average. Use of stable manure for barley after winter rye provided the highest yield increase by 0.92 t ha^{-1} on average during 2003-2004. The influence of stable manure (η^2 %) on the formation of grain yield was 40 % (2003) and 12 % (2004).
In 2003 harrowing increased the grain yields significantly only after winter rye for green manure with stable manure, whereas time of harrowing had no significant influence on the grain yield. In 2004 the influence of harrowing was not significant.

Conclusions

In Latvia organic methods are used on 1200 organic farms with total area 48000 ha (in 2004). They cover 1.92 % of agricultural area.
Cereals were grown on 5120.52 ha, oilseeds - 369.71 hectares and potatoes - 646.70 hectares.
The grain yield in the field trial varied from 1.56 to 3.85 t ha^{-1}. Data show that previous plants and stable manure influenced barley grain yields significantly. The highest yields in barley were obtained after red clover.
Harrowing increased the yields of barley only after winter rye for green manure by using stable manure, but the time of harrowing had no influence on the yield of barley.

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Animal health and welfare in dairy farming – an advisory tool for securing animal welfare on farm level

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Abstract

An important objective of organic farming is to ensure the welfare of farm animals. Regulations cannot guarantee animal health and welfare. It is the management practice by the farmer that is decisive for good animal welfare. An advisory tool for securing animal welfare in organic dairy production has been developed. The advisory tool includes a farm visit by advisers with special qualifications within animal welfare and organic farming. During the farm visit an assessment of welfare is conducted using welfare check lists looking at parameters within: 1) the general impression of the herd, 2) animal behaviour, 3) interaction between animals and humans, and 4) farm management and operation systems. Further, the advisory tool consists of a written report with suggestions on welfare improvements, counselling meetings, a follow up visits and a welfare certificate.

Keywords: Animal, welfare, organic, dairy, assessment

Introduction

Both national and international regulations for organic livestock husbandry aim to ensure a high level of animal health and welfare. Nonetheless, organic livestock husbandry has been criticised for cases of poor animal welfare. Organic livestock husbandry places some different demands on the farmer from those seen in conventional livestock farming. These differences are most pronounced with regard to housing, access to open-air runs, feedstuffs, disease treatment and breeding stock. Also, there are different risk factors in organic than in conventional livestock farming. The production system places stringent requirements on farm operations, surveillance and risk management. Thus, the dissemination of know-how aimed at the challenges inherent in organic farming methods are important in order to secure a high level of animal health and welfare. There is a need for a tool to measure and improve animal welfare on organic farms. There is also an international discussion if animal welfare assessments should be compulsory on organic farms.

An advisory tool for animal welfare

The farm advisory tool is designed for organic dairy farmers. It includes a farm visit by to advisers with veterinary and husbandry qualifications specialized on animal welfare and organic farming. The visit is conducted in order to evaluate herd health and welfare, as well as advice on disease prevention and the improvement of animal welfare. During the farm visit, the advisers and the farmer jointly assess welfare where they consider the status of herd health and animal welfare with the help of welfare check lists and health reports of the herd records. A plan for improving animal welfare is put up. A follow up visit looks at implementation of new initiatives. A revision or removal of existing welfare measures are also evaluated on the basis of the developed plan. In addition, counselling meetings are held with groups of farmers, production advisers, veterinarians and other advisers as a forum for discussion. Relevant topics of current interest are presented at these group meetings. The farmer also receives a welfare certificate with scores for cow comfort and human – animal interaction.

Assessment of animal welfare

Our system of assessment of animal welfare is based on a welfare assessment system which has been tested in Denmark. The parameters they considered were housing construction and design, the interaction between animals and humans, cow behaviour during milking and clinical studies of the animals. The welfare assessment routine tested on Danish dairy farms was time consuming. This advisory tool limit the visit to one round of milking, thus limiting the scope of tests and measurements that can be used. The system in Denmark was developed and tested in loose housing systems. Many of the Norwegian stables for dairy cows have tethering systems. The typical Norwegian dairy herds are also smaller than the dairy herds in Denmark. Due to this, some changes of the tests and registrations had to be done. Currently, four different parameters are being recorded: 1) general impression of the herd, 2) animal behaviour, 3) interaction between animals and humans and 4) farm management and operating systems.

1) General impression of the herd
Animal health (or lack thereof) is considered to be an important welfare indicator. Often disease is linked with pain, discomfort and stress for the animals. Especially, acute painful diseases and long-term chronic ailments have an effect on animal welfare. We use data from The Norwegian Cattle Health Recording System in addition to a visual assessment during the farm visits. Such aspects as fatness, cleanliness, excrements, respiratory problems and various types of injuries are recorded.

2) Animal behaviour
Normal and abnormal behaviour are recorded during the farm visits:
Milking is a daily, routine operation. Thus, it is important that milking routines are not a source of stress for the cows. Discomfort during milking can be seen in such behaviour as leg stamping, kicking, tail switching and attempts to remove the milking machine. Reasons for such behaviour include social stress associated with loose housing or while waiting outdoors to be milked, discomfort during milking or fear of the stockman.

Rising is a frequent behaviour in dairy cows. If the cows are obstructed from rising, or have any difficulties in carrying out this activity, this may indicate that rising causes discomfort or may lead to injuries.

Excessive oral contact with other calves, themselves or housing installations indicate that calves have not become accustomed to their situation. This could be due to factors as isolation in individual pens, pail feeding or early weaning. Well-being is indicated by playfulness, i.e., jumping, kicking and nudging other calves.

Stereotypic behaviour may indicate environmental stress and that the animal is, or has been frustrated and not in command of the situation. One example is tongue-rolling in cattle, which may be linked to tethering heifers in cubicles and feeding too little fibre. Social factors, such as being tethered next to a superior animal, can also lead to frustration and stereotypic behaviour.

3) Interaction between animals and humans
The relationship between herd members and the human(s) feeding, milking and caring for them is of major importance for the animals' behaviour, welfare and performance. This relationship can be affected by such factors as genetic disposition, housing design as well as

the frequency and quality of animal-human interaction. If the relationship is characterised by stress, animals will feel discomfort or fear each time they interact with humans. Various types of tests have been developed to assess human-animal relationships. We are using tests which record the reaction of an animal to a person slowly approaching it in order to attempt to pat the animal.

4) Farm management and operating systems
Information about operating systems and farm management is important in order to find the causes of different types of behaviour and diseases. During the visits, the farmer is asked about the farm operations and the routines of the dairy work. Available data from The Norwegian Dairy Herd Recording System and The Norwegian Cattle Health Recording System on farm level is used. Also, data on livestock housing, technical installations and cleaning routines are recorded. Animal welfare is not only affected by the farming system itself, but also by how the system is used. Therefore, farm management can have at least the same effect on animal welfare as the actual farming system and housing design.

Conclusion

Organic agriculture wishes to emphasise animal welfare, and aims to be at the forefront with regard to promoting the welfare of farm animals. It is therefore important to increase the expertise in the field of animal welfare in organic farming systems among veterinarians, advisers and farmers. The advisory tool presented here can improve animal welfare on the farm, improve knowledge on welfare by the farmer and influence the attitude of the farmer. An advisory tool including on-farm assessment of animal welfare will contribute to securing a high level of animal welfare in organic production. It is also conceivable that this concept can be adapted to other organic and conventional livestock production systems.

Reproductive performance in organic dairy husbandry

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Abstract

The animal welfare aspect is one of the most important trademarks for organic products. The current paper focuses on reproductive performance in dairy cows as a measure of animal welfare. An epidemiological study of organic and conventional dairy farms revealed that energy requirements had not been adequately met to ensure optimal reproductive success in Norwegian organic dairy farming. Characteristics such as herd size, geographical distribution, breeding season, milk yield, parity, breed, and use of artificial insemination (AI) were taken into account in these analyses. Organic grain production is limited in Norway and breeding efficiency proved difficult to maintain among organic cows bred during winter, as these cows could not benefit from pasture during peak lactation. Organic husbandry proved more efficient than did conventional husbandry in converting roughage into milk, and cows in organic husbandry lived longer.

Keywords: Animal, welfare, organic, dairy, reproduction

Introduction

The public tend to associate the term “organic dairy husbandry” with superior management and high standards of animal welfare. This notion is, at least partly, true as low milk production levels might act to reduce production-related diseases such as hypocalcemia and mastitis (Strøm & Olesen 1997) and a low fraction of concentrate in the feed ration can prevent rumen acidosis and abomasal displacement (Goff & Horst 1997), and last but not least, cows in organic husbandry live longer (Reksen et al. 1999).
The animal welfare aspect is one of the most important trademarks for organic products. There are however some areas, which will require attention in order to maintain such high standards. As organic grain production is limited in Norway, a relevant question to ask is whether energy requirements are adequately met during peak lactation in organic cows. An additional constraint on the relationship between energy requirements and energy coverage is expected to take place when feeding of conventional grown concentrate will be prohibited in organic dairy farming from August 28 this year. My own research has focused on the effect of feeding on reproductive performance, and it has been demonstrated that there is room for improvement in organic dairy farming (Reksen et al. 1999).

Material and methods

This is a comparative cohort study of reproductive performance in organic and conventional dairy husbandry conducted using longitudinal data from the Norwegian Dairy Herd Recording during the period from January 1, 1994 to December 31, 1996 (Reksen et al. 1999). The organically managed cohort consisted of 998 lactation periods, and the conventionally managed cohort consisted of 3016 lactation periods. Both groups were similar in herd size and geographical distribution. The data was analysed both in univariate and multivariable analyses. In the latter, characteristics such as breeding season, milk yield, parity, breed, and use of artificial insemination (AI) were taken into account using a repeated measures mixed model (PROC MIXED) of SAS (Littell et al. 1996). Significance (P<0.05) was assessed by the type III F-test. T-tests were used in the univariate analyses (Altman, 1996).

Results and discussion

Breeding and culling Practices

Univariate analyses revealed that natural breeding, during the period from 1994 to 1996, was used in 19 to 27% of the pregnancies in organic dairy husbandry and in 3 to 5% in conventional husbandry. Annual replacement was 23% in organic and 35% in conventional husbandry. Norwegian Red Cattle comprised 85% of organically managed and 97% of conventionally managed dairy cows. Winter was the main breeding period for conventional husbandry, and summer was the major breeding period for organic husbandry. The results from 1996 are reported in Table 1.

Milk yield and use of concentrate

The daily use of concentrate in the 305-d period after calving was estimated and the energy uptake given in feed units (FEM). One FEM was 6900 KJ net energy. 305-d milk yield was reported in Kg energy-adjusted milk (EKM) (Ekern 1991). Mean 305-day milk yield was significantly lower for organic husbandry than for conventional husbandry (Table 1). Conventionally managed farms used nearly twice as much FEM from concentrate per cow as did organic farms (Table 1). Energy consumption calculated as FEM (from concentrate) per 100 kg milk produced, was 33 % greater in conventional husbandry compared with organic husbandry (Table 1). Thus, organic husbandry proved more efficient than did conventional husbandry in converting roughage into milk.

TABLE 1. Mean calving interval, mean days open, mean interval from calving to first AI, mean energy adjusted 305-d milk yield, mean feed units (FEM) per day from concentrate, mean feed units (FEM) from concentrate/100 kg milk, mean % of cows bred during summer, and mean % of cows bred by natural service, distributed by class of husbandry systems during 1996.

	Organic	Conventional
Calving interval (days)	369.0*	374.1*
Days open (days)	112.8*	130.5*
Calving to first AI interval (days)	78.7	80.9
305 day milk yield (kg)	4554*	6040*
FEM/day from concentrate	2.4*	5.3*
FEM from concentrate per 100 kg milk	18.1*	27.1*
Breeding in summer, %	52*	36*
Natural breeding, %	19	4

* Significant difference ($P < 0.05$) between organic and conventional husbandry assessed by the t-test (Altman, 1996).

Reproductive performance

In the univariate analyses, calving interval was shorter during 1996 in organic husbandry as compared to conventional husbandry (Table 1). The same relationship was found for days open during all three years of the study (Table 1). The interval from calving to first AI was not different between management category for either of the years of study. However, parity and the interaction between season and management (organic / conventional) were significantly related to calving interval, days open and calving to first AI in the multivariable analyses (Table 2). The effect of the significant interaction term between season and management on the reproductive traits revealed that conventionally managed cows bred during winter showed the better breeding performance, and impaired performance was observed in organically managed cows bred during winter (Table 2). In these analyses level of milk yield, breeding season, service (AI / natural mating), and parity were taken into account.

TABLE 2: Least square means of calving interval, days open and calving to first AI interval as predicted by the repeated measurement models (Littell et al. 1996). Significance ($P<0.05$) was assessed by the type III F-test.

	Days open		Calving interval		Calving to AI interval	
	days	P	days	P	days	P
Breeding season						
Winter	118.8	.59	379.0	.38	81.8	.67
Summer	117.1		377.7		81.3	
Management						
Conventional	116.7	.47	374.1	<.01	79.3	<.01
Organic	119.2		382.7		83.8	
Parity						
Primiparous	121.3	.02	383.3	<.01	84.4	<.01
Multiparous	114.6		373.4		78.7	
Service						
Artificial	132.1	<.01	379.3	.41		
Natural	103.8		377.4			
Season X management						
Winter and conventional husbandry	112.8		371.4		78.3	
Winter and organic husbandry	124.8	<.01	386.6	<.01	85.3	.03
Summer and conventional husbandry	120.5		376.7		80.3	
Summer and organic husbandry	113.7		378.7		82.4	

The energy requirements might not have been fully met during winter, as the cows could not benefit from fresh pasture during peak lactation. Strøm and Olesen (1997) found that the energy requirements during winter were not adequately met in individual organic herds in a Norwegian survey. Hence, breeding in summer might be essential to balance genetic capacity for milk yield and energy needs in organic dairy husbandry in Norway. As breeding in winter would be necessary for year-round delivery of organic dairy products, and some organically managed cows inevitably will attain high milk yields, an improvement of the feeding regimens should be sought.

Conclusion

The current paper focuses on reproductive performance as a measure of animal welfare. Although there is a tendency among the public to associate the term “organic dairy husbandry” with superior management and high standards of animal welfare, there is room for improvement within this production system as the current study indicates that energy requirements had not been adequately met to ensure optimal reproductive success on Norwegian organic dairy farms. This situation will be even more challenged when conventional grown concentrate will be prohibited in organic dairy farming from August 28 this year.

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The use of alternative veterinary medicine in organic dairy farming

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Abstract

Decreased use of chemical substances, e.g. antibacterial drugs, is a basic tenet of organic farming. In relation to disease treatment this is reflected in the regulations on organic livestock production, in which the use of ‘natural medicines and methods’ is emphasised. Homeopathy is one of the methods explicitly mentioned in the EU-regulation 1804/99 on organic livestock production. Several studies have indicated that the use of homeopathy is considerable within organic farming, whereas other alternative therapies seem to be quite rare.

Efficacy of alternative therapies is generally poorly documented and, particularly in the case of homeopathy, implausible seen from the point of view of the natural sciences. The use of homeopathy has therefore led to concerns that this use may exert an adverse influence on animal health and welfare. In this paper, a study addressing Norwegian dairy farmers´ motivation for utilisation of homeopathy is used as a background for discussing the relation between the organic regulations and the use of homeopathy, and furthermore the implications such use may have for animal health and welfare.

Keywords: Alternative medicine, homeopathy, dairy farming, animal health and welfare

Introduction

Alternative veterinary medicine can be defined as the utilisation of alternative therapies in the treatment of diseased animals. Alternative therapies include modalities such as homeopathy, acupuncture and phytotherapy. Homeopathy is believed to be the alternative therapy most commonly applied in dairy herds. Alternative therapies are commonly regarded as holistic. The term holistic refers to the view that the combination of physical, psychological and social levels is important in relation to health protection and restoration, and also emphasises the body’s capacity for self-repair and the influence of the external environment. The holistic approach is, along with the understanding of homeopathy as a mild, ‘natural’ therapy without negative side effects, the background why organic farming and homeopathy are said to have similar views on health and disease (Vaarst et al, 2004).

The use of homeopathy in organic dairy herds differs between countries, but may reach considerable proportions (Busato et al 2000, Weller & Bowling 2000). The use of homeopathy outside organic farming is poorly documented, but there are some indications that homeopathy is more commonly used in organic herds than in conventional herds. A survey among Norwegian organic dairy, beef and sheep farmers concluded that at least 15% of these used homeopathy as a part of the disease handling in the herd (Henriksen, 2002). In contrast, in a survey from 2000, 5.5% of the dairy farmers questioned (organic as well as conventional) stated to have used alternative therapies (Østerås, 2002). Hovi and Roderick (2000) also found homeopathy to be used more frequently on organic farms compared to conventional farms in the UK.

Homeopathy is emphasised in the EU-regulation 1804/99 on organic livestock production (CEC 1999). According to this regulation, section 5.4.a., the use of veterinary medicinal products in organic farming shall comply with the following principles: *Phytotherapeutic (e.g. plant extracts (excluding antibiotics), essences, etc.), homeopathic products (e.g. plant, animal or mineral substances) [....] shall be used in preference to chemically-synthesised allopathic veterinary medicinal products or antibiotics, provided that their therapeutic effect is effective for the species of animal, and the condition for which the treatment is intended.*

The regulation restricts the use of homeopathy or other alternative therapies to situations in which the treatment is effective for the current animal species and condition. The efficacy of homeopathic treatments is not accepted as scientifically documented (Hektoen, 2004a). However, "effective" may be a question of the readers', e.g. the farmers', interpretation, and the organic regulations are purported to encourage and increase the utilisation of homeopathy (de Verdier et al., 2003, Hovi, 2002, Hammarberg, 2001). This has created concerns that such treatments are used to the exclusion of conventional treatments, and that this may influence animal welfare adversely (Ekesbo, 2000, Hammarberg 2001).

In this paper, a study addressing Norwegian dairy farmers´ motivation for utilisation of homeopathy is used as a background for discussing the relation between principles and regulations of organic husbandry and the use of homeopathy, and to address the implications such use may have for animal health and welfare.

Material and methods

Qualitative research interviews were used to address the question of *why and how dairy farmers use homeopathy*. Eighteen Norwegian dairy farmers utilising homeopathy as a major part of their herd health management were interviewed (Hektoen, 2004b). For 17 of the herds, health and production data from the Norwegian Dairy Herd Recording system were compared to that of 77 control herds matched on herd size and municipality, with emphasis on udder health and milk production. In the last herd, the use of homeopathy had been discontinued. This herd was therefore not included in the comparative part of the study.

Results

In the 18 study herds, homeopathy was the first choice of treatment, and was considered as an alternative to conventional veterinary treatment in all disease cases (Hektoen 2004b). The farmers generally carried out the homeopathic treatments themselves, without the involvement of veterinarians. However, they did not exclude the use of conventional veterinary treatment. Homeopathy was used as an alternative to conventional veterinary treatment for the individual disease case, while the two comprised complementary treatment approaches at herd level.

Farmers´ use of homeopathic treatment for personal health problems and the experience of their colleagues with use in dairy production were important factors motivating the initial use of homeopathy. Other factors included a desire to decrease the use of antibacterial drugs, reduce costs and find alternatives when conventional veterinary medicine had no good solutions to offer (typically high somatic cell counts). Experience of clinical efficacy, the farmers´ personal satisfaction by being the one curing the animal and the feeling of personal control in the disease situation were important factors for continuing the use of homeopathy.

Mastitis was the most common indication for homeopathic treatment, and in two of the herds it was used for mastitis only. For the individual diseased animal, the severity of disease, the farmers' previous experiences from similar cases, personal knowledge and available time were important factors influencing the choice between homeopathic and conventional veterinary treatment (Hektoen, 2004b).

The relationship between homeopathy and organic farming was addressed in the interviews with the six organic farmers. One of them related the use of homeopathy directly to the conversion to organic production. The other farmers had been using homeopathy prior to the conversion and stated that they used homeopathy independently of this. However, they saw links between organic farming and homeopathy; the desire to decrease the use of chemical substances was viewed as a common underlying factor for both.

No significant differences in milk yield, bulk milk somatic cell count or culling rates between the herds utilising homeopathy and the control herds were found. The prevalence of mastitis pathogens and dry quarters in the herds using homeopathic treatments was comparable to that previously found in Norwegian dairy herds. The incidence rates of conventional veterinary disease treatments were significantly lower in the study herds, both for the sum of all diagnoses ($p<<0.01$) and for clinical mastitis ($p<<0.01$). There were no significant differences between organic and conventional herds.

Discussion

The interview study revealed the importance of the farmers' personal motivation and experiences in the choice of treatment. The utilisation of homeopathy has effects beyond the potential effects of the remedies. These include the farmers' satisfaction and sense of control through personal involvement in disease handling, the ability to do "something" when there are no good conventional alternatives, and an opportunity to decrease the use of antibacterial drugs. For the farmers included in this study, the organic regulations as such were not an important motivational factor for the use of homeopathy. Rather, the desire to reduce the use of chemical substances seems to be a common underlying factor for going organic as well as using homeopathic treatments. This indicates that personal values and beliefs are more important for the decision to use homeopathy than regulations.

The specific effect of homeopathic remedies is not scientifically plausible or documented, and the role of homeopathy in treatment of mastitis is most likely that its utilisation allows natural resolution of mastitis signs to take place, without this exerting significant influence on the outcome as compared to the outcome after antibacterial treatment. The results regarding health and production indicate a potential for substantial decreases in the use of antibacterial drugs in mastitis handling in general. Considerable differences are exhibited in health and production between the herds, both among those in which homeopathic treatments are used and among those in which they are not, indicating that in relation to udder health, factors other than choice of therapy are more important to address (Hektoen 2004a).

Conclusions

The farmers´ personal experiences and beliefs are important in the choice of treatment. Independent of efficacy, the homeopathic remedies help the farmers fulfil their aim to reduce the use of antibacterial drugs. The results indicate that the implementation of homeopathy in the herd health management, and the ensuing decreased use of antibacterial drugs, do not have negative impact on health and production of any practical significance. As far as these results can be used as welfare parameters, it is indicated that the utilisation of homeopathy does not influence animal welfare adversely. However, preventive measures should be the main focus in future research on udder health in organic dairy production.

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Sulphur supply: a challenge for organic farming?

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Abstract

There is generally low atmospheric sulphur (S) deposition in northern Scandinavia. Because of this, the herbage S content on 28 organic farms was monitored in order to discover eventually shortage in the S-supply for plants or ruminants in organic livestock production. The S content and the protein content were generally low. In spite of this, the yields were surprisingly good in many locations, and S fertilisation improved yields, biological nitrogen fixation and the protein content of red clover only when the S supply was very low. In a pot trial, increasing S application did not increase the S content of red clover above a certain level. That level depended on the growing conditions. Instead of an increase in the shoots with increasing S supply, there was an accumulation of S in the roots.

Keywords: biological nitrogen fixation, roughage, protein, feed quality, Norway

Introduction

The objective of this paper is to introduce the challenges connected to S supply in organic farming systems, with emphasis on S supply for herbage in organic livestock production. Release of S from soil organic matter and deposition of atmospheric S are the main sources of S. Because of many areas with short, cool and/or rainy summers and low atmospheric S deposits, the supply of S for plants is likely to be low in most parts of northern Scandinavia.
In many areas S deposits are below 5 kg $ha^{-1}yr^{-1}$, and the non-sea salt (nss) deposits have decreased in recent years.
In high rainfall areas, there is a high risk of leaching losses of S, especially on sandy soils. In areas with low temperatures and drought, S mineralization is restricted and therefore also the plant availability of the organic S.
It is difficult to circulate S within the production system of an animal farm effectively, as only a small part of the S in solid livestock manure seems to be available to plants in the short term.
S deficiency is likely to reduce both the quantity and quality of the yield, the plants' resistance to pests and diseases, and potential biological N fixation.
In a survey on 28 organic farms in Norway, we observed that S and protein content of the grassland herbage were generally low (Strøm et al, 2005). We wanted to test whether S fertilisation increased S content, yield, biological nitrogen fixation and the protein content of the herbage.

Materials and methods

The studies consisted of a farm survey in 2001 and 2002, field trials with S application levels in established grass-clover leys (3 in 2002 and 7 in 2004), and pot experiments with S applications to red clover (*Trifolium pratense*). In all investigations, the herbage dry matter (DM) yield and the herbage total content of S and N were determined.

In the survey, herbage was sampled from the first and second cuts from three grass-clover fields on each of 28 organic farms in central, eastern and western Norway.
In the field trials in 2002, S was applied in spring as $MgSO^4$ at rates of 0, 30 and 60 kg S ha^{-1}, and in 2004 S was applied in spring as $CaSO^4$, $Na2SO^4$ and $K2SO^4$ at rates of 0, 20 and 40 kg S ha^{-1}. In both years herbage samples were taken in mid June and mid August at the first and second cuts.

The growth media in the pot experiments were a sandy soil poor in S, and expanded vermiculite with almost no S. Sulphur was supplied as $Na2SO^4$ at a rate of 0, 20 and 50 mg S pot^{-1} in the soil and 10, 20, 30, 40, 50 and 60 mg S pot^{-1} in vermiculite. In Soil-u (unamended soil) (Figure 1) no additive was given except S and 250 mg $CaCO^3$ pot^{-1}. In Soil+ 50 mg N, 86 mg P, 440 mg K, 30 mg Mg pot^{-1} and micro-nutrients were added. The plants were harvested twice. Plants were cut at the soil surface in the first cut, whereas at the second cut the whole plants were harvested. The growth medium was washed off the roots, and the roots and shoots were separated.

Biological N fixation in the field experiment was estimated with a modification of the model of Høgh-Jensen et al (1998), in the soil-pot experiment with the difference method (Nfixed= N in clover – N in timothy), and in the vermiculite-pot experiment as the total harvested N minus added N.

Results and discussion

The herbage S content in the survey was generally quite low, particularly in the first harvest samples (Table 1). In spite of the low S supply, good yields were obtained in some locations. In the district with the lowest S supply (Trøndelag), 10% of the yields were above 8 tonnes ha^{-1} (Govasmark et al, 2004).
The S content in herbage is also important for ruminants, however. The standards for minimum S content in feeds for lactating dairy cows vary from 1.0 to 1.5 g kg^{-1} DM according to British standards (ARC, 1980) to a requirement of 2.0 g kg^{-1} DM for according to NRC standards (NRC, 2001).

Table 1. Content of total S (g kg DM^{-1}) in herbage from 28 organic farms in four districts of Norway, given as median and 25 and 75% percentiles for the years 2001 and 2002.

	25% percentile	Median	75% percentile
First cut	1.2	1.3	1.5
Second cut	1.5	1.8	2.1

The herbage crude protein (CP) content also was low. The median content of CP at the first cut was 106 g kg^{-1} DM, and in 25% of the samples the content was below 92 g. The value for the protein balance of the rumen (PBV) was negative in 90 and 44% of the first and the second cut samples, respectively, indicating an impaired protein supply when fed as the only fodder to animals in production.
In the first cut, S application rate had no significant effect on either DM or N yields, and thus on the estimated biological N fixation. In the second cut, there were higher dry matter yields with S application in two field trials, but not the third. On all sites there was a tendency toward higher N content in the clover and higher clover N yields on plots with S application. Increasing S application from 30 to 60 kg ha^{-1} did not significantly affect either herbage S content or yield or biological nitrogen fixation in either the first or second cut. Our findings

are in accordance with the results of (Arstein 2004), who also observed low effects of S fertilisation on yields and N-content.

Table 2. Total yield (kg DM ha^{-1}), N yield in clover (kg ha^{-1}) and content of S (g kg^{-1}) in red clover (Trifolium pratense) with increasing S supply in grass-clover at two harvests on three farms in summer 2002.

	First cut			Second cut		
S applied in MgSO4 (kg ha^{-1})	0	30	60	0	30	60
Yield (kg DM ha^{-1})	4580	4420	4520	2740	3000	3120
N-yield in clover (kg N ha^{-1})	41	45	44	37	48	45
S content in clover (g kg^{-1}DM)	0.8	1.3	1.4	0.7	1.1	1.1

There also were only marginal effects of S application on yields in 2004, and a significant increase due to S application was observed at only one site.
The lack of response to S application can be explained by low levels of other nutrients in the plant-soil system on these organic farms. The plants' demand for S is less in situations with low application of other nutrients. However, we are surprised that the yield responses were so low. At some sites the S content in red clover was less than half the level of 2 g S kg^{-1} DM that is often used as a marginal value for optimal plant growth.
In the pot trial we could demonstrate how the yield response to S application depends on nutrient supply (Figure1a).

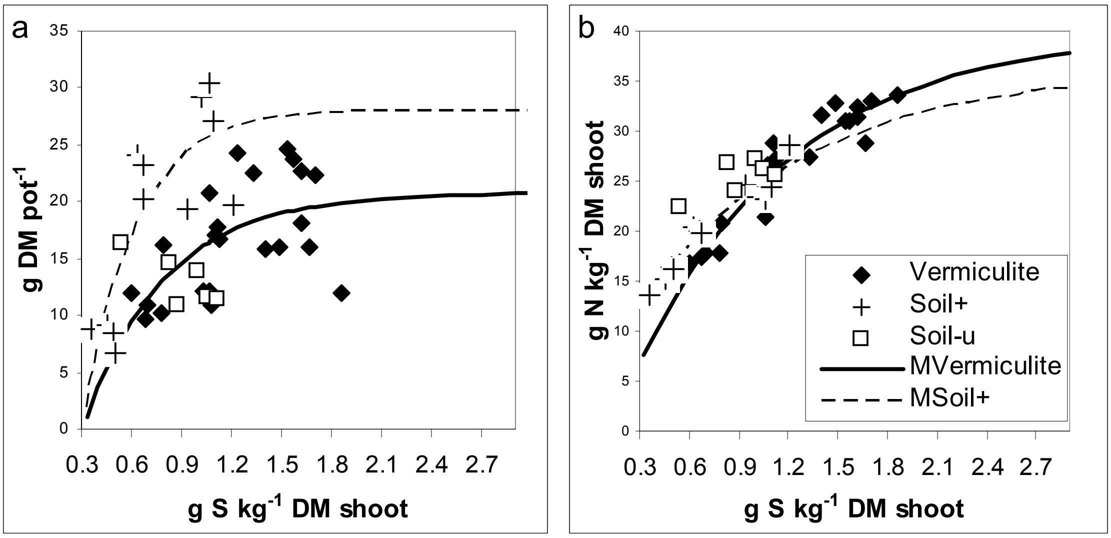

Figure 1. Scatter plots for the interaction between dry-matter yield pot-1 and S concentrations in shoot (a) and between concentration of N and S (g kg^{-1} DM) in red clover shoot (b) in second cut for red-clover grown in Vermiculite, Soil+ and Soil-u, respectively.
For Vermiculite (MVermiculite) and Soil+ (MSoil+), Mitscherlich response curves (N,DM =A $(1-e^{(-k(S-S_o))})$ are given. For Soil-u no significant response curve was found.

In Soil-u we did not get any yield response when the S concentration increased from 0.5 to 1.1 g S kg^{-1} DM, whereas in Soil+ there was a strong yield response in the same interval. In vermiculite the yields never became as high as in Soil+. In all growth media the S concentration in the shoot seemed to level out when approaching a certain level, despite increasing S application. In both Soil-u and Soil+ this happened at a concentration around 1 g S kg^{-1} DM, and in vermiculite around 1.5 g S kg^{-1} DM. Above this level the S concentrations in roots increased.

More detailed studies are needed to find out why the plants have a luxury uptake of S that stays in the roots and whether the same mechanism happens in no legume plants as well. The level of S supply when S accumulates in roots probably depends on the nutrient supply and other growth conditions, and can be illustrated by the differences in the three growth media we compared. This mechanism is likely one reason that in the field experiments we observed only minor increases in S concentrations in plant shoots when the S application was increased from 30 to 60 kg S ha^{-1}.
In the pot experiments, we observed close interactions between S and N concentrations in shoots in Soil+ and vermiculite (Figure 1b), but not in Soil-u. The amount of biologically fixed N increased with increasing S application at all S levels in Soil+, but in Soil-u only at the first S level. The results in Soil-u correspond with the result in the field experiment, where we observed only a week increase in estimated biological N fixation with increasing S application, and only at the lowest S levels. This could be expected, as the supply of other nutrients was low both in the pot experiment and in the field experiments on the organic farms.

Conclusions

Despite low S content in the herbage, yields were surprisingly good in many locations. However, the content of S in herbage is generally so low that it should be monitored in order to ensure sufficient S in the diets of ruminants. S fertilisation at organic farms with low supply of other nutrients will increase the herbage S concentration, yields, biological N fixation and protein-content only when the S concentration is very low.

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Acknowledgements

We would like to thank professor William Lockeretz who has most kindly helped us with language corrections. We would also like to thank him for his enthusiastic support through many years.

100% organically produced feed – how to adjust in dairy farming systems?

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Abstract
The EU regulation governing organic production will require 100% organic feed in organic dairy systems from August 2005 compared with 85% currently in Norway. This study aimed to assess adjustments in resource use and financial impacts on organic dairy herds using a stochastic programming model. Farm management effects of the regulatory change varied between farm types. For the two organic dairy systems examined, both having a milk quota of 100 000 litres, the introduction of the 100% organic feed regulation resulted in an economic loss of approximately 6-8% of the net income compared to the current regime.

Keywords: feed regulation, stochastic programming, feeding, land use

Introduction

The EU regulation governing organic production will require 100% organic feed in organic livestock systems from 25 August 2005. Currently, the maximum percentage of conventional feedstuffs authorised per year is 10% in the case of herbivores (15% in Norway) and 20% for other species. The requirement for 100% organic feed will potentially have the greatest impact on organic dairy systems (Nicholas et al., 2004).
The new regulation will directly impact on the price of purchased concentrates since organic concentrates are more expensive than conventional ones. This may subsequently influence many aspects of the farming system and its financial performance. Dairy farmers are faced with a large number of options or combinations of options, including direct substitution of purchased conventional concentrates with purchased organic concentrates, growing more concentrate feeds on the farm, reducing the use of concentrates and increasing the use of forage, purchasing of livestock manure, and reducing the beef enterprise activity or the milk production. The profitability of the options may vary according to the farm conditions (e.g., farm resources, climate, managerial ability), the market situation for feeds, milk and meat and the public payment system. How the new regulation will affect organic dairy systems is however to a great extent unknown, and research needs to be undertaken to assess the various options under a variety of conditions (Nicholas et al., 2004).
The aim of this study is to assess adjustments in resource use and financial impacts due to the 100% feed regulation on organic dairy herds under lowland conditions in Norway.

Materials and methods

A two-stage discrete stochastic programming model of organic dairy farms, developed by Flaten et al. (2004), was used to examine farm-level effects of the 100% feed regulation. Two types of model farms reflecting conditions for typical organic dairy farms in the lowlands of Southern Norway were analysed. The annual milk quota on both farms was 100 000 litres. The first farm owned 25 ha of farmland; an additional 15 ha of land could be rented. The second farm only owned 22 ha of land with no land rent possibilities. In the model a risk-neutral farmer maximise expected net income (i.e., the family's return to farm as well as off-farm labour and management). Fixed costs are deducted from the income measure.
The model assumes a one-year plan starting in spring. First-stage decisions are, e.g., how many cows and heifers to keep, allocation of land to various crops, and the use of manure.

Once the numbers of cows and heifers are decided, the dairy herd size is fixed. The risk associated with the dairy herd is thus non-embedded risk (upper branch of Figure 1).

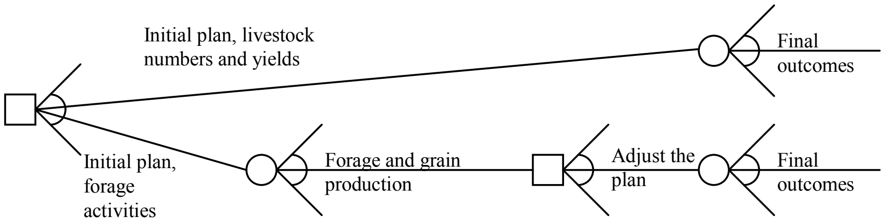

Figure 1. Outline decision tree for our problem.

The actual yields are being known after harvest. In the spring time the farmer is uncertain about the area of crops needed to produce the necessary feed for the livestock. However, some decisions can be postponed until better information is available. The farmer is assumed to do the necessary adjustment only once during the year, in the mid of September. At that time, the type of growing season will be known and the herd's indoor-season starts. The second-stage decisions allow us to model a response to the observed crop yields outcome. One set of second-stage variables for each state of crop yields outcome is defined. Feedstuffs can be sold or purchased. Bulls can be sold or retained. The possibility to adjust the farm plan in response to uncertain outcomes of crop yields creates embedded risk (lower branch of Figure 1).

Land can be used for growing grass and barley. Grass can be used for grazing or for silage making to be used in the indoor season. All crop yields respond to manure applications, but at a diminishing rate. The barley crop can be sold or used as home-processed concentrate. Silage can be traded. Conventional produced cattle manure can be purchased.

Two mixtures of organic concentrate supplements as well as one of conventional origin can currently be purchased. Prices are NOK 2.65 (€ 1 = NOK 8.15) per kg feed of the conventional feed mixture, NOK 3.80 per kg feed of the organic standard concentrate and NOK 5.00 per kg feed of the organic protein concentrate.

Farm livestock includes dairy cows, followers and beef bulls. Heifers raised on the farm replace cows. In stage 1, bull calves can either be sold or kept over the grazing season. At stage 2, remaining bull calves can be sold immediately or be fed over the indoor season and sold as yearlings. Livestock are given free access to forage. Higher milk yields are achieved through addition of concentrates, which depress forage intake. Livestock feeding requirements includes minimum dry matter limits of concentrates and forages and minimum protein requirements, specified for all stages and types of livestock.

The farm family has the opportunity to work off-farm. Provision is also made to hire labour. The prevailing public livestock and area payment schemes are included (2003/2004).

Data from 1993 to 2002 for organic dairy farms in the Norwegian Farm Accountancy Survey were used to estimate the historical variation in enterprise income and crop yield variables within farms between years (Flaten et al., 2004). These historical variations combined with subjective judgments represented the uncertainty in the stochastic variables. Forage yield uncertainty was modelled with three outcomes and the same for grain yield uncertainty, in total nine states of nature for yield combinations. For the final financial outcomes (of the stochastic enterprises dairy and beef/calf), we modelled 10 states of nature. The mean of the stochastic enterprise incomes were set equal to the 2004 price level.

Organic legislation regarding use of manure, livestock housing requirements, livestock density, feeding requirements, etc. (Debio, 2003) were handled through a number of constraints. One constraint per livestock type ensured that a maximum of 15% of the *energy* *content* in the annual feed ration could be of conventional origin (Debio, 2003). With the new 100% organic feed regulation this option will be removed.

Results

Table 1 summarizes the main activities in stage 1 under the current as well as the 100% feed regulation for both of the farm types. Table 2 illustrates the main features of the tactical decisions at stage 2.

Table 1. Model solutions in stage 1 for two different farmland sizes.

	Land 40 ha 85% organic	Land 40 ha 100% organic	Land 22 ha 85% organic	Land 22 ha 100% organic
Expected net income (1000 NOK)	345.3	325.5	221.9	203.2
Land use (ha)				
Land for grazing, 10 m^3 of manure/ha	10.0	10.0	6.5	6.8
Land for silage, 20 m^3 of manure/ha	18.6	18.6	10.0	9.7
Land for grain, 30 m^3 of manure/ha[a]	11.4	11.4	5.5	5.5
Purchase of manure, m^3	413	413	120	122
Livestock management				
Dairy cows	21.1	21.1	16.2	16.0
Milk, kg per cow	5500	5500	7000	6603
Concentrates, kg DM per cow	808	808	2379	1920
Heifers	6.3	6.3	4.9	4.8
Sold calves	4.2	4.2	3.3	3.2
Keep male calves	10.5	10.5	8.1	8.0
Milk supply, 1000 litres	100.0	100.0	100.0	92.6

[a] Sward establishment undersown in barley is included. The ley lasts for three years (the sowing year excluded).

The 40 ha farmer under the 85% organic feed regime used all of the available land (Table 1). More than 28 ha were allocated to forage crops. Manure applications per ha were highest in grain. The milk quota was produced with 21 cows each yielding 5500 kg milk. Male calves were kept over the grazing season. The main adjustments in stage 2 were to sell silage in the best forage years and to sell some bulls at the start of the indoor season in the weak forage years (Table 2). All farm-produced grain was sold off-farm. More than 23 tonnes of concentrates were purchased, 17 tonnes of it of conventional origin. Available family labour not used in the farm business, was used off-farm (NOK 80 per hour).

The optimal farm management activities for the 40 ha farm were similar under the 85% and 100% organic feed regulation. The only adjustment in the production system was direct substitution of the purchased conventional concentrate mixture with purchased organic concentrate mixtures. The decrease in expected net income was NOK 19 750, equivalent to NOK 1.15 per kg of the purchase of conventional feed under the current regulation.

The second farm type had only 22 ha land available. In the 85% organic feed situation, grain was only produced as a cover crop in the sward establishment years. The milk quota was produced with much higher yielding cows than at the 40 ha farm. The cows' intake of forage

was then less, as the supply of concentrates was higher. The bull calves were only kept over the grazing season. Silage was purchased, and most in the weak forage years. Approximately 46 tonnes of concentrates were purchased, included 16 tonnes of conventional supplements.
The 22 ha farmer coped with the changed feed regulation in a number of ways. The lower yielding cows reduced the need of concentrate supplements with around 450 kg per cow. This change was driven by the higher prices of organic concentrates compared to the conventional price. The cows were also slightly fewer, and only 92.6% of the milk quota was produced. The farmer purchased more silage than under the current regulation. The financial outcome of the 100% organic feed regulation was an economic loss of more than NOK 18 750 annually.

Table 2. Model solutions in stage 2.

	LL[a]	LN	LH	NL	NN	NH	HL	HN	HH
Land 40 ha, 85% organic / 100% organic									
Grain trade, tonneb	33.3	35.1	37.4	33.3	35.1	37.4	33.3	35.1	37.4
Silage trade, tonne dry matter[b]	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4
Concentrates, tonne[c]	23.2	23.2	23.2	23.9	23.9	23.9	23.9	23.9	23.9
– conventional conc., tonne[c, d]	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1
Keep bulls	6.6	6.6	6.6	10.5	10.5	10.5	10.5	10.5	10.5
Off-farm work, hours	23	23	23	7	7	7	7	7	7
Land 22 ha, 85% organic									
Grain trade, tonne dry matter[b]	15.7	16.5	17.6	15.7	16.5	17.6	15.7	16.5	17.6
Silage trade, tonne[b]	-8.5	-8.5	-8.5	-6.8	-6.8	-6.8	-4.5	-4.5	-4.5
Concentrates, tonne[c]	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
– conventional conc., tonne[c]	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1
Keep bulls	0	0	0	0	0	0	0	0	0
Off-farm work, hours	365	365	365	365	365	365	365	365	365
Land 22 ha, 100% organic									
Grain trade, tonne dry matter[b]	15.7	16.5	17.6	15.7	16.5	17.6	15.7	16.5	17.6
Silage trade, tonne[b]	-10.5	-10.5	-10.5	-8.9	-8.9	-8.9	-6.6	-6.6	-6.6
Concentrates, tonne[c]	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Keep bulls	0	0	0	0	0	0	0	0	0
Off-farm work, hours	396	396	396	396	396	396	396	396	396

[a] LL, low forage yield and low grain yield: LN, low forage yield and normal grain yield: LH, low forage yield and high grain yield: … : HH, high forage yield and high grain yield.
[b] A positive sign indicates sale of fodder, a negative sign purchase of fodder.
[c] Sum of purchased concentrates in stage one as well as stage two.
[d] Only under the 85% organic feed regime, i.e., zero for the 100% organic feed regulation.

Conclusions

Farm management effects of the 100% organic feed regulation varied between the two farm types, both with a milk quota of 100 000 litres. With much land available, the only adjustment was to substitute conventional purchased concentrates with more expensive organic concentrates. In the situation with less land available, lower yielding cows, more purchase of silage and reduced total milk production were the profitable adjustments. In both cases, the organic dairy systems faced a substantial economic loss of almost NOK 20 000 (or 6-8% of their expected net income) with the regulatory change compared to the current regime.

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Productivity, economy and nutrient balances on organic dairy farms using different strategies for homegrown feed

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Abstract

Since the summer of 2001, 100% organically grown feed has been a requirement from the majority of the dairy industry in Denmark. This has increased focus on homegrown feed. In the present paper the consequences of different types of supplement feed (cereal, rapeseed/cereal, rapeseed cake/cereal or grass pellets) and of different production systems (increased grazing, increased grazing combined with spring calving or an increased calving interval) were investigated at farm level. Type of supplement feed should be chosen based more on crop yield potential than on milk yield potential. Alternative production systems like spring calving or increased calving intervals have the potential of increasing both productivity and financial result on an organic dairy farm.

Keywords: dairy, feed production, production system, self-sufficiency, whole farm

Introduction

Today, organic herds produce 10% of the milk delivered to dairies in Denmark. The organic herds are in general larger than the conventional ones (93 cows versus 77 cows) and mainly housed in loose-housing systems (94% versus 61% of the conventional herds). However, milk production per cow per year is about 8% lower in organic than in conventional herds (Danish Holstein: 8,065 versus 8,736 kg ECM). A lower level of feeding may explain the lower milk production in organic herds. The principles and standards in organic farming have as a result that feeding of the organic dairy herd is very different from feeding of the conventional dairy herd. Within the organic system, crop yields higher in roughage than in crops for concentrated feed have increased focus on roughage even more than in the conventional system. Grass-clover covers 43% of the area in rotations on organic dairy farms and makes up more than half the total energy intake of the cows during the summer period, and in the winter period grass-clover silage covers an average of 62% of the total roughage intake. It is also a characteristic that the organic dairy cows are given large amounts of cereals, 922 SFU/cow/year as an average.

Milk production based entirely on organically grown feed was introduced in the summer of 2001 because of a requirement from the majority of the dairy industry in Denmark. Most farmers tried to maintain the feeding level and milk yield per cow after introducing 100% organically grown feed (Mogensen, 2004). The proportion of roughage in the ration was typical increased, as was the proportion of grass-clover in whole crop silage. Cereal supplement was typically increased as well. The aim of the present paper is to describe the consequences for productivity and financial result on organic dairy farms using different strategies for homegrown feed.

Materials and methods

A fixed farm size (200 ha in rotation) is assumed for all strategies. All farms are self-sufficient with feed and manure, but straw and minerals can be imported. In each strategy the size of the herd depends on the actual feed production on the 200 ha. The herd includes only cows and heifers as bull calves are sold as young. The size of the stable is adjusted to the actual herd size, and capacity cost is a fixed amount per cow, 8,000 DKK/cow/year. All fieldwork is done by machine pool at standard costs. Land is paid with an interest rate of 3,000 DKK/ha. The financial result is the balance for paying the owner for the work in the stable.

Milk yield response of different types of supplement is based on results from production experiments on private, organic farms (Mogensen & Kristensen, 2002; Mogensen & Kristensen, 2003; Mogensen et al., 2004) and the milk yield from cows on increased calving interval is based on results from an experiment at the organic research station Rugballegård (Christiansen & Danfær, 2005).

Results

Preliminary calculations of strategies with an increasing share of grass-clover in the crop rotation and feed ration showed a positive effect on feed intake and milk production per cow, as well as on the financial result of the farm (Mogensen, 2004). The reason for this is that crop yield potential (SFU/ha) in grass-clover is high. Furthermore, the digestibility of grass-clover silage is often higher than the digestibility of whole crop silage. In the present strategies, the share of grass-clover in rotation is high – 60% of the area. If the share of grass-clover is increased further, it may result in a reduction in yield .

In the basic strategy (No 1 in Table 1), supplement for cows in early lactation consists of 6 kg cereals per day. The roughage is based solely on high quality grass-clover silage with a digestibility of organic matter of 78.5%. During the summer, cows are at pasture for 185 days eating a total of 1,500 SFU fresh grass-clover supplied with silage and cereals at the stable. The milk production is 8,000 kg ECM per cow per year.

Table 1. Effect of different types of supplement feed and different production system

Strategy	Type of supplement				Production system		
	1 Cereal	2 Rapeseed cake/cereal	3 Rapeseed/ cereal	4 Grass pellets	5 Increased grazing	6 Spring calving	7 Increased calving interval
Cow level							
SFU/cow/year	6143	6190	6278	5996	6143	6141	6302
ECM/cow/year, kg	8000	8070	8193	7781	8000	7874	8206
Herd level							
No of cows	124	109	120	130	123	131	130
Gross margin/cow/year, DKK	10246	10315	10513	9729	10247	9950	10737
Field level							
Ha/cow	1.62	1.84	1.67	1.54	1.62	1.52	1.54
SFU/ha	4739	4202	4690	4886	4730	4915	4774
Grass-clover, % of ha	59	54	59	60	59	64	59
Gross margin/ha/year, DKK	2770	2230	2675	2995	2825	3190	2820
Farm level							
ECM/ha/year	4946	4392	4918	5049	4937	5168	5325
Financial result, 1000 DKK	232	120	238	219	243	285	304

To grow the said ration, 59% of the area is grown with grass-clover and the remaining part with cereals. In strategy 1, crop yield in grass-clover is assumed to be 5,600 SFU/ha (6,040 kg dry matter) and 3,500 SFU/ha (3,680 kg) of cereals. Given the feed ration per cow and crop yield in actual crops, the area needed to grow the ration is 1.62 ha/cow (Table 1). On 200 ha, feed for 124 cows can be grown. The manure production is 181 kg N/milk producing unit (MPU)/year. 72 kg N is secreted at pasture and the remaining part for spreading amounts to 59 kg N per ha. The total milk production of the herd is 990,000 kg ECM or 4,946 kg ECM/ha. With a milk price of 2.51 DKK/kg ECM and an internal cost of feed of 1.20 DKK/SFU, the resulting gross margin is 10,246 DKK/cow/year. Similar gross margin of the fields is 2,770 DKK/ha/year. The financial result is 232,000 DKK.

In strategy 2, the supplement for high yielding cows during the winter period is 2.5 SFU from rapeseed cake and 3.5 SFU from cereals. Even though milk yield of high yielding cows is increased during the winter, milk yield per cow per year is only increased by 1%. As the financial result is almost halved, it is not attractive to grow rapeseed to produce own rapeseed cakes and sell oil. With a yield of 2,000 kg rapeseed per ha, only 1,500 SFU of rapeseed cakes can be produced. Therefore, there is only feed for 109 cows and milk production per ha decreases.

In strategy 3, once again rapeseed and cereals are grown for supplement feed. When srapeseeds are rolled and fed together with cereals the productivity and financial results are very similar to strategy 1 with supplement of cereals. The assumption is that crop yield in cereal and rapeseed both are 3,400 SFU/ha.

With supplement of grass pellets in strategy 4, feeding level/cow and therefore milk production per cow decreases due to a higher fill of grass pellets when compared with cereals. Higher crop yield in grass-clover compared with cereals increases number of cows that can be fed from the crop production at the 200 ha. Despite the fact that milk production is increased compared with strategy 1, the financial result is decreased because of the costs connected with having more cows.

The level of grazing of 1,500 SFU grass-clover/cow/year used in strategies 1 to 4 corresponds to the average level in Danish organic dairy herds. The level of grazing is increased to 1,700 SFU/cow/year in strategy 5 and to 1,950 SFU/cow/year in strategy 6. In strategy 6, spring calving is introduced at the same time, to synchronize a high demand for feed of cows in early lactation with the maximum grass growth in the springtime. Feeding level is the same in strategies 1, 5 and 6. Milk production per cow per year is 8,000 kg ECM in strategies 1 and 5, but decreases to 7,870 in strategy 6. This is because of the fact that heifers are only 24 months at calving compared with 27.3 months in the other strategies. As these heifers are smaller at calving they have to grow more in 1st lactation and milk production is reducedbecomes lower. In strategy 5, the financial result is 5% higher than in strategy 1, mainly because of saved costs when more feed is grazed and less is ensiled. In strategy 6 with spring calving, share of grass-clover, both fresh and silage, is increased as well as share of grass-clover in rotation. Because grass-clover has the highest expected crop yield, the total feed production is increased. So is total number of cows, total milk production and financial result by 23%.

In strategy 7 with an increased calving interval of 17.5 months the total milk production is 11,500 kg ECM from 475 days in milk. That corresponds to 8,206 kg ECM/cow/year. The 56 days dry per lactation is reduced to 38 days dry/cow/year. Only 0.7 calf/cow/year is born versus 1.0 in the other strategies. With increased calving interval there is fewer days/cow/year in early lactation. Therefore, the share of roughage in the ration/cow/year can be increased. At the same time, the total need for fsome feed for heifers is lowersaved as fewer heifers per cow are produced. So, even though the milk production/cow is increased the need for feed/MPU is decreased. The financial result is increased by 30%.

Discussion and conclusions

In a situation with entirely home produced feed, different type of supplement feed result in almost similar productivity and economic result. This is on the assumption that the milk yield response from supplement rich in protein is lower than the response traditionally used (Madsen et al. 2003). A ration with a high proportion of easily digestible clover-grass silage and plenty of fermentable carbohydrates may stimulate the microbial protein synthesis in the rumen, and the utilization of the digestible protein in rumen may reach a higher level of amino acids absorbed from the small intestine (AAT) than calculated. Furthermore, it is assumed that a ration based solely on cereal and grass-clover does not affect cows health negatively.

Alternative production systems like spring calving or increased calving intervals have the potential of increasing both productivity and financial result on an organic dairy farm. Increased level of grazing presumes that the farm has the right conditions, and concentrated spring calving implies increased focus on reproduction. In the system with increased calving interval is assumed that health, and involuntary replacement are unaffected.

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Acknowledgements

This project was a part of the project “Organic dairy production systems“ funded by the research program “Research in organic farming 2000-2005 (DACOF II)”.

Grazing management for Nordic organic dairy farming

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Abstract

The aims of this study were to identify limiting factors and to develop adjusted grazing management for Nordic organic dairy farming conditions. The focus was to combine the aspects of plant, animal and organic production, as they are all involved in organic dairy pastures. This pioneer work provides a characterisation of Nordic organic pastures, suggests novel legume species for Nordic conditions, considers the advantages of manure compost fertilisation, proposes tools to improve grazing efficiency and assesses the benefits of supplementary feeding.

Keywords: Nordic organic dairy farming, pasture species, compost fertilisation, grazing system

Introduction

Grazing dairy cows form part of a complex ecosystem involving their interaction with the pasture plants, soil micro-organisms and climatic conditions (Figure 1). In Nordic organic dairy farming, grazing represents a challenge with the short grazing season and limited number of winter-hardy plant species combined with restrictions on the use of fertilisers and supplementary feeding and with nutritional demands of high-yielding milk cows. Grazing management based on conventional farming practice does not fit into the Nordic organic farming system, where mineral fertilisers are not permitted. Neither natural pastures, nor extensive grazing systems can supply adequate herbage (quantity and quality) for lactating dairy cows. Hence, grazing management needs to be specially adjusted for organic dairy farming.

Table 1. Description of seven experiments contributing data to this study (Kuusela, 2004).

Subject of experiment	Treatments	Measurements
Sward renovation	Compost application or no fert. Reseeding or no reseeding	Sward measurements
Clover species for perennial swards	Five seed mixtures	Sward measurements
Birdsfoot trefoil and white clover	Three seed mixtures	Sward measurements
Grazing method and supplementary feeding	Strip or paddock grazing Four supplementary feedings	Sward measurements Animal measurements
Herbage allowance and supplementary feeding	Two levels of herbage allowances Two levels of supplementary feeding	Sward measurements Animal measurements
Compost fertilisation and legumes for annual swards	Compost fertilisation Four seed mixtures	Sward measurements
Legumes for annual swards and concentrate feeding regimen	Two seed mixtures Two concentrate feeding regimens	Sward measurements Animal measurements

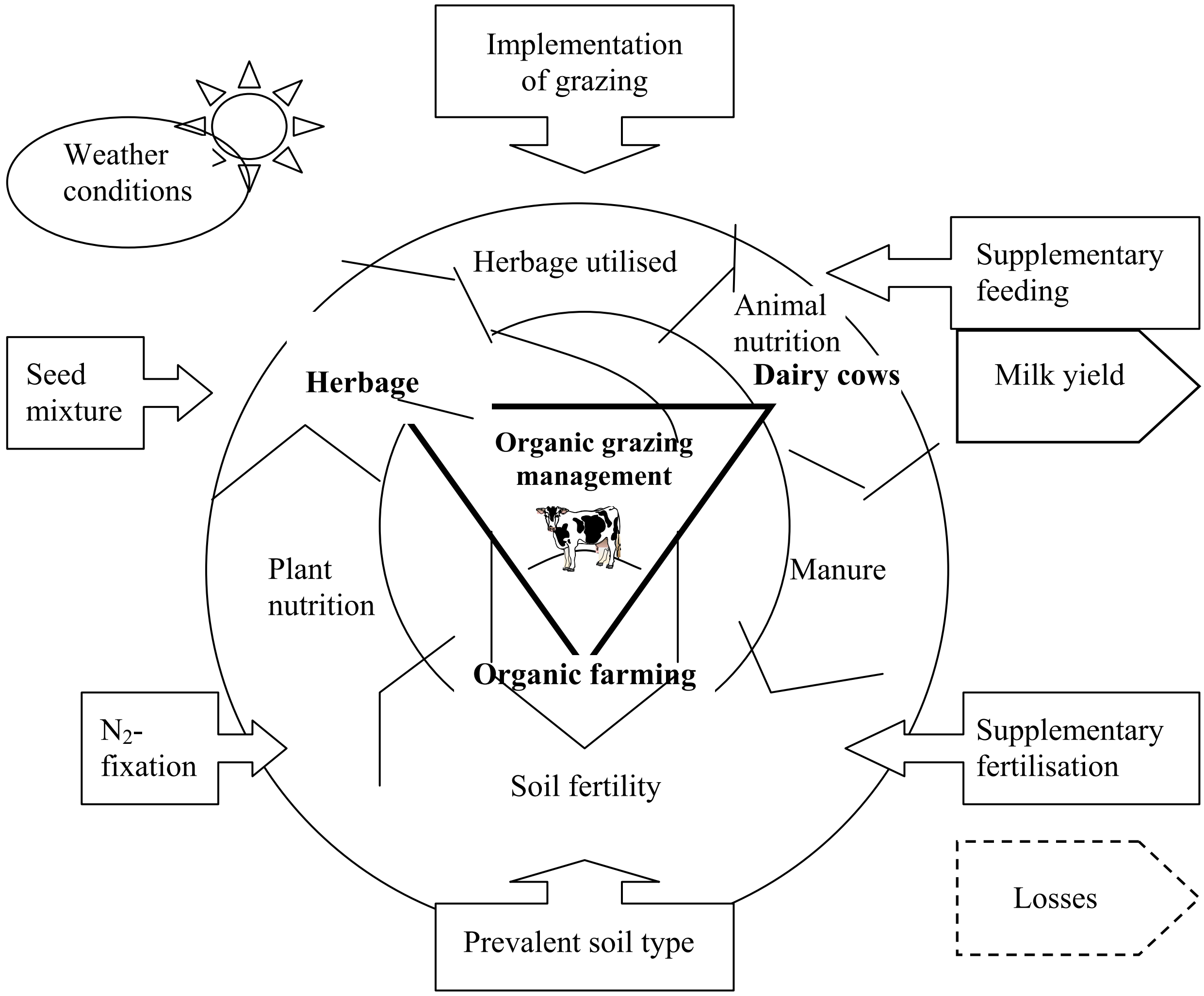

Figure 1. Elements influencing the grazing management under development for Nordic organic dairy farming (Kuusela, 2004).

Material and methods

The study, including seven field or feeding experiments (Table 1), was conducted on the Siikasalmi research farm of the University of Joensuu (62°30'N, 29°30'E) in Eastern Finland in 1994 – 1999 (Kuusela, 2004).

Results and discussion

This study showed that intensively managed organic pastures could support at least moderate herbage production with good nutritive value. Mean pre-grazing herbage mass (above 3 cm) varied between experiments from 1265 to 1985 kg dry matter (DM) per hectare, when approximately 3 weeks rotation cycle was applied in order to obtain adequate herbage quality. Mean crude protein content between experiments varied from 165 to 217 g/kg DM and *in vitro* digestibility of organic matter from 0.75 to 0.76. Organic pastures were heterogeneous mixtures of three botanical components, grasses, legumes and weeds, which were clearly divergent regarding dependence on soil nitrogen availability and herbage nutritive value. The botanical proportions and seasonal changes affected the nutritive value and growth of the herbage.

The choice of legume species for the grazed mixture is of key importance, since red clover (*Trifolium pratense*), the basal legume for organic silage, is known to suffer from frequent grazing. In the present study white clover (*Trifolium repens*) was the most suitable perennial pasture clover for Nordic conditions, but the additional inclusion of beneficial birdsfoot trefoil (*Lotus corniculatus*) in perennial clover-grass mixtures is suggested. Hairy vetch (*Vicia villosa*) was best suited for grazed annual legume-grass-cereal mixtures and could support extended grazing in the autumn. At the farm level, including both annual and perennial swards is recommended to balance the temporal variation of the herbage mass and extend the grazing season in the autumn.

In organic farming systems, the proportion of legumes and their ability to accumulate N2 determine the potential productivity of the whole system and farm yard manure is a practical tool to circulate nutrients and improve the fertility of low-fertility areas. Grazing supports soil fertility intrinsically because most of grazed nutrients and nutrients from supplementary feeding are directly recycled to pasture. In the present study, application of soil-deposited manure compost increased the amount of pre-grazing herbage mass by 18 %, but increased also the amount of post-grazing herbage mass by 27% and had no effect on the amount of utilised herbage. The reduction in intake was attributed to smell, since the differences in the chemical composition between unfertilised and compost fertilised herbage were minor. Hence, manure compost fertilisation, when necessary, is recommended to be used for cereals included in pasture-crop rotation rather than for grazed swards.

In organic grazing systems herbage production is often lower than in heavily fertilised conventional systems when normal rotation cycles are used in order to obtain herbage with adequate nutritive value. In organic farming systems the length of the rotation cycle is a compromise between digestibility and the amount of herbage mass, where nitrogen deficiency often depresses the production of herbage mass from grasses. The pre-grazing herbage mass affects the stocking rate, grazing area requirement, milk yield per animal and milk yield per hectare. It should be noted that grazed herbage mass is the only DM harvested from pasture and generally pasture productivity is limited due failure in grazing management. However, efficiency of grazing can often be improved. In the present study, the milk yield per hectare was clearly (36 %) increased by applying daily strip grazing instead of paddock grazing, because of the benefits of short animal occupation. An excessive herbage allowance in connection with a low herbage mass is an inefficient combination, because they both increase the grazing area requirement while large incremental increase in herbage allowance are known to have only minor effects on the milk production of individual animals per day. In the present study, moderate decreases in the daily herbage allowance (24 vs 18 kg DM, above 3 cm) decreased slightly (8.8%) grazing area requirement, but resulted in lower post-grazing sward height, depressed sward growth and had no significant effect on the milk yield per hectare. The herbage allowance should not go below the level which the system can tolerate. In Nordic organic dairy farming, an adequate daily herbage allowance for mid-lactating cows might be 20-26 kg DM per cow, depending on the milk yield, supplementary feeding and growing conditions. Based on the current data a target post-grazing, a sward height of 10-12 cm is suggested for Nordic organic legume-grass pastures.

The intake of herbage and the nutritive value supply from the herbage for grazing cows is determined by the nutritive value of the herbage and herbage allowance, but also herbage mass and sward structure are affecting. On grass-based diets, a maximum milk yield of 20 kg per day has often been assumed to be the highest level of production that can be achieved at pasture, but recent studies have shown that milk yield of 30 kg per day can be achieved on grass under excellent grazing conditions. In the present study a grass-only diet resulted in a daily milk yield of 16.8 kg per mid-lactation cow, indicating some deficiencies on herbage mass or its nutritive value. Both energy (barley + oats) and protein (rape seed meal) supplementation (4 and 1.25 kg per day, respectively) resulted in increased daily milk production (19.1 and 18.2 kg milk, respectively). Increasing the amount (2.5 *vs* 5 kg per day) of concentrate supplementation (barley + oats + rape seed meal) resulted in relatively high milk response (0.68). Base on current study, a moderate level of concentrate (4 kg per day) could be offered once instead of twice daily to simplify feeding.

Calcium, Mg, P, K and Na concentrations of pre-grazing herbage samples collected in 1997 and 1998 averaged 6.20, 2.08, 4.05, 32.94 and 0.09 g/kg DM, respectively. The main differences between seed mixtures were connected to the proportion of legume in the sward, which affected Ca and Mg contents of the herbage. The temporal changes in mineral contents and mineral ratios were significant. The organic pasture herbage did not fully satisfy the mineral requirements of grazing dairy cows. Low concentration of Na and moderate Mg in herbage, especially the latter associated with high K in early summer, require mineral supplementation. Because of temporal variation, measured values of herbage mineral content are needed to control the risk of disorders in grazing animals and for planning adequate mineral feeding.

Conclusions

Heterogeneity in herbage production, species and herbage chemical content both spatially and temporally was characteristic for organic pastures. However, intensively managed organic pastures could support at least moderate herbage production with good nutritive value. A sufficient legume proportion was essential for the nutritive value of herbage and current and future growth. In Nordic conditions white clover was the most suitable legume for perennial pastures and hairy vetch for grazed annual legume-grass-cereal mixtures. At the farm level, including both annual and perennial swards will help to balance the temporal variation of the herbage mass and extend the grazing season in the autumn. Manure compost fertilisation, if necessary to improve the soil fertility of a given area, is recommended to be used for harvested cereals included in pasture crop rotation rather than for grazed swards.

Efforts to improve grazing efficiency are essential in organic systems, where herbage production is often lower than in heavily fertilised conventional systems. In the present study the milk yield per hectare was clearly increased by applying daily strip grazing instead of paddock grazing. In organic dairy farming, excessive herbage allowances are rarely useful because of the limited pre-grazing herbage mass. On the other hand, the herbage allowance should not go below the level which the system can tolerate. Post-grazing sward height is a good indicator for the implementation of adequate allowances and for continuous monitoring to prevent inefficient under-grazing and detrimental over-grazing also for organic pastures.

In the present study, the milk yield response to concentrate feeding was relatively high for mid-lactating cows grazing on organic cultivated swards. This was mainly because the herbage intake was limited on a herbage mass basis. Both energy and protein supplementation resulted in increases in milk production. A concentrate supplement including additional protein adjusted according to the state of lactation is recommended for early-mid lactating cows grazing clover-grass swards grown under the conditions of Nordic organic farming. Organic pasture herbage did not fully satisfy the mineral requirements of grazing dairy cows. Low concentrations of Na and relatively low Mg in the herbage, the latter especially in connection with high K, require mineral supplementation.

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Closing the plant-animal loop: a prerequisite for organic farming

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Abstract

An analysis of a number of published surveys of dairy farms in Europe is used to exemplify the consequences of the use of alien feed on nitrogen loss from organic animal productions. It is concluded that the present international regulations are not adequate to enforce the adoption of environmental friendly and sustainable organic production systems, in harmonious balance between crop production and animal husbandry.

Keywords: emission factor, life cycle analysis, nitrogen efficiency

Introduction

Since their origin, organic farming movements have considered fundamental to achieve a production in good balance with the natural conditions of the farm (Balfour, 1943; Steiner, 1999). Imports of external resources that can burst up the production have been considered negative, based on the intuition that the agro-ecosystem will enter an unbalanced and unstable situation. This principle is reflected, e.g., in the ban of easily soluble fertilizers. Searching for techniques to mitigate the eutrophication of the environment brought about by intensive agriculture, special attention has been paid to the efficiency of nitrogen (**N**) and phosphorus within the single sectors of the farm. It has been suggested that supplementing grass with energy concentrated feed can improve the protein retention and off-take in milk by dairy cattle, and thus the N efficiency of dairy production (Tamminga, 1992). This in turn is used as an argument for the use of concentrate supplements, a practice leading to a further specialization of separate animal and crop farms. This affects the skills and economic conditions surrounding the organic enterprise, and it challenges organic farming: if specialization and use of off-farm feed improves the nutrient use efficiency on the farm, why not adopting them? And: is it more important to focus on the principle of local resources or on the organic purity of the feed used? These questions are the focus of the present study.

Methods and results

We use the N efficiency of cattle milk production in Europe as an example. Data were collected from published farm surveys and intensive studies of prototype farms (Bleken et al., 2004). Prerequisites for this analysis were: 1) a holistic approach, which includes all primary (plant) production necessary for the animals, and 2) the distinction between trophic levels. The products considered were net milk and livestock sale (**P**). The net purchased feed ($_{Foff\text{-}farm}$) was calculated by subtracting crop sale. Systems with net crop sale or where Foff-farm accounted for more than 50% of the total feed were not considered. All fluxes are expressed in kg N ha^{-1}y-1. It was assumed that the N surplus (**S**: total N input as fertilizer, biological fixation and atmospheric deposition minus P) represents the potential N emission to the environment in the long run. The emission factor $E_{farm} = S_{farm} / P$ gives the amount of N (in kg kg^{-1}) that is dissipated from the farm system in order to produce 1 kg of N in milk + livestock (ca 200 kg milk, or 40 kg animal live weight). The total emission factor $\mathbf{E} = (S_{farm} + S_{off\text{-}farm}) / P$ included both the N dissipation on the farm and the N dissipation related to the production of purchased feed ($S_{off\text{-}farm}$). We calculated also how much N was exploited by the farm in order to yield one unit of N in forage and other crops: α_{farm} = (manure N + biological N fixation + atmospheric N deposition) / F_{farm}.

The farm surveys included 7 organic or integrated farming systems and 14 conventional ones, and covered environmental conditions from Northern Italy to Southern Norway and yield intensity (from 3000 to 13000 l milk $ha^{-1}y^{-1}$). One of the organic farm surveys was eliminated due to uncertainties about the biological N fixation. The results showed that the N-utilization on the farm decreases as the proportion of the bought feed ($F_{off\text{-}farm}$) to the farm crop production (F_{farm}) increases. Farms with large purchase of $F_{off\text{-}farm}$ relatively to F_{farm} used increasingly larger amounts of N to produce one unit of F_{farm} (α_{farm}, Figure 1A). Also the N emission factor from the farm increased with feed imports (Figure 1B). If feed purchase improves the N utilization by the animals, this advantage was not reflected by a lower N emission factor E_{farm}, primarily due to a lowered N efficiency ($1/\alpha_{farm}$,) of the plant sector.

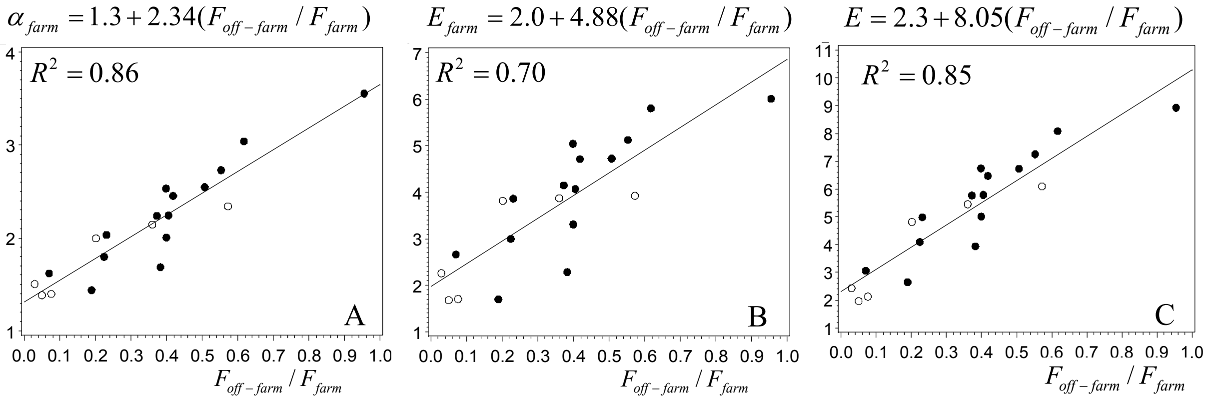

Figure 1. A: N units exploited by the farm to get a plant yield containing one N unit: αfarm = (manure N + biological N fixation + atmospheric N deposition) / F_{farm}, B: N emission factor from the farm: $E_{farm} = S_{farm} / P$, and C: emission factor for the entire production $E = (S_{farm} + S_{off\_farm}) / P$, versus the ratio of the imported feed to the plant production on the farm ($F_{off\text{-}farm}/F_{farm}$). Open symbols: organic or integrated production. Closed symbols: conventional production. α_{farm}, E_{farm} , E and $F_{off\text{-}farm}/F_{farm}$ are in (kg N ha^{-1}) / (kg N ha^{-1}).

In spite of no use of chemical N fertilizer, additional manure N derived from feed imports was not effectively utilized by organic and integrated farms. This has two negative consequences: 1) directly on the emission from the farm, 2) indirectly by raising the need for additional reactive N in order to produce $F_{off\text{-}farm}$. Taking the latter into consideration, we have estimated the total emission factor $E = (S_{farm} + S_{off\text{-}farm}) / P$. This is illustrated in Figure 1C assuming an average $E_{off\text{-}farm} = S_{off\text{-}farm} / F_{off\text{-}farm}$ based on nationwide surveys in Europe (see Bleken & Bakken, 1997): E increases from roughly 2 to 10 kg N per 200 kg of milk as $F_{off\text{-}farm}$ increases from nil to be equal to the farms own plant production. A closer inspection of the organic farming systems illustrates the significance of alien feed, in doses which are usually considered small or moderate, on the N dissipation (Table 1). The share of alien feed was low (< 6% of the total) in the two surveys in Austria and in the Norwegian prototype farm. The Danish organic farms and the Welsh prototype had a larger use of alien feed, 26 and 36% of the total ration respectively. Within this interval (5 – 36% of the total ration) the emission factor E increased by a factor of ca. 2.6. The total N surplus, including that occurring during the production of alien feed, was estimated by multiplying the farm produce (kg N ha^{-1}) with the relevant E: It increased from 40 – 50 to 240 – 280 kg N y^{-1} per ha of dairy farm (Table 1).

Table 1. Farm's crop production and milk + meat produce (kg N ha^{-1} y^{-1}), total animal manure available at the farm, ratio bough feed to total feed (kg N / kg N), N emission factor (E, kg N/kg N) and total farm surplus (kg N ha^{-1} y^{-1}).

	kg N ha^{-1} y^{-1}			Ratio	E, kg/kg		Total farm N surplus kg N ha^{-1} y^{-1}	
	Farm's production		Total animal manure	bought feed/ total feed				
	Crop	milk + meat			1	2	1	2
Norway, prototype	77	17	62	0.03	2.4	2.5	42	44
Austria, n = 40	88	20	72	0.05	2.0	2.7	39	54
Austria, n = 51	88	21	74	0.07	2.1	2.9	44	60
Germany, n = 6	84	22	79	0.17	4.8	3.9	106	86
Denmark, n = 14	108	32	124	0.26	5.5	5.2	175	166
Wales, prototype	117	40	144	0.36	6.1	6.9	244	276

E: total emission factor, 1 calculated specifically for the farm considered, and shown as a point in Figure 1C; 2 calculated from $F_{off\text{-}farm}/F_{farm}$ using the regression equation in Figure 1C. Total farm surplus, 1 and 2, is estimated by multiplying the farm produce (meat/milk) with E 1 and E 2, respectively.

Discussion

The present results show clearly that the use of imported feed relative to the farms own plant production increase dramatically the N emission factor. It is surprising that feed imports play such an important role on the N emission factor, in spite of the large variation in ecological conditions considered (continental and maritime climates, latitude from 45° to 60° N, alpine and low land regions). We had expected a difference between organic or integrated farms and conventional ones, but there were no statistically significant effects in this respect.

The N efficiency of the soil-plant sector ($1/\alpha_{farm}$) clearly decreases as the ratio $F_{off\text{-}farm}/F_{farm}$ rises. At least in conventional farms this can partly be due to a lower efficiency of the chemical fertilizer. However, the most likely explanation for the reduced soil-plant efficiency on the organic as well as on the conventional farms is a lowered N efficiency of the animal manure when this was available in amounts that exceeded those sustained by the farm's own plant production.

There are evidences that high milk yield per cattle with good N utilization can be achieved by feeding the farm's own roughage without or only small concentrate supplementation (Mogensen, 2004; Steinshamn et al., 2004). This is confirmed also by some of the surveys considered in this study. Furthermore, organic dairy farming based on home-grown feed can be financially more attractive than systems based on imported feed (Mogensen, 2004).
Excess manure contributes to several other environmental problems. On the other side, soils with large export of plant products and no return of animal manure can be depleted not only in N but also in several other minerals. Thus, the increased N-pollution problem is only an example of several reasons for adjusting animal rearing to the plant production of the farm.

The regulations for organic agriculture indicate that the original aim that animal production should be based on farm's plant production is no longer perceived as fundamental, as long as the purchased feed is organically produced. The USDA standards as formulated in the National Organic Program has no restrictions (Organic Foods Production Act of 1990). The European Council allows a feed import up to maximum 50% of the feed requirement on an energy base, and the application of animal manure is limited to 170 kg N ha^{-1}, which indirectly limits the number of animal and the feed imports (EU Regulation No 2092/91 and supplementing regulations). This is, however, a very high ceiling, and only three of the European surveys considered exceeded it. The present draft of the IFOAM's Basic Standards, states that one of the principal aims of organic farming is "to create a harmonious balance between crop production and animal husbandry" (IFOAM, 2004). However, we have not been able to identify adequate rules to enforce this principle. The draft states that "The prevailing part (>50%) of the feed shall come from the farm unit itself ...". This is what conventional intensive Dutch farms used before they had to cut down the surplus due to new Dutch regulations (Aarts et al., 2000), and it is considerably more than found in the surveys of organic farms in Europe (Table 1).

Fluctuations in the feed quantity and quality due to weather conditions and animal welfare considerations may necessitate some feed purchase. A complete ban of feed import is therefore not desirable. On the other hand, unless a low ceiling is enforced through international regulations, there will be strong pressures on organic farms to adapt to production methods with large use of purchased concentrates. We tentatively suggest a ceiling of 5 - 10% of the annual ration on energy basis, which can be raised in years with exceptionally adverse weather conditions. An important theme of further discussion isthe local ecological and environmental drawbacks of promoting a specialised production of organic feed-concentrates in areas without livestock,

Conclusions

Closing the plant-animal loop legitimates organic dairy farming as more environmentally sound than farming based on imported feed and fertilizers. Official regulations of organic farming should ensure that this aim is fullfilled by stating clear and low ceilings for the amount of imported feed allowed, relative to the farms own plant production.

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Nitrogen studies of conventional and organic wheat cultivation, 1992-2002

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Abstract

This study concerning resource conservation of nitrogen (N) in the cultivation of winter and spring wheat was carried out at the research farm of Kvinnersta Örebro in Central Sweden. This farm contains three different whole-field cultivation systems; conventional animal production (CONV), organic animal production (ORG1) and organic cereal production (ORG2) where the study was performed during 1992-2002 using the years as replicates.

Sustainability was measured in terms of the nitrogen use efficiency of plant available N. The amounts of N entering the field and the amounts removed in the harvested crop and remaining as unused mineral nitrogen in the soil at harvest were determined. The amount of utilized nitrogen by the wheat crop in the different cropping systems was calculated from measured data, and the environmental variables influencing N-harvest in the different cultivation systems were identified using multivariate regression (PLS).

The study was an average for all years and sampling occasions in winter wheat, there were approx. 60 kg more mineral nitrogen left in the soil during the growing season in CONV than in ORG1 and coefficients of variation were higher in CONV. The max values were considerably higher in CONV than in ORG1 ($p=0.06$ to 0.09), which increased the risk of leaching in the former, particularly in winter wheat cultivation. Nitrogen use efficiency was 74% in the whole crop of conventional winter wheat and 81% in the organic winter wheat, respectively. Nitrogen use efficiency in harvested winter wheat grain was 44% for CONV and 49% for ORG1. ORG1 spring wheat was as efficient as ORG1 winter wheat, while ORG2 spring wheat utilised 73% of N in the whole crop and 39% in grain.

Multivariate regression analysis showed that climate affected CONV and ORG1 winter wheat differently. High temperature in May increased grain yields in ORG1, but the converse was true for CONV. Large unused mineral N reserves at harvest coincided with large N-harvest in CONV winter wheat. Residual fertility effects from the preceding crop produced high yields in ORG1 winter and spring wheat but had no effect in CONV. Generally, an increase in N reserves between plant development stages 13 and 31 was positive for both CONV and ORG1 winter wheat. Both winter and spring wheat require most N during this period, so the potential for improvement seems to lie in increasing mineralisation, e.g. by intensified weed harrowing early in stage 13 in winter wheat and between stages 13 and 31 in spring wheat.

Cultivation of winter wheat in ORG1 was a more efficient use of nitrogen resources than it was in CONV. CONV efficiency could be improved by precision fertilisation on each individual field with the help of N analysis before spring tillage and sensor-controlled fertilisation.

Management of perennial weeds and nitrogen leaching in arable cropping systems

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Abstract

A crop rotation experiment was established in 1997 at three locations representing different soil types and climates. Three factors were tested: crop rotation, catch crop and manure. Catch crop reduced nitrate leaching, but prohibited stubble cultivation. The use of catch crops resulted in increased levels of perennial weeds (*E. repens*) at one location, while at another; the level of *C. arvense* was not affected by catch crops, when compared with the use of stubble cultivation. Management of perennial weeds should include considerations of where in a crop rotation to use stubble cultivation, and this should preferably not be after a pulse crop. Catch crops are a more profitable way to manage *C. arvense* than stubble cultivations.

Keywords: crop rotation, catch crop, nitrate leaching, perennial weeds, stubble cultivation

Introduction

In Denmark, perennial weeds such as *Elymus repens* L. Gould and *Cirsium arvense* L. are traditionally controlled by stubble cultivation in the autumn after harvest of a cereal or pulse crop. When the weed no longer reappears after stubble cultivation, or soil or weather conditions prohibit the cultivations, the field is ploughed either in late autumn/early winter on heavier soils or in spring prior to sowing of spring crops on lighter soils. Carrying out cultivation during autumn prohibits growing a catch crop. Since autumn and winter is the time of excess precipitation, cultivation may lead to higher risks of nutrient leaching. Contrary to this, when a catch crop is grown, nutrients are retained within the topsoil by being incorporated in the biomass of the catch crop. If the catch crop is a leguminous species, N_2-fixation can further increase the N supply for the next crop. Thus catch crops will both reduce N leaching and increase yields of the following crops. Therefore, mechanical control of perennial weeds may have negative effects for the N supply in the crop rotation. The aim of this study was to clarify the effects of catch crops on the development of perennial weeds and the N leaching at two sites under different climatic and soil conditions.

Materials and methods

A crop rotation experiment was initiated in 1996/97 at three sites in Denmark representing different soil types and climates: a coarse sand at Jyndevad, a loamy sand at Foulum and a sandy loam at Flakkebjerg. Average precipitation was 964, 704 and 626 mm at Jyndevad, Foulum and Flakkebjerg, respectively (Olesen et al., 2000). The following experimental factors were included in a factorial design with two replicates and all crops in the rotations were represented every year: i) crop rotation, with different proportions of N2-fixing crops, ii) with (+CC) and without catch crop (-CC), and iii) with (+M) and without animal manure (-M) applied as slurry. Different four-year crop rotations were compared in the experiment (Table 1), and two courses of the rotations were completed in 2004 (Olesen et al., 2000, 2002). The

Table 1. The crop rotations are carried out with the treatments: without catch crops (-CC), with catch crops (+CC) in combination with the treatments: without manure (-M) and with manure (+M). The crops undersown with catch crops and the manure application rates (kg NH4-N/ha) are indicated.":" indicates undersown ley, "/" indicates intercropping.

	Rotation 1 (R1)	+ CC	+ M	Rotation 2 (R2)	+ CC	+ M	Rotation 4 (R4)	+ CC	+M
First course 1997-2000	Spring barley:ley		50	Spring barley:ley		50	Oats	+	40
	Grass-clover			Grass clover			Winter wheat	+	70
	Spring wheat	+	50	Winter wheat	+	50	Winter cereal	+	70
	Lupin	+		Pea/barley	+		Pea/barley	+	
Second course 2001-2004	Spring barley:ley		50	Spring barley:ley		50	Winter wheat	+	50
	Grass-clover			Grass-clover			Oats	+	50
	Oats	+	30	Winter cereal	+	50	Spring barley	+	50
	Pea/barley	+		Lupin/barley	+		Lupin/barley*		
Sites	Jyndevad			Jyndevad Foulum Flakkebjerg			Foulum Flakkebjerg		

+CC: + = catch crops in +CC treatments +M: 30-70 = kg ammonium-N/ha in +M treatments
*: Pure lupin at Foulum

plots receiving manure were supplied with anaerobically stored slurry at rates where the NH4-N amount corresponded to 40% of the N demand of the specific rotation based on a Danish national standard. The N demands for grass-clover, pea/barley and lupin or lupin/barley were set to zero. The target rates for application are shown in Table 1. All cereal and pulse crops were harvested at maturity. The grass-clover was used solely as a green manure crop, and the cuttings were left on the ground. All straw was left in the field. The crops were irrigated at one site (Jyndevad).

Weed harrowing and row hoeing were used to control annual weeds. A reduced effort was used in the treatments with catch crops. Perennial weeds were primarily controlled by stubble cultivation in autumn after cereal and pulse crops without catch crops. *C. arvense* plants were pulled out in all plots at the time of budding, which coincided with anthesis of the cereals. At Flakkebjerg in 2000 to 2002, winter wheat was row hoed in the –CC treatments to control *C. arvense*.

Nitrate leaching was measured using ceramic suction cells installed at 0.8 m depth (Jyndevad) and at 1.0 m depth (Foulum and Flakkebjerg) in selected plots. *C. arvense* above-ground shoots were counted and weighed (fresh weight) in the whole plot at the time of anthesis of the cereals. Shoots of *E. repens* that extended above the crop were counted in five 0.1 m2 areas in the same crops two weeks later.

Results

The nitrate leaching losses were largest at Jyndevad and least at Flakkebjerg ($p<0.001$) (Table 2). Catch crops reduced nitrate leaching in both rotations at Jyndevad and in rotation 2 at Foulum. The same tendency was seen in rotation 2 at Flakkebjerg ($p=0.09$). At Jyndevad, in six combinations of crop and year, stubble cultivation for control of *E. repens* was carried out in one of the two –CC/+M replicates only due to differences in infestation with *E. repens*. This allowed for a comparison of nitrate leaching between +CC plots, - CC plots without

Table 2. Effect of crop rotation and catch crop on nitrate leaching (kg NO3-N ha^{-1} yr^{-1}) at the three experimental sites. Values with the same letter within a row are not significantly different ($P<0.05$) (Askegaard et al. 2005).

Site	Rotation 1		Rotation 2		Rotation 4	
	– CC	+ CC	– CC	+ CC	– CC	+ CC
Jyndevad	106 a	56 b	104 a	65 b		
Foulum			54 a	38 b	37 b	39 b
Flakkebjerg			35 a	26 a	29 a	28 a

stubble cultivation and –CC with stubble cultivation. Stubble cultivation after pulses (lupin and pea/barley) in the –CC plots doubled the nitrate leaching compared with no harrowing. After cereals there was no effect of stubble cultivation on nitrate leaching (Askegaard et al. 2005).

At Jyndevad, the *E. repens* infestation developed into a problem during the first few years; in several cases more than 100 shoots m^{-2} were found in plots. Stubble cultivations decreased *E. repens* infestations (Fig. 1).

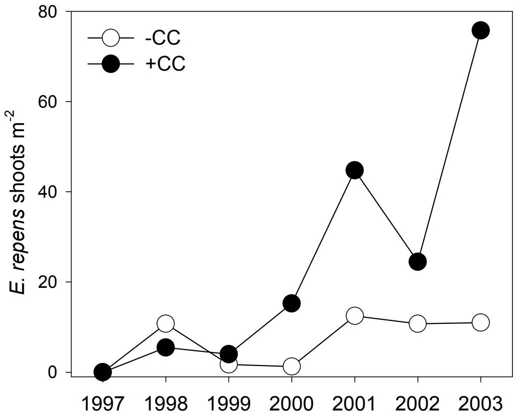
At Flakkebjerg, there was a lower infestation of C. arvense in rotation 2 than in rotation 4, with least biomass in the crop the year after grass-clover. There was no significant difference between the biomass of C. arvense in –CC and +CC treatments (Fig. 2), in spite of the fact that stubble cultivations and row hoeing were carried out in the –CC and not in the +CC treatments.

Discussion

The experiment has demonstrated that there are interactions between effects of management factors such as catch crop and stubble cultivation on nitrate leaching and perennial weeds. Nitrate leaching was reduced by use of catch crops at the sandy soil and in the rotation with grass clover also at the other two sites. Stubble cultivation after pulse crops doubled the nitrate leaching compared to no stubble cultivation and no catch crop. Management of perennial weeds should include considerations of where in a crop rotation to use stubble cultivation, and this should preferably not be after a pulse crop.

In spite of the high level of *E. repens* infestations in the +CC treatments at Jyndevad, the mean of cereal and pulse yields where higher in the +CC than in the –CC treatments, probably because of an improved nutrient supply. This difference decreased from the 1st to the 2nd course, probably partly caused by the *E. repens* infestation. Stubble cultivations to control *E. repens* might not always be profitable on sandy soils, but knowledge is lacking to decide when it is necessary.

The reason why *C. arvense* biomass was the same with and without catch crops was most likely because the nutrients retained in the topsoil by the catch crops benefited the crops, which became more competitive against the weeds. Without catch crops, stubble cultivation and row hoeing decreased *C. arvense*, but also made more nutrients available for the weed, making it more competitive against the crop. There was a yield increase in the +CC treatment in rotation 4 at Flakkebjerg, probably due to the increased nutrient availability to the crop. Thus it seems that catch crops are a more profitable way to manage *C. arvense* than stubble cultivations.



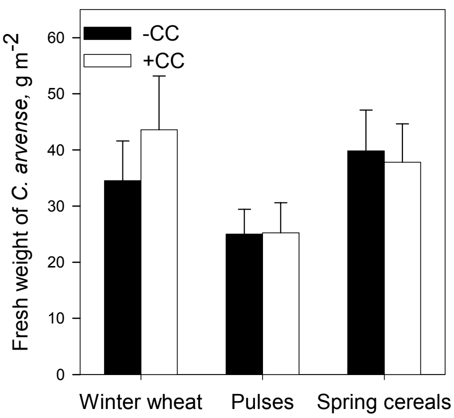


Figure 1. Development in number of *E. repens* shoots m^{-2} in spring barley at Jyndevad in the –CC treatment, which received stubble cultivations in most of the previous crops, and the +CC treatments, which were not stubble cultivated except after pulses in 2001. Mean of rotations and manure treatments.

Figure 2. Fresh weight m^{-2} of *C. arvense* in different crops at Flakkebjerg without (-CC), which received stubble cultivations in most of the previous crops or with (+CC) catch crops, which were not stubble cultivated. Mean of 1999-2003, rotations and manure treatments. Bars indicate standard errors.

Conclusion

The interactions between different management tools are not always possible to predict. In this experiment, yield gains from catch crops were obtained in spite of problems with perennial weeds. Results from long-term experiments make it possible to understand and explain some of these interactions, and to point out new areas of research. Management of perennial weeds should include considerations of where in a crop rotation to use stubble cultivation, and this should preferably not be after a pulse crop.Thus it seems that catch crops are a more profitable way to manage *C. arvense* than stubble cultivations.

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Acknowledgements

The Danish Ministry of Food, Agriculture and Fisheries financed this work, which was performed in the context of the Danish Centre for Organic Farming.

Density, structure and management of landscape elements on Danish organic farms

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Abstract

Density and management of landscape elements on organic farms were investigated for 345 organic farms in Denmark in 2001, representing approximately 10% of the total number of organic farms. The density of hedgerows, area habitats and ponds was estimated and related to various aspects of farm character, such as size, type and lifestyle/part time/full time farms, as well as region and biophysical context. A large variation in the densities was found, the highest densities were found on the smallest farms. Farm size was the farm parameter that was closest related to the density of landscape elements as well as landscape structural variables. Farm size was related to the other farm characteristics.
Keywords: landscape elements, farm character, hedgerows, ponds, farm management
Introduction
Organic agriculture represents a whole-farm approach to natural resource management, aiming at an integration of production goals, environmental goals and goals for nature management and protection. A common goal is that biodiversity in farmland and adjacent areas must not be compromised (IFOAM, 2002). Unlike in UK (Soil Association, 2002) concrete and measurable objectives have not been linked to this goal in Denmark, but standards related to the density of uncultivated areas on the farm have been discussed. The ways the aspirations for protecting farmland biodiversity manifest themselves in the practice of organic farming in different socio-economic and biophysical contexts are not well known.

In an intensively cultivated country as Denmark (62% of the total land area is agriculture, of which only 7% is permanent grassland and the rest is in rotation) the potential for biodiversity is to a large extent related to the agricultural land use and management. Landscape heterogeneity at farm scale has been shown to be positively correlated to species richness (Weibull et al., 2003) and structural adjustment with increasing farm sizes, larger fields and fewer crops is expected to influence biodiversity negatively (Hole et al., 2005). In the absence of larger uncultivated areas, landscape elements (hedgerows, woodlots, ponds, etc.) and extensively managed grassland often constitute important biotopes for biodiversity, and preservation and restoration of these elements are vital for preservation of farmland biodiversity (Aude et al., 2003, Bengstsson et al., 2005). It has been shown that the organic farming system increases species richness by approximately 30% compared to conventional farming, especially in intensively cultivated areas (Bengtsson et al., 2005). In these areas it is to be expected that the farmer's short and long term management of owned and rented land is important to the development of quality landscape elements, and thus to biodiversity. Management is both in terms of non-removal, securing elements with a long continuity, and in terms of new planting, adding to the total area of elements and increasing density.

The aim of this study was to investigate the variation in the density and management of landscape elements as well as landscape structure related to field size and crop diversity on organic farms in Denmark. Moreover we investigated if this variation was related to aspects of farm character such as type, size and workload (lifestyle, part time or full time farming) as well as biophysical and regional context.

Material and methods

Data on crop distribution and field size were retrieved from the registry on land use of organic farmers (Plant Directorate, 2001). These were complemented with a quantitative survey consisting of personal interviews with 345 organic farmers constituting approximately 10% of the Danish organic farms. The interviews included questions concerning the farm enterprise, time spend in farming, management of permanent grassland and fields in rotation, location and age of uncultivated areas on the farm and land use changes within the last five years. Farmers were located in eleven case areas all over the country, covering main landscape types of Denmark and all with a relatively high density of organic farms. All the organic farmers in the case areas (35-40 farms pr area) were approached for an interview, and the response rate was 75%. The resulting sample of farms represents the national distribution of organic farm types.

The interviewed farmers were asked to identify landscape elements on their farm on a copy of an aerial photo covering the farm area (used for applications for agricultural subsidies). Density of landscape elements was calculated for 1) linear landscape elements (hedgerows and dikes), 2) area habitats (woodlots and small uncultivated areas), and 3) ponds. Hedgerow areas were estimated based on length and information on number of rows. Area habitats were estimated directly from the photo. Ponds were all assigned an area of 400m^2 (national mean densities of ponds in the farmland was estimated to 390m^2/ha in 1996, (Holmes et al., 1998)). The density of landscape elements was calculated based on total field area rather than farm area, aiming at a description of farmland density. Landscape elements were assigned to age classes: less than 5 years old, 5-15 years old, 15-30 years old, more than 30 years old.

In the analysis we tested if farm characteristics (lifestyle-, part time- and full time farms, farm type and farm size) and biophysical setting (dominating soil type, flat or undulating topography and region), could explain landscape structural elements (density of different types of landscape elements, the existence of young and old landscape elements, average field size and crop diversity). Undulating topography was defined as farms where more than 5% of the farm area is sloping more than 5%). Relationships between farm character and biophysical variables and landscape structural elements were analysed with non-parametric analysis of scores.

Results and discussion

Landscape elements constituted on average 3,6 % of the total field area on the farm, with a range of 0 to 34%. A large variation within farms was found for all elements, but with a skewed distribution dominated by low densities. The area of linear landscape elements made up 44% of the total area of landscape elements, while area habitats contributed with 51% and ponds 5% of the total area. Mean on-farm densities of landscape elements are seen in Table 1. 7% of the organic farms had no hedgerows, 30% no area habitats and 33% no ponds, but only two farms had no landscape elements at all, indicating that the different types of landscape elements were located at different farms.

Table 1 Length, number and area of types of landscape elements on 345 organic farms

Landscape elements	N *)	Mean length / number / area per farm	Mean density: length / number / area per ha	Mean estimated area density, m2/ha
Linear (hedgerows, banks)	333	1966 m	59 m/ha	150 m^2/ha
Point (ponds)	333	1,4	0,06/ha	24 m^2/ha
Area (woodlots etc.) <1ha	333	5923 m^2	188 m^2/ha	188m^2/ha

*) Missing values for 12 farms

The three types of landscape elements differed in age distribution. Linear landscape elements were represented in all four age groups, albeit less in the youngest. Their presence in the middle age groups is to a large extent due to the subsidies for hedgerow planting that was initiated in the 1980's. The class representing more than 30 years old elements made up the largest share of the area habitats and the ponds, indicating that these landscape elements may constitute an important target for nature conservation as habitats with a long continuity. The lack of medium age ponds and the high frequency of young ponds (23% of total number of ponds) indicate a change in approach to management of the small habitats. Removal of landscape elements during the last 5 years has been insignificant, according to farmers.

For all types of landscape elements, farms with old elements were most frequent among large dairy farms. Hedgerows were also established with higher frequency on large dairy farms, while establishment of area habitats was most frequent on mixed farms of medium size, predominantly in moraine landscapes. Ponds were established with higher frequency on medium sized arable farms.

Analyses of the relationships between farm character variables and landscape elements showed statistically significant relationships among several variables as shown in Table 2.

Table 2: Relationship between farm characteristics and density of landscape elements

	hedgerows/ banks	area habitats	Ponds	av. field size	N of crops
N	333	333	333	340	340
Farm type	**	ns	**	***	***
Lifestyle/part time/full time	ns	ns	*	***	***
Soil type	***	ns	**	***	ns
Topography	**	**	**	ns	ns
Region	***	*	***	***	ns
Size class	***	ns	**	***	***

(Significance levels: $p<0.05$ **, $p<0.001$ ***)

Farm size was a good descriptor of several aspects of landscape structure, as most landscape parameters – except area habitats – were significantly related to farm size. This is not so surprising, as boundaries between farms often carry physical structures such as hedgerows. Furthermore, as farm size and average field size is positively correlated ($r=-0.29$, $p<0.0001$), small farms and thus lifestyle- and part time farms usually has a smaller scaled mosaic, with smaller fields and more field divides. Especially the very small farms (< 10 ha) tended to have high densities for ponds and area habitats. Further inspection revealed that for small farm sizes a dual pattern of density exist: most farms have either no landscape elements at all or they have a high density. For larger farm sizes (above 30- 50 ha) the relationship between farm density and farm size is less significant. When the analysis of relationships were repeated including only farms with presence of the respective landscape elements, the significance of the test increased for almost all relationships, and also area habitats were then significantly related to all farm character variables, except the soil type.

High hedgerow densities were found on small, arable or meat farms and on the sandy soils on the outwash plains in West Denmark, as they are still to some extent established due to the need for wind protection. High densities of area habitats were found in regions with more undulating topography like river valleys and moraine deposits, probably partly due to farm optimisation. Ponds were found to have a strong regional attachment, as high densities were predominantly found on smaller lifestyle farms of different types in the moraine area in Eastern Denmark. Here amenity values may play a prominent role for the etablishment. While average field sizes were correlated to farm size, they were also linked to the status of farms as full time, part time or lifestyle farms. Number of crops increased with farm sizes up to 30 ha, above which it tended to be alike.

Conclusion

There is a large variation in presence and density of landscape elements on organic farms in Denmark, but few farms have no landscape elements at all. The presence of hedgerows, area habitats and ponds follow different patterns. Smaller farms, which are most often part time or lifestyle farms, have higher densities of all elements in general. Regional variation is found for all landscape element types, but the presence of the different types vary in different landscapes. The frequency of farms with old and young elements also differ according to element type, but large farms seem to have a high frequency of both young and old hedgerows. Given that size enlargement is taking place among organic farms, similar to that in conventional agriculture, it is uncertain whether size changes will result in a continued decrease in landscape elements on organic farms or whether goals related to landscape protection weaken this development on larger organic farms in the future.

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Organic farming enhances biodiversity - but there is a larger picture

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Abstract

Organic farming has been suggested to enhance biodiversity. In our literature review and meta-analysis we show in general a 30 % higher species richness on organic compared to conventional units. The results were variable between studies and in 16 % of the studies the species richness was higher on conventional units. We then divided the data into different organism groups and spatial scale of the studies. Birds, insects and plants showed a higher species richness in organic farming. Studies where landscape characteristics were considered showed a significant but a highly heterogeneous result of higher species richness in organic farming systems compared to plot comparisons with highly significant positive species richness.
Abundances were also studied and a 50% higher abundance was found on organic units. Significant positive response was found in birds, predatory insects, soil organisms and plants.
However, at the end of the day it is the farmer who decides what to grow and how to grow it on the farm. No matter what farming system, his/her attitudes, knowledge and interest will strongly affect the farms effect on the surrounding environment. Thus to fulfill the Swedish environmental objective 'A varied agricultural landscape' we all, farmers, researchers, extension specialist and administrators, have to respect each other and acknowledge the knowledge and interest of the different groups.

Keywords: Meta-analysis, attitudes, farming system, species richness

Introduction

The loss of biodiversity in the agricultural landscape is well known (Fuller et al. 1995, Benton et al. 2003). Organic farming generally increases biodiversity (Paoletti et al. 1992, Bengtsson et al. 2005). Thus organic farming has been suggested to partly replace the loss of biodiversity seen in agricultural landscapes. However, this has also been questioned (Trewawas 1999, Goklany 2002)

Meta-analysis is a method for analyzing and synthesizing the results of several independent studies examining the same question (van Zandt & Mopper 1998, Gurevitch & Hedges 2001). The statistical procedures allow quantitative analyses of treatment effects, and account for the fact that all studies are not equally reliable (Bengtsson et al. 2005). The method will weigh different studies differently depending on number of replicates and the standard deviation within each study. A study with high number of replicates and a low standard deviation will have a higher impact on the general results compared to a study with few replicates and high standard deviation.

Biodiversity issues in the agricultural landscape are much more than merely a biological issue. The manager of the land, often the farmer, will of course affect biodiversity. The effect will differ depending on attitudes, knowledge and interest towards nature, economical situation, and social acceptance for change in the farmer community etc. Thus it is crucial to communicate and cooperate with farmers to be able to conserve biodiversity.

Materials and methods

We conducted a literature research for comparing studies of biodiversity on organically and conventionally managed units. We included all studies published before December 2002. All together we found 66 publications comparing diversity on organic and conventional systems.

From the included studies we tabulated the mean species richness or abundance, the n-values and calculated the respective SD, for the two farming systems. This extracted data made it possible to calculate the effect size (Q; Hedges'g) and the pooled SD of each study. Studies that did not provide information on n or SD were included in a sign-test.

The effect size was tried if it was heterogeneous (Q significant) or homogenous (Q not significant) i.e. whether or not the effect size differed greatly between studies. When results were heterogeneous we divided the studies in taxonomical or functional units. We also divided the comparative studies by scale, plot, field on farm and fields/farms in matched landscapes. For more information about the method used see Bengtsson et al. 2005.

During spring and summer 2004 sixteen Swedish farmers from Uppsala and Heby were interviewed (open-ended and semi-structured) about their feelings for, knowledge of, interest in, nature, nature conservation, nature conservationists and the life as a farmer. The interviews will be fully transcribed and analyzed with qualitative methods. Their farms were also studied in terms of different crops, management of crops, landscape characteristics, and biodiversity (birds, bumblebees, Carabidae, solitary wasps and weeds).

Results

Organic farming usually increased species richness (Table 1) and abundances (Table 2) with 30 % and 50 %, respectively. Divided into organism groups birds, insects and plants species richness was higher and the abundance of birds, predatory insects, soil organisms, and plants, was higher in organic units.

Studies made in smaller areas, plots, showed in general a bigger separation of species richness and abundance between the farming systems. Organic fields/farms in matched landscapes had a higher biodiversity but showed no difference in abundance, compared to conventional units, in our meta-analysis.

The interviews and field work from 2004 are not yet processed. The interview answers will be used briefly in the discussion.

Discussion

Organic farming generally enhance biodiversity. The reason for higher biodiversity in organic management can be the lack of pesticides, the higher variation of crops, the ley in the crop rotation and the use of farm and green manure. All farmers can of course have a varied crop rotation with ley and use farm manure but the incentives to do so is higher in organic farming. We want to highlight the fact that at the end of the day it is the farmers who decide what to grow and how to grow it on the farm.

There are systemic differences between the farming system on the theoretic level but not always on farm level. Many studies try to overcome this by using farm pairs. There is a risk of erasing the differences between the systems working with farm pairs. Finding an organic matching neighbour in the most intense agricultural area in Sweden is hard. Thus it is an obvious risk for underestimating the differences between the systems.

Table 1. A meta-analysis of the effects of organic management on species richness. Positive effect sizes indicate higher species richness in organic farming systems. The studies in the meta-analysis are available from the web site http://www.cul.slu.se. The number of positive studies column and the associated n column include all studies, and those in which no quantitative effect size, only increases or decreases in species richness, was given. When Q (heterogeneity of effect sizes among studies) is significant, the results are shown for a random effects model. *P < 0·05 for average effect size ≠ 0, for heterogeneity of effect sizes (Q) and for binomial test of the number of positive studies; CL, confidence limit.

	Average effect size (Hedges'g)(± 95% CL)	n	Q	No. of positive studies	n
Total	1.152(±0.524)*	32	170*	53*	63
By organism group					
Birds	1.495(±1.236)*	2	0	3	3
Arthropods	0.929(±0.589)*	19	71.7*	21*	28
Predatory insects	0.843(±0.590)*	15	43.8*	15	21
Carabidae	0.941(±0.861)*	11	34.7*	10	13
Non-predatory arthropods	1.046(±1.982)	4	26.2*	6	7
Soil organisms	0.306(±0.559)	5	3.3	7	10
Plants	2.684(±1.976)*	6	81.6*	22*	22
By scale of study					
Plot or single field	2.917(±1.769)*	8	55.8*	15*	17
Field on farm	0.703(±0.550)*	11	19.3*	24*	27
Field/farm in matched landscape	0.818(±0.791)*	13	79.6*	14	19

Table 2.A meta-analysis of the effect of organic management on the abundance of organisms.

	Average effect size (Hedges'g)(± 95% CL)	n	Q	No. of positive studies	N
Total	0.700(±0.272)*	71	522*	96*	117
By organism group					
Birds	0.708(±0.868)*	7	18.5*	12*	12
Insects	0.122(±0.300)	30	85.4*	29*	42
Predatory insects	0.486(±0.457)*	14	27.4*	16*	21
Carabidae	0.799(±0.865)	9	19.2*	9	12
Non-predatory insects	-0.133(±0.373)	16	47.4*	13	21
Pest species	-0.398(±0.441)	7	10.4	3	7
Soil organisms	1.022(±0.551)*	26	144*	44*	49
Earthworms	0.286(±0.362)	8	6.94	12*	13
Plants	1.305(±0.358)*	5	15.4*	7*	7
By scale of study					
Plot or single field	0.567(±0.308)*	16	23.3	30*	33
Field on farm	1.278(±0.358)*	30	122*	43*	51
Field/farm in matched landscape	0.029(±0.273)	25	93.6*	23*	33

With our multidisciplinary project with interviews and ecological/agronomical data we want to highlight the farmer and that we cannot ignore his/her knowledge, interest and feelings when designing subsidy programs and management strategies. A diverse landscape with a diversified management will promote biodiversity. Thus it is not good if management is uniform over big areas or if the same habitat is uniformly managed over the whole country. This has been the case with the semi-natural pastures in Sweden. The rules have in general mostly focused on enhancing the botanical diversity not biodiversity (Söderström et al. 2001). The appearance of the semi-natural pastures has thus been a product of the management requirement of the subsidy. Local knowledge of management and tradition and farmer interest has not been considered. To be able to reach the Swedish environmental objectives we all, farmers, researchers, extension specialist and administrators, have to respect each other and acknowledge the knowledge and interest of the different groups.

Conclusion

Organic farming enhance biodiversity but this effect varies between organism groups and landscapes. Positive effects of organic farming on biodiversity will be more pronounced in intensive than in small-scale heterogeneous landscape. We suggest that more work is focused on the socio-economic unit; the farm. Measures to preserve biodiversity ought to be more landscape-, farm-, and farmer specific than is presently the case.

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Acknowledgement

This work was funded by the Ekhaga foundation, Oscar & Lili Lamm’s foundation and FORMAS. This paper was written while Johan was a visiting PhD-student at University of Nebraska-Lincoln and Kansas State University-Manhattan. We would like to thank Dr. Francis at UNL and Dr. With at KSU for their hospitality.

Biogas from manure – a new technology to close the nutrient and energy circuit on-farm

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Abstract

The Biodynamic Research Institute in Järna developed a two-phase on-farm biogas plant. The plant digests manure of dairy cattle and organic residues originating from the farm and the surrounding food processing units containing 17.7-19.6 % total solids. A new technology for continuously filling and discharging the hydrolysis reactor was developed and implemented. The output of the hydrolysis reactor is separated into a solid and liquid fraction. The solid fraction is composted. The liquid fraction is further digested in a methane reactor and the effluent used as liquid fertiliser. Initial results show that anaerobic digestion followed by aerobic composting of the solid fraction improves the nutrient balance of the farm compared to mere aerobic composting. Composted solid fraction and effluent together contain about 70.8 % of total input nitrogen and 93.3 % of input NH4. The manure that was merely aerobic digested contained about 51.3 % of total input nitrogen and 3.9 % of input NH4. Additionally anaerobic digestion improves the energy balance of the farm producing up to 269 l biogas kg^{-1} volatile solids or 1.7 kWh heat kg^{-1} volatile solids.

Keywords: biogas, compost, nutrients, carbon, anaerobic digestion

Introduction

During the last decade some so called 'dry fermentation' prototype plants were developed for anaerobic digestion of organic material containing 15-50 % total solids (Hoffman, 2001). These plants show added advantages compared to slurry digestion plants: Less reactor volume, less process energy, less transport capacity, less odour emissions. However on-farm dry fermentation plants are not common and rarely commercially available. We assume that lack of tested technical solutions, difficult and time-consuming feeding and discharging, and scarceness of on-site research results are the main reason for low acceptance of dry fermentation technology. Recent on-farm research (Kusch & Oechsner, 2004) and prototype research (Linke, 2004) show promising technical solutions for dry fermentation batch reactors on-farm. This paper reports about an innovative two phase prototype biogas plant. The plant digests continuously manure of dairy cattle and organic residues of the farm and the surrounding food processing units. The two phase reactor technology was chosen for two reasons: First it offers the separation of a solid and a liquid fraction for composting after hydrolysis and secondly the methanisation of the liquid fraction using fixed film technology results in a very short hydraulic retention time, reduction in reactor volume, and higher methane content of the biogas (Lo et al., 1984).

Material and methods

Process A: Manure of a dairy stanchion barn with 65 adult bovine units is shifted by a hydraulic powered scraper into the feeder channel of the hydrolysis reactor. The urine is separated in the barn via a perforated scraper floor. The manure is a mixture of faeces, straw and oat husks. Figure 1 shows the material flow of the biogas plant at the Ytterenby farm.

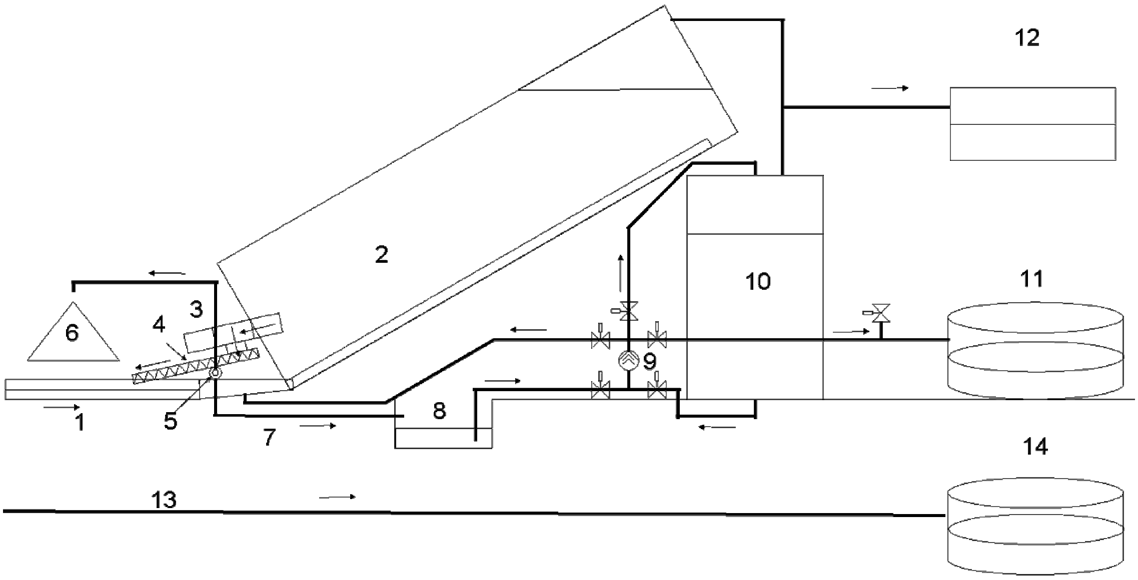

Figure 1. Material flow of the biogas plant at the Yttereneby farm in Järna. 1 feeder channel; 2 hydrolysis reactor; 3 drawer; 4 transport screw; 5 extruder screw; 6 solid fraction; 7 liquid fraction; 8 buffer; 9 screw pump and valves; 10 methane reactor; 11 effluent store; 12 gas sack; 13 urine pipe; 14 urine store

From the feeder channel the manure is pressed via a 400 mm wide feeder pipe to the top of the 30° inclined hydrolysis reactor of 53 m^3 capacity. The manure mixes itself with the substrate sinking down by gravity force. After a hydraulic retention time of about 26 days at 38 °C, the substrate is discharged by a bottomless drawer from the lower part of the reactor. Every drawer cycle removes about 100 l substrate from the hydrolysis reactor to be discharged into the transport screw underneath. From the transport screw the substrate partly drops into a down crossing extruder screw where it is separated into solid and liquid fractions. The remaining material is conveyed back to the feeder channel and inoculated into the fresh manure. The solid fraction from the extruder screw is stored at the dung yard for composting. The liquid fraction is collected into a buffer and from there pumped into the methane reactor with 17 m^3 capacity. Liquid from the buffer and from the methane reactor partly returns into the feeder pipe to improve the flow ability. After a hydraulic retention time of 16 days at 38 °C the effluent is pumped into a slurry store covered by a floating canvas. The gas generated by both reactors is stored in a sack and fed by a compressor to the process heater and the furnace of the estate for heating purposes. We took samples on 3.3.2004 and 6.5.2004 from the input manure, solid fraction, effluent, straw, and oat husks. Total solids and nutrient content was analysed by HS Miljölab Ltd. in Kalmar, Sweden and Novalab Ltd. in Karkkila, Finland. Volatile solids were analysed at the laboratory of MTT/Vakola by heating samples for 3 h at 550 °C. The gas yield of each reactor was measured by a gas meter (Actaris G6 RF1) and the reading was daily recorded. CO2-content of the biogas was measured once by falling out soda in soda lye.

Process B: For the compost trials (10.5.2004-13.8.2004) samples of 50 l manure and 50 l solid fraction from the hydrolysis reactor were aerobically digested at 15 °C in the climate chamber of MTT/Vakola. During the trial period the samples were turned three times and 1.3 l water was added.

Results

Between 15.11.2003 and 8.5.2004 the plant generated 44 m3 biogas d-1 or 283 kWh heat d^{-1} that corresponds to 84 l methane kg^{-1} volatile solids. Mass and nutrient balance is shown in table 1.

Table 1. Mass and nutrient balance of the biogas plant at Yttereneby in Järna. FM Fresh mass; VS volatile solids; Norg organic nitrogen; Nsol soluble nitrogen; Ntot total nitrogen

	FM	VS	N_{org}	N_{sol}	N_{tot}	NH_4	NO_3, NO_2	K	P
	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}	kg d^{-1}
Faeces	1717	99			8.29			6.06	2.01
Straw	27	23			0.14			0.61	0.04
Oat husks	257	218	0.55	0.02	0.56		0.018	1.13	0.20
Sum input	2000	340	7.36	1.64	9.00	1.34	0.242	7.80	2.25
Process A: anaerobic digestion of 2000 kg d^{-1} manure									
Solid fraction	919	243	3.26	0.69	3.95	0.63	0.056	2.85	0.76
Liquid fraction	1025	41	2.15	1.44	3.79	1.23	0.205	3.49	0.81
CO_2	34								
CH_4	20.8								
Vapour	1.15								
Sum output	2000	284	5.41	2.13	7.74	1.86	0.261	6.33	1.57
Compost of solid fraction	398	96	2.51	0.04	2.55	0.02	0.020	2.89	0.64
Compost and effluent	1424	137	4.66	1.48	6.34	1.25	0.225	6.37	1.45
Losses	576	203	2.70	0.16	2.66	0.09	0.017	1.43	0.80
Process B: aerobic compost of 2000 kg d^{-1} manure									
Compost	872	160	4.51	0.11	4.62	0.05	0.061	5.93	1.74
Losses	1128	180	2.85	1.53	4.38	1.29	0.181	1.87	0.51

More than 70 % of the volatile solids originate from oat husks and straw. About 70 % of the total solids of the manure remained in the solid fraction and after composting the solid fraction we measured about 38 % overall dry matter losses in process A. In contrast, during process B, up to 47 % of total solids in the manure escaped into the atmosphere. Carbon losses of processes A were about 47 % of which 14 % were bound in the biogas but more than 57 % in process B. Total nitrogen losses exceeded 48 % in process B and more than 29 % in process A. Similar values we found for NH4 and NOx: 6 % losses in process A versus 96 % in process B and 7 % versus 74 % respectively. Potassium and phosphorus losses in both processes ranged between 18 % and 36 %.

Discussion

The biogas yield measured is in accordance with common slurry biogas plants on-farm although the biogas production potential measured in laboratory is up to three times higher (Lo, 1998, Linke, 2004, Møller et al., 2004). Nitrogen losses are reduced compared to mere aerobic digestion, a fact that is known also from slurry biogas plants (Möller, 2003). Further the prototype biogas plant in Järna provides good compost. Additionally anaerobic digestion improves the energy balance of the farm. The results cannot yet be statistically confirmed because there are up to now mean values of only two measuring days on-farm available.

Conclusions

Anaerobic digestion of manure and organic residues followed by composting the dry fraction of the hydrolysis reactor improves the energy and nutrient balance on-farm. Appropriate new technology as used at the prototype biogas plant in Järna is a key factor. To confirm the present results more measurements are necessary. The optimisation of the plant in respect of hydraulic retention time and load rate may lead to higher gas generation but requires an improved measuring technique. Thereafter an economic evaluation is necessary to assess the competitiveness of the new technology.

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Learning in Switching to Organic Farming

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Abstract

Organic farming technology may be relatively unknown to farmers at the time when they switch from conventional into organic farming. Therefore, experience gained over time and learning by doing may be important determinants in the efficiency of organic farming. It may also take time to reach the optimal nutrient stock of soil and optimal nutrient supply for arable crops under organic farming. This paper estimates technical efficiency of organic and conventional dairy farming and its development over time. We control for possible selection bias and regional heterogeneity. The results suggest that technical efficiency measured as a ratio between actual and maximum obtainable output (relative to the peer group) at first diminishes when the conversion towards organic production starts. After 6-7 years from the switch, technical efficiency starts to increase again. The estimates signal that the length of the conversion and learning process of organic farming is relatively long.

Keywords: technical efficiency, output distance function, stochastic frontier

Introduction

Organic farming methods are relatively unknown to farmers when they switch to organic farming. .Ricci Maccarini and Zanoli (2004) found that organic livestock farms were technically less efficient compared to the common production frontier but more efficient compared to their own frontier. They suggest that this lower average performance may partially be explained by underestimated difficulties related to conversion from conventional to organic production. However, it may be possible to observe learning effects, which may take several forms: technical change may be different on organic and conventional farms but also the technical efficiency may change over time in a different way. Learning-by-doing literature suggests that education and management experience can lead to productivity gains when the knowledge increases with the results of experiments (Arrow 1962). There are several studies that have assessed the effect of experience on technical or allocative efficiency. Kumbhakar et al. (1991) and Rougoor et al. (1998) have used age, experience and education when describing the ability of the farm manager. Reinhard and Thijssen (1999) added milk output per cow as an explanatory variable, although it is at the same time an indicator of different feeding strategies. Stefanou and Saxena (1988) used age and experience as explanatory variables of varying price distortions. Kumbhakar and Bhattacharrya (1992) applied years of education and farm size for the same purpose.

This paper measures and compares technical efficiency of organic and conventional farms and tests for the presence of learning effects in organic farming, i.e. whether organic farmers are able to increase their technical efficiency as they gain experience with organic farming. We assume that the farmers choose organic or conventional production because they benefit from the choice. Possible selection bias between organic and conventional production can be taken into account applying Heckman’s (1979) two step procedure.

Data and model

The dairy farm data are collected from bookkeeping farm data base of MTT Economic Research. The data include a detailed production and cost data of panel farms for the period from 1995 to 2002 (8 periods). The data are an unbalanced panel of 279 farms. The total number of observations is 1921, the number of organic farms being 49 (159 observations). Only part of the farms classified as organic dairy farms produce organic milk since the classification to organic and conventional farms is based on subsidies paid for organic crop production. The experience of organic farmers in organic farming varies between 1-11 years.

In the analysis we apply two outputs (milk and other output) and five inputs (labour, land, energy, material and capital). Milk (liters), labour (hours) and land (hectares) are measured in physical units per farm. Other output, energy, material (fertilizers, seeds, purchased feed) and capital inputs per farm have been derived from their monetary values using respective aggregate indices as prices. Capital input is measured as the sum of machinery and building capital stock. Organic farms are on average statistical significantly larger than conventional when measured by the arable land area and the number of animal units. However, their average milk output per farm is 10 percent smaller than the output of conventional farms. The other output is significantly larger on organic farms indicating that their production is more diversified. Assuming a translog specification where technical change is represented by a time trend, the output distance function can be written as (see e.g., Coelli et al. 1999):

$$-\ln y^{t}_{oi} = \beta_0 + \sum_{k=1}^{5}\beta_k \ln x^{t}_{ki} + \sum_{k=1}^{5}\beta_{kD} D_D \ln x^{t}_{ki} + \tfrac{1}{2}\sum_{k\le}^{5}\sum_{j=1}^{5}\beta_{kj}\ln x^{t}_{ki}\ln x^{t}_{ji} + \beta_m \ln y^{t}_{mi}$$

$$+ \tfrac{1}{2}\beta_{mm}\ln y^{t}_{mi}\ln y^{t}_{mi} + \sum_{k=1}^{5}\sum_{m=1}^{1}\beta_{km}\ln x^{t}_{ki}\ln y^{t}_{mi} + \beta_t t + \beta_{tD} D_D t + \tfrac{1}{2}\beta_{tt}t^2 + \sum_{k=1}^{5}\beta_{kt}\ln x^{t}_{ki} t$$

$$+\beta_{mt}\ln y^{t}_{mi} t + \sum_{r=2}^{7}\beta_r D_r + \beta_{IMR} IMR + u_{it} + v_{it}, \text{ where} \qquad (1)$$

$y^t_{oi} = milk\ output,\ y^t_{mi} = other\ output / milk\ output, x^t_{ki} = labour, land, energy, materials\ and\ capital\ input, t = time\ trend, D_r = regional\ dummy, D_D = organic\ dummy, IMR = inverse\ Mill's\ ratio, \beta = estimated\ regression\ coefficients.$

Subscript i refers to a farm and superscript t to a time period. Neutral technical change is specified as a time trend. Biased technical change is defined by interactions of time trend and respective inputs and outputs. A full translog model includes second order and cross terms of inputs and outputs. Production potential of different regions and technologies (organic vs. conventional in a pooled model) was taken into account by regional and organic dummies. Inverse Mill's ratio (IMR) was also introduced in the separate organic and conventional farming models to capture possible selection bias. The error term is decomposed into two components. The first component, vit, is a standard random variable capturing effects of unexpected stochastic changes in production conditions, measurement errors in milk output or the effects of left-out explanatory variables. It is assumed to be independent and identically distributed with N(0, σ_v^2). The second component, uit, is a non-negative random variable, associated with the technical (output) inefficiency in production, given the level of inputs. The uits are independently distributed with a truncation at zero of N(μ_{it}, σ_u^2), where μ_{it} is modelled in terms of determinants of inefficiency as follows (see Battese and Coelli 1995):

$$\mu_{it} = \delta_0 + \delta_{\exp} Exp + \delta_{\exp^2} Exp^2 + \delta_{age} \ln(Age) + \delta_{age^2} \ln(Age)^2 , \qquad (2)$$

where Exp and Exp2 refer to first and second order terms of years of experience in organic farming. ln(Age) and $\ln(\text{Age})^2$ refer to the first and second order logarithmic terms of farmer's age. The δ :s are regression coefficients of respective efficiency effects. The inefficiency effects part of the equation makes it possible to test whether technical efficiencies differ by experience and age. Estimations are performed by Frontier 4.1 (Coelli, 1996).

Results

Pooled and separate models for organic and conventional farm data were estimated. In some separate models selectivity bias was significant. The differences in elasticities (a relative increase in output obtained by a relative increase in input) and returns to scale (RTS; as elasticity but it measures the effect of a relative increase in all inputs) between conventional and organic farms are fairly small. The share of the other output is on average larger on organic than on conventional farms indicating that organic farms are less specialized. Results are mixed for labour but for land the elasticity tends to be larger on organic farms. The elasticity of energy is low in all models but it tends to be larger on organic farms. Over time distance elasticities evolve in a similar manner in both groups: elasticities of labour and energy are decreasing but elasticities of materials and capital are increasing. The elasticity of land decreases or remains the same. In almost all models the average RTS is slightly larger than one indicating increasing returns to scale. In general, RTS is slightly decreasing over time but in the group of organic farms the annual variation is larger. Technical change tends to be slightly faster on organic than on conventional farms. In all models technical change is slowing down over time. The pattern of changes in technical efficiency is similar in all models of conventional farms. On these farms technical efficiency at first increases from 1995 to 1996 but starts then to diminish. In 2001 the level of technical efficiency is the same as in 1995 but in 2002 it again slightly increases. Organic farms are on average less efficient in each year. In 1996 the gap is the smallest.

In the pooled data technical efficiency is on average 10 percentage units higher on conventional (0.813) than on organic farms. The confidence intervals of technical efficiencies calculated following the procedure presented by Battese et al. (2000) show that even ten percentage unit's differences in average efficiencies of the groups are not statistically significant at the critical 5 percent level. In our case the distributions of efficiencies in models of conventional farms are almost exactly similar. In the group of organic farms the differences are bigger between models but the general feature is that the whole distribution has moved downwards when compared to the group of conventional farms.

We could observe significant learning-by-doing/adjustment effects in conversion to organic farming. According to our analysis, technical inefficiency increases at first after the switch to organic farming. Inefficiency increases for several years reaching the peak after five to six years. According to our estimates, inefficiency starts to diminish after 6 – 7 years of experience in organic farming.

Conclusions

Although the data suggest learning effects related to the experience in organic farming, differences in the development of organic and conventional farm groups were small. In our sample organic farms are less technically efficient even compared to the organic frontier than conventional farms compared to the conventional frontier indicating that the variation is larger. This result contradicts Oude Lansink et al. (2002) and Ricci Maccarini and Zanoli's (2004) observation that the variation in technical efficiency is smaller in the group of organic farms. The difference is probably caused by a different evaluation method and/or target group. Our result indicates that organic production is more risky but it may also be partially caused by the sample where we had to include all organic dairy farms to guarantee the sufficient number of observations. Organic farms do not necessarily produce organic milk but the conversion may only concern arable farming. The results suggest that temporary premium schemes over a certain conversion period are justified in promotion of organic farming. The result also suggests that this conversion period takes for a fairly long time.

Conventional production seems to be more technically efficient, i.e. more productive when only conventional inputs and outputs are taken into account. However, we have not considered possible external effects on the environment or landscape. These considerations might affect the relative performance of different production systems.

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Studies in environmentally friendly plant protection in Estonia

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Abstract

52 species of polyphagous predators – carabids - were identified in different crops. Specimens from genera *Pterostichus, Harpalus, Amara* and *Bembidion* were dominating in all crops but species composition and abundance depended on location and crop. The positive impact of winter crops and diverse field boundaries on carabids was discovered. The plant protection properties of extracts of more than 60 different plants were studied. Extracts of Heracleum sosnowskyi, Artemisia absinthium, *Melissa officinalis, Artemisia vulgaris, Rheum rhaponticum, Tanacetum vulgare* and *Achillea millifolium* are effective in different ways against greenhouse pests, the Colorado potato beetle and the cabbage butterfly. The insecticidal activities of plant extracts were strengthening by synergetic effects evoked in certain mixtures of extracts. Commercial plant preparations NeemAzal T/S and Neko are effectively regulating greenhouse pests.

Keywords: carabids, field crops, intercropping, plant extracts

Introduction

For avoiding plant damages by pests it is important to keep balance between pests and their natural enemies. The ground beetles – carabids - constitute a rich and abundant group in arable sites and are active during whole vegetation period (Kromp, 1999). As generalist predators they are regulating the populations of several pests (aphids, different insect larvae etc) (Hokkanen & Holopainen, 1986; Kromp,1999; Büchs, 2003). For the estimation of the role of carabids in different agrocoenosis, it is important to know their species composition and abundance. Therefore since 1998 in Estonia the carabid fauna was investigated on farms in different crops - barley, oats, clover, potato, wheat, rye, oilseed rape, raspberry, strawberry intercropping and carrots – beans intercropping. In organic plant protection the natural plant compounds can be used as plant strengthening factors – making plants less atractive or killing pests in diffent ways. For that purpose more than 60 different plants were studied and the plant protection properties of their extracts were evaluated. Also the effects of some commercial plant preparations (NeemAzal T/S, Neko) on insects were estimated.

Materials and methods

The pitfall traps were used for the collection of carabids in different crops:
field crops´ fields (barley, clover, wheat, oats, rye, oilseed rape) (Eenpuu & Luik, 1999, Tarang & Luik, 2001; Tarang et al, 2004),
a raspberry plantation (Arus & Luik, 2000),
a strawberry intercropping plantation with different side cultures - *Allium sativum, A. shoenoprasum*, and *A. fistulosum* (Tarang & Luik, 2000) ,
a carrot - garden beans intercropping (Luik et al,2000).
The influence of water or alcohol plant extracts and commercial plant preparations were tested in different objects - two spotted spider mite , greenhouse whitefly, aphids , thrips ,

cabbage butterfly and the Colorado potato beetle (Luik,1997; Hiiesaar et al, 2000, 2001; Kuusik et al, 2000; Luik et al, 2001, Luik & Viidalepp, 2001; Metspalu et al, 2001).

Results and discussion

52 species of carabids were identified in different crops in total. In all crops specimens from genera *Pterostichus, Harpalus, Amara* and *Bembidion* were dominating but species composition and abundance depended on location and crops. In organic barley field the carabid abundance was 3.8 times higher in Lauri Antsu farm in Western Estonia than in Hartsmäe farm in Southern Estonia. In field crops the number of carabids was significantly lower on potato field than in cereals and clover because in potato carabids life cycles and movement were interrupted by mechanical treatments. In potato fields the specimens of Bembidion were dominating. In the cereals´ and clover fields the specimens of genus Pterostichus were highly dominating, whereas *P. cupreus* and *P. vulgaris (melanarius)* were prevailing. In fields located side by side they were accordingly 1.5 and 2.4 times more abundant in organic barley field than in conventional ones. Their abundance was higher in winter crops and especially in the field parts which were bordering on other winter crop. For example in Puki organic farm in winter oilseed rape field in the part with winter wheat margin carabids number was 1.4 times higher than in field centre and 31 times higher than in part bordering with gravel road. In Tali organic farm in barley field part bordering on ditch edge and covered with diverse plant coenosis the number of the *P. cupreus* was three times and total number of carabids two times bigger than in field part bordering on cultural hay. With undersowing of clover to oats the abundance of carabids was growing 1.3 times but the number of aphids decreased 10 times in oats. The clover was acting in dual ways - repelling aphid colonization and offering new conditions for carabids. In the 16-year-old raspberry plantation *Pterostichus spp* and *Harpalus spp* of carabids were dominating. The occurrence of carabids and damage of Butyrus domentosus did not differ in six different raspberry cultivars. In strawberry the intercropping with different side cultures - *Allium sativum, A. shoenoprasum,* and *A. fistulosum* - did not significantly influence on the occurrence of carabids and phytophagous insects in two cultivars. There was a tendency that the number of dominant carabids - genera *Pterostichus, Harpalus* and *Amara* - was depending on strawberry cultivar. During three study years the number of carabid species´ increased from 21 to 36 and their higher abundance was established in ´Red Countlet´ than in ´Jonsok´ beds. That was correlated with higher abundance of polyphagous sucking generalists as cicadina and leaf bugs in´Red Countlet´ plants. Only slight tendences appeared for increase of sucking insects in intercropped variants in comparsion with control variant. The number of phytophagous strawberry specialists was very low during whole investigation period. The side crops did not have significant influence on the yield, the average yield per strawberry plant was significantly higher in ´Jonsok´ plants than in ´Red Countlet´ plants. In carrots and garden beans intercropping experiment was surrounded by other crops and the smallest number of carabids - only 19 species - were found. Dominant species´ were *Harpalus spp* and *Amara spp*. Carabids were more abundant in carrots, mulched with fresh coniferous saw dust, growing in 3 meter rows in garden beans. In this cultivation type the percentage of damaged carrots by carrot rust fly as well as carrot psylla was the lowest . So, in all studied Estonian crops carabids can play a certain role in pest regulation while the survey has shown the presence of quite diverse and numerous carabids´ populations. The further studies in carabids have been aimed at understanding their behavioural reactions for finding ways to attract them more to crops.

Extracts of more than 60 local plant species were tested for insecticidal properties. The plants with repellent or deterrent or toxic properties were established. Extracts of *Heracleum*

sosnowskyi, Artemisia absinthium, Melissa officinalis, Artemisia vulgaris, Rheum rhaponticum, Tanacetum vulgare, and *Achillea millifolium* were the most effective. They had different modes of action which varied depending on the test object. The treatment with *H. sosnowskyi* extract was killing more than 70% of greenhouse whiteflys, aphids, Colorado potato beetle larvae and cabbage butterfly caterpillars. The extracts of *Artemisia absinthium* and *Tanacetum vulgare* inhibited the feeding, oviposition had direct toxic effect in greenhouse whitefly. All the tested extracts had a polyfunctional influence on cabbage butterfly, they were acting as oviposition and feeding deterrents and also intoxicated caterpillars via food, as well as in a contact way. Against cabbage butterfly the most effective extracts were *Artemisia absinthum, Matricaria inodora, Tanacetum vulgare, Rheum rhaponticum* and *Lycopersicum esculentum*. Practically with the treatment of cabbage plants with extracts it is possible to influence oviposition of butterflies as well as the survival of caterpillars (Luik et al, 2001). The further investigation has shown that it is possible to enhance the insecticidal activities of plant extracts by the synergetic effects evoked in certain mixtures of these extracts. For example, the effectiveness of absinthe water extract on greenhouse whitefly, tobacco thrips and two- spotted spider mite was significantly increased from nearly 50% to 80-90% by combining the extract with a pine shoot extract at a mixing ratio of 1:1. The behavioural reaction of the pests due to the deterrent/or repellent effects was also synergised by mixing absinthe and pine shoots extracts (Kuusik et al, 2000). It is important to take into account the fact that the plant extract influence can be dependent on the insect host-plant. The extract of *Allium sativum* evoked strong deterrent actions on whitefly only on the tomato cultivar ´Holland´ and did not on the ´Mato´. That can be caused by difference in allelochemicals of the tomato varieties (Hiiesaar et al, 2000).
From commercial plant preparations NeemAzal T/S (1% azadirachtin A, Trifolio-M) caused high mortality in two- spotted spider mite and some insects-*Aphis gossypii* and *Thrips tabaci*. In larvae of Colorado potato beetles it had poyfunctional effects: direct toxic action, the prolonged development of larvae and failures in morphogenesis due to interfering in hormonal regulation (Hiiesaar et al., 2000). In cabbage butterfly NeemAzal T/S had a deterring effect for feeding and was poisoning of caterpillars via food and in a contact (Luik & Viidalepp, 2001). The natural preparation Neko (Finnish firm OY Neko AB, containing compounds from pine, sage, tansy and lavender) caused higher mortality than NeemAzal T/S in greenhouse whitefly, tobacco thrips and two- spotted spider mite (Hiiesaar et al, 2001).

Conclusions

In organic crop rotation generalist predators – carabids - are promoted by winter crops and diverse field margins.
Certain plant extracts, their synergistic mixtures and some commercial plant preparations can effectively regulate pests´ populations.

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Acknowledgements

Studies were partly supported by the Estonian Science Foundation grant no 5736

Importance of Nematodes in Organic farming

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Abstract

Soil nematodes are important components of soil ecosystems, but have so far received little attention in organic farming. Many free-living nematodes are important for decomposition and mineralization processes, and it is estimated that the nematode grassing of bacteria would mobilise up to 124 kg N $ha^{-1}yr^{-1}$. Furthermore, their feeding activities on the rhizoplane may reduce microbiological immobilisation of nitrogen. In organic farming the use of clover and other nitrogen fixating legumes is important for securing appropriate nitrogen levels. Clover is an excellent host for a wide range of plant parasitic nematodes. In organic farming damage has so far been reported for root lesion nematodes (*Pratylenchus spp*,), clover cyst nematode (*Heterodera trifolii*) and the northern root knot nematode (*Meloidogyne hapla*). Nematode monitoring is a prerequisite for management. Effective control measures of plant parasitic nematodes and good management systems for beneficial nematodes would allow for increasing yields and improved quality. Organic farming puts new challenges to the science of nematology, and would profit from a close interaction between nematology and soil science.

Keywords: free-living, plant parasitic, nematodes, ecosystem processes

Introduction

Organic farming seeks to build up the reserves of nutrients in the soil while at the same time reducing inputs. Soil microorganisms are the essential link between the mineral nutrient reserves and the plants. Soil nematodes are important components of the soil ecosystem. Microbivorous and predatory nematodes may enhance the rate of mineralisation, while plant parasitic nematodes seriously affect plant health and reduce the yield and quality of crops. In this paper we want to draw the attention to the roles of nematodes in organic farming.

Nematodes in general

Nematodes are worm-like animals, which inhabit almost every niche available in nature, and are the most numerous multicellular animals on earth. Soil nematodes are microscopic and their population densities may reach millions of individuals per m^2. The morphology of the nematode stoma often indicates the food preferences and makes it possible to distinguish between different ecological groups like bacterial-, fungal- and plant feeders, omnivores and predators.

Beneficial nematodes

Bacterial feeding nematodes have a higher carbon:nitrogen (C:N) ratio than bacteria (Ferris et al. 1997), and consume therefore more N than is required for the maintenance of their body structure (assimilation). The excess nitrogen is excreted as ammonia/ammonium, urea, peptides and amminoacids (Thompson & Geary 2002). The assimilation of bacterial feeding nematodes is between 30-60 % of the consumption (Sohlenius, 1979), and it is estimated that the nematode grassing of bacteria would mobilise19-124 kg N $ha^{-1}yr^{-1}$ (Anderson et al. 1981)

for uptake by plants and by microbes. In the presence of a suitable carbon source bacteria may out-compete plant roots for N, resulting in a microbiological immobilisation of N on the surface of growing root tips. By grassing on rhizoplane bacteria, nematodes may liberate N of bacterial cells and again make it available to plant roots.
Fungal-feeding nematodes have a C:N ratio closer to that of their food source. However, for nematodes of both feeding habits the grazing activity stimulates the growth and metabolic activity of the microflora (Trofymow & Coleman, 1982, Griffiths, 1994, Wasilewska et al. 1975). Predatory nematodes contribute to nitrogen mineralization by feeding on other nematodes. Under field conditions bacterial feeding nematodes and predatory nematodes are estimated to contribute to 8% and19% of the nitrogen mineralization in conventional and integrated farming systems respectively (Beare, 1977).
Nematodes respond rapidly to changes in their environment. Increased microbial activity first leads to an increased proportion of opportunistic bacterial feeders, which later are followed by general opportunists, which include fungal feeders and slower growing species of bacterial feeders (Bongers & Ferris, 1999). This succession is important for the decomposition of soil organic matter and mineralization of plant nutrients (Ingham et al. 1985, Hunt et al. 1987). The faunal composition may mirror the activity of decomposition pathways and give indications of nutrient status and fertility of soil (Bongers & Ferris, 1999).

Harmful nematodes

Out of the 20 000 nematodes described today some 4000 species are parasites of plants. The major characteristic of plant parasitic nematodes is the presence of a mouth spear (stylet), which is used to puncture plant cell walls, and inject nematode secretion, which changes plant physiology and facilitates food up-take by the nematode. Some species feed only on the outer tissue of the root (ectoparasites), others penetrate more deeply (migratory endoparasites), and some completely enter the host inducing the formation of a permanent feeding site (sedentary endoparasites) (Table 1).
Above-ground symptoms
Symptoms are similar to those resulting from many kinds of root injury, lack of nutrients or inadequate plant nutrition. Growth is stunted and weak and attacked plants wilt readily in dry weather. Symptoms usually appear in patches, which increase over time.
Below-ground symptoms
Root symptoms include stunting of roots, root lesions, reduced or excessive proliferation of lateral roots, forked or fanged roots and root galls, Damaged roots are often dark in colour. Fungi and bacteria which cause root rots, wilts, and other plant diseases often infect nematode-damaged roots earlier and more severely than uninjured roots (Back et al. 2002, Khan, 1993).
Important plant parasitic nematodes
In organic farming the use of clover and other nitrogen fixating legumes is important for securing appropriate nitrogen levels. Some plant parasitic nematodes of potential importance on crops in the Nordic area are presented in table 1, together with some crops, which are relevant to organic farming. Clover is an excellent host plant for many plant parasitic nematodes. The stem nematode (*Ditylenchus dipsaci*), the root lesion nematodes (*Pratylenchus spp*.) and the clover cyst nematode (*Heterodera trifolii*) are a few examples of potentially damaging species which could reach high populations in cropping systems with clover (Holgado & Magnusson, 2000). Plant parasitic nematodes also have been reported to interfere with the formation of *Rhizobium* nodules in various leguminous plants (Khan 1993).
So far, few studies have been made on the importance of plant parasitic nematodes in organic farming. Observations in Germany, however, demonstrate that problems with plant parasitic

nematodes may arise after a 5 years period (Hallmann et al. 2004). Especially nematodes with broad host spectra, such as *Meloidogyne hapla* and *Pratylenchus spp*., can cause severe damage occasionally leading to almost a total loss of the crop. In Denmark, Møller & Søegaard (2004) have demonstrated the involvement of clover cyst nematode (*Heterodera trifolii*), in the ”clover-tired soil” syndrome.

Table 1. Examples of some crops and some plant parasitic nematodes likely to cause economic damage in organic farming in the Nordic area.
E = ectoparasite; M = migratory endoparasite; S = sedentary endoparasite.

Cereals	Stunt nematodes	*Tylenchorhynchus spp.*	E
		Merlinius spp.	E
	Root lesion nematode	*Pratylenchus spp.*	M
	Cereal cyst nematode	*Heterodera avenae*	S
	Rye cyst nematode	*H. filipjevi*	S
Clover	Stem nematode	*Ditylenchus dipsaci*	M
	Root lesion nematode	*Pratylenchus spp.*	M
	Clover cyst nematode	*H. trifolii*	S
Potato	Potato rot nematode	*Ditylenchus destructor*	M
	Root lesion nematode	*Pratylenchus spp.*	M
	Potato cyst nematode	**Globodera rostochiensis**	S
		G. pallida	S
Sugar beet	Stubby root nematodes	*Trichodorus spp.*	E
		Paratrichodorus spp.	E
	Beet cyst nematode	*H. schachtii*	S
Carrot	Pin nematode	*Paratylenchus bukowinensis*	E
	Stubby root nematodes	*Trichodorus spp.*	E
		Paratrichodorus spp.	E
	Carrot cyst nematode	*H. carotae*	S
	Northern root knot nematode	*Meloidogyne hapla*	S
Strawberry	Leaf nematodes	*Aphelenchoides fragariae*	M
		A. blastophthorus	M
	Root lesion nematodes	*Pratylenchus spp.*	M
	Needle nematode	*Longidorus elongatus*	E

Nematode control

The aim of control measures should be to keep plant parasitic nematode at densities below their economic threshold for damage. Nematodes need to be monitored on a regular basis. Control measures include hygiene, black fallow, crop rotation (with poor host plants between main crops), trap crops, resistant cultivars, weed control, soil conditioning (soil amendment), soil steaming and biological control. It is likely that good management strategies for nematodes would allow for increased yields and better sustainability of organic cropping systems.

Conclusion

The occurrence of plant parasitic nematodes in organic farming systems needs to be investigated further, and the reaction of these nematodes on cultural practices would provide valuable information for management routines. Organic farming obviously puts new and exciting challenges to the science of nematology in that the management systems also need to maintain and improve the environment for the important beneficial nematodes. Organic farming would profit from a close interaction between nematology and soil science.

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Mechanical weed control in vegetables

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Abstract

Weed harrowing and torsion weeding performed at two development stages has been investigated in onion, carrot, red beets, dill and common bean in Sweden. Weed control effect, yield and hand weeding time to obtain a weed free plot were measured. The results implicate that torsion weeding can be used in common beans and most likely in carrots and red beets. In onions, additional weed control methods such as flaming at emergence needs to be included in order to achieve a satisfying effect. Dill does not respond to harrowing and torsion weeding as clear as the other crops.

Keywords: weed harrowing, torsion weeding, red beets, onion, carrot, dill, common bean

Introduction

Modern agriculture has developed a wide range of cropping techniques and tools to control annual and perennial weeds. To generalise, the weed problem in cereal production is not as problematic as in row-grown vegetable crops. This is due to the fact that e.g. carrots and onions are highly sensitive to weed competition compared to wheat or rye. A field sown with carrots that is left unweeded will not results in any marketable yield.

Although scientists and commercial companies worldwide struggle to develop methods and machines to control weeds in vegetable production, many farmers – especially organic – needs to use hundreds of hours of hand labour in order to keep the fields weed-free. Two methods that we use in cereal production and row-crop production are especially interesting due to their high efficacy, measured either as treated area per hour (weed harrowing) or accurate weed control capability (torsion weeding). We have however, only begun to investigate these methods in vegetables crops. The main reason for this is, i) a general belief among farmers/scientists that these methods are damaging the crop, ii) experimental problems to investigate these methods and iii) lack of funding for project with unpredictable results.

This project has studied weed harrowing and torsion weeding in common beans, dill, oil-seed rape, red beet, sugar beets, carrot and direct-seeded onions. Parts of the results are shown and discussed in this paper.

Materials and methods

The chosen crops using standard cultivars were sown at the Torslunda Experimental Station for Horticultural Research and treated when they had reached a specified development stage (tab. 1). Five types of treatments had been selected for this experiment where treatment 3 can be considered as a standard weed control system which all farmers can carry out.

Treatment 1 – an early start with weed harrowing followed by row cultivations
Treatment 2 – a late start with weed harrowing followed by row cultivations
Treatment 3 – standard row cultivation (Hatzenbichler row-cultivator with duck-foot shares)
Treatment 4 – an early start with row cultivation in combination with torsion weeders
Treatment 5 – a late start with row cultivation in combination with torsion weeders

A spilt-plot design with four replicates was used. Each main plot consisted of 15 rows 6 meter long. This plot was divided into 5 sub-plots used for the five different treatment strategies.

Table 1. Development stage of the crop at first treatment time.

Crop	Development stage	
	Early start	Late start
Dill	3 true leaves	<5 true leaves
Carrot	2-3 true leaves	4-5 true leaves
Red beet	2 true leaves	4 true leaves
Dry bean	1-2 true leaves	2-4 true leaves
Onion		

Annual weeds were assessed before and after treatment. The time for hand weeding of each plot to achieve a weed-free stand was measured. Each plot was harvested either in autumn or at a time suitable for the specific crop.

Results

The weed control effect of the different treatments varied considerably. As an example weed harrowing in common beans did not results in any weed control while a late start of torsion weeding (treat. 5) resulted in about 90 % effect. For carrots the effect of the harrowing operations were about 37 % (early start) and 20 % (late start) while torsion weeding resulted in 66% (early start) and 56% (late start). Input of manual labour to control the weeds could also vary considerably; in beans treatments 1-5 demanded about 60, 71, 59, 16 and 18 hours per hectare respectively. For carrots the five treatments (1-5) needed 127, 127, 155, 77 and 88 hours per hectare respectively to become weed-free.

Based on yield and input of manual labour the amount of working hours per ton yield was calculated as a measure of effectiveness (tab. 2 partial data presented).

Table 2. Manual weeding time (h) per ton harvested product

Treatment	Crop				
	Carrot	Onion	Bean	Red beet	Dill
Standard row cultivation	2.3	7.5	31	7.8	5.2
Early harrowing	1.9	7.9	30	9.3	5.9
Early torsion weeding	1.0	4.5	10	4.1	5.1

Discussion

It is obvious that there is an interaction between crop and weed control method. This can be illustrated by the difference in effect between carrots and dill. A standard row cultivation in carrots resulted a demand of 155 working hours for manual weeding while a treatment with torsion weeder reduced this manual labour to 77 hours per hectare. We could thus lower the input of manual hand weeding to about 1 hour per ton harvested product. As a contrast dill did not seem to respond to the treatments as obvious as carrots. Standard row cultivation didn't statistically require more hand weeding time per ton yield compared to a system using torsion weeding. In that sense introduction of a new weeding technique didn't pay back.

For beans torsion weeding seems to be an interesting methods for weed control. Compared to a standard row cultivation and 72 h hand weeding per ha the torsion weeders lowered hand weeding time to 16-18 hours per ha or 10 hours per ton yield. Harrowing could also be used but required more input of hand weeding. Measuring effectiveness as input of manual labour per ton yield can be interesting in a farmers' perspective. Again, using the common beans as an example this measurement shows that torsion weeding results in less need for manual labour (costs for manual labour) although the yield in this case was somewhat higher in plots using the other treatments.

Conclusions

The results of the project show an interesting potential for weed harrowing and torsion weeding in vegetable crops, which in general are believed to be sensitive to mechanical weed control. It is obvious that torsion weeding can be used in common beans and most likely in carrots (provided they are seeded as single rows) and red beets. In onions, torsion weeding needs to be assisted by flaming at emergence. Dill do not respond to harrowing and torsion weeding as clear as the other crops. However, an improved mechanical weed control did lower the need for manual labour to 59 hours compared to 93 hours in the standard system.

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Acknowledgements

The project is funded by the Swedish University of Agricultural Sciences programme"Ekoforsk". The field experiments have been carried out at the Torslunda Experimental Station for Horticultural Research, SUAS. I am grateful to the staff of the station for their professional work.

Intra-Row Weed Control by use of Band Steaming

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Abstract
Soil disinfection by steam is a well-known technique used within horticulture and market gardening. The most common steam application technique is sheet steaming, where the soil is covered with a thermo resistant sheet, which is sealed at the edges and then blowing steam under the sheet so that the steam penetrates through the soil. When the desired soil temperature is reached, the equipment is moved stepwise forward over the area to be treated. The method is effective for control of weed, plant pathogens and nematodes, and it represents a viable alternative to the use of pesticides. However, high fuel consumption and low capacity are serious disadvantages. Moreover all living organisms, harmful and useful, in the treated soil are killed, and therefore the method is not in line with the basis ideas of organic farming.

A new concept and technique for band heating by use of steam has been developed. By heating only a narrow band around the rows to a depth of 5cm, and by optimising the implement control, energy savings of more than 90% can be achieved, compared with a full steaming of the entire soil surface. By this method only a minor part of the soil is affected. The aim has been to develop a machinery system for thermal soil treatment by steaming in close bands covering the crop rows, only. Focus has been at optimization of the technical application for minimum energy consumption and at the same time effective weed control in the intra-row area. Weed control in the area between the rows will be achieved by means of precisions hoeing. The project has included establishment of a laboratory test rig for detailed analyses of the thermal processes involved as well as development of a prototype machine to be used for field trials. An important subject has been the design and construction of application for effective and controlled penetration of the steam in the soil. The effect on the microbiological life in the soil has also been investigated.

Treatment of soil samples containing weed seeds
The purpose of the soil sample steaming was to study the effect on the weed seeds when different soil types with varying water contents were exposed to steaming. Figure 1 shows an example of soil temperature after treatment in the test rig.

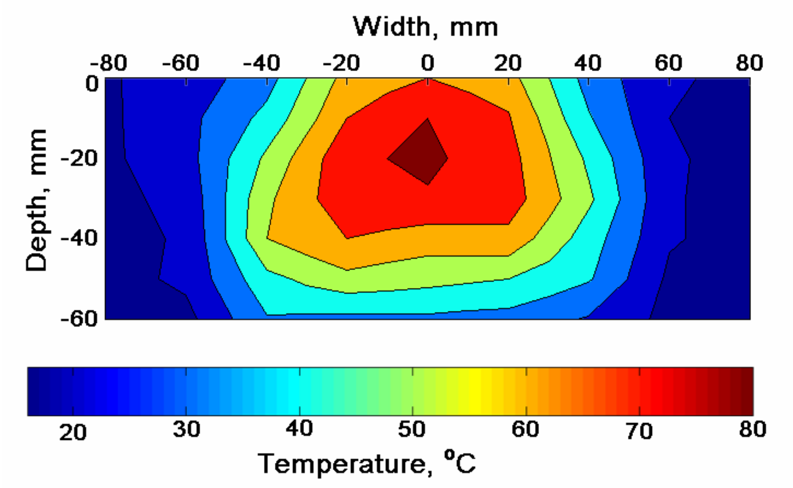

Figure 1. Soil temperatures from a cross-section across the groove, measured 40 sec. after treatment. The width is measured from centre of the treated band. Treated area: With –30 - +30, depth 0 - 50 mm.

The results of the germination tests show that at a temperature of about 65–70°C the weed seeds generally lose their ability to germinate (figure 2). From a technical point of view, this means that the control system for field application has to ensure that the temperature in the processed soil band uniformly reaches at least 70°C. Higher temperatures mean a loss of energy, especially if they rise to above 90°C, when evaporation of soil water starts to take place. In subsequent field trials, increased effects on weed germination were observed at increasing treatment temperatures up to about 90°C. This may be due to uneven heat distribution in the soil and higher heat loss to the surroundings.

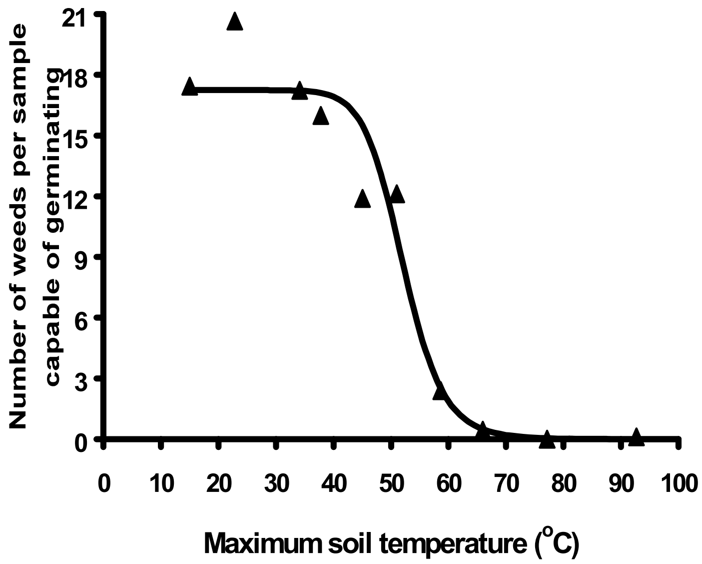

Figure 2. Number of surviving weed plants in relation to the soil temperature

For band heating, such a treatment in 50 cm rows requires about 5.8 GJ/ha. However, the field test with an one-row band steamer prototype machine (figure 3) showed that slightly higher temperatures – about 90°C – are necessary to achieve a good effect in the field. At the field tests, about 9GJ/ha (300 l/ha of oil) were needed.

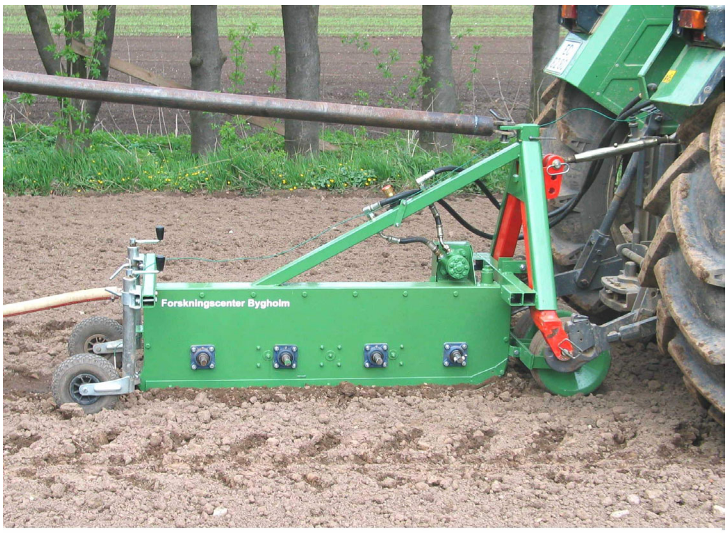

Figure 3. Prototype band steaming machine

By band steaming the microbiological flora and fauna is influenced in the local area representing less than 10% of the total volume calculated in a 15cm surface layer. The microbiological life is affected during the growing season (Elsgaard et al., 2004), but after a primary tillage operation the influence is erased.

Conclusions

An experimental test rig, used for steaming soil samples mixed with weed seeds and for examining the thermal efficiency involved in soil steaming, has been developed. It was seen that soil temperatures exceeding 70°C will be needed in order to destroy the germination capacity of the weed seeds. At the field trial slightly higher temperatures, 80-90°C, were needed to achieve god effect. In connection with the transfer of steam energy to the soil, efficiencies of 91–100% were found. Part of the energy will, however, be transferred to the soil surrounding the steamed band, and therefore, in the case where a 6 × 5 cm soil band is exposed to steaming, the efficiency will only be 50–60%. For an efficiency of 55% and a row interval of 50 cm, about 300 l/ha of oil will be needed to heat a 6 × 5 cm soil band to a temperature of 80°C. On the basis of the experiments in the test rig, a prototype one-row band steamer has been developed for field purposes. Good results have been achieved from the preliminary tests.

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Sonchus arvensis – a challenge for organic farming

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Abstract

Perennial sow-thistle (Sonchus arvensis L.) represents an increasing problem in Finland. Options for mechanical and cultural control of S. arvensis were studied in a 3 year field experiment on clay soil under organic production. The experiment consisted of different crop sequences: spring cereal (barley in 2001, oats in 2002) with or without inter-row hoeing and/or stubble cultivation, bare fallow, fibre hemp (*Cannabis sativa* L.), and ley with mowing. In 2003 the entire field was sown to spring wheat. Crop plant and *S. arvensis* dry mass prior to cereal harvest and crop yield were assessed. The control effect was rated: bare fallow > ley > cereal with or without inter-row hoeing > poor growth fibre hemp. Bare fallow was an effective but costly method to reduce *S. arvensis* infestation. Introduction of a regularly mown green fallow or silage ley in the crop rotation was beneficial. Mechanical weed control by inter-row hoeing in cereals limited *S. arvensis* growth. Infestation was also reduced by stubble cultivation in autumn. When managing S. arvensis using mechanical and cultural methods, appropriate options, including a competitive crop, should be chosen for the specific field and rotation.

Keywords: perennial weeds, *Sonchus arvensis*, mechanical control, crop rotation, inter-row hoeing

Introduction

Perennial weeds, including sow-thistle (*Sonchus arvensis* L.), are becoming increasingly problematic in Finland, particularly in organic farming (Salonen et al. 2001). Managing S. arvensis using non-chemical (mechanical and cultural) methods is not easy. However, crop competition and cultural practices, including mowing, hoeing and bare fallowing, provide some possibilities for managing *S. arvensis*. Information on the response of *S. arvensis* to various physical and cultural control measures is a prerequisite for successful management.

Much research has been carried out on mechanical weed control in cereals in Nordic countries (for example Rasmussen 1992, Rydberg 1995, Johansson 1998, Lötjönen & Mikkola 2000). These studies concentrate mainly on control of annual, but not perennial weeds. One reason for this is a patchy growing habit of perennial weeds. As a result, it is difficult to find a field where the perennials would be distributed evenly.

The aim of this study was to establish non-chemical methods for managing *S. arvensis*, particularly for organic cropping. The objectives were to 1) study the effect of crop, mechanical weed control and other management on *S. arvensis* biomass 2) study crop yield under different treatments and finally 3) provide some recommendations for crop rotations.

Material and methods

A three-year field experiment was set up in 2001 at Vihti, southern Finland. It was conducted on a clay soil (containing 6–12% organic matter) heavily infested with S. arvensis. The field had been in organic production since 1997. The previous crop in 2000 was spring wheat.

The experiment had seven treatments (see Table 1) and two levels of stubble cultivation (yes/no) organized in a strip-plot design with five replicate blocks. Stubble cultivation and treatment strips were randomized separately in each block. The plot size was 3 m × 25 m, except for fibre hemp it was 5 × 25 m. In 2003 the entire experimental area was sown to spring wheat to establish the subsequent effects of the treatments. In 2003 no weed control was carried out.

Table 1. The treatments during the years 2001-2003. The treatments remained at the same locations throughout the experiment. Sc means stubble cultivation in autumn.

Abbreviation of treatment	**Year 2001**	**Sc in autumn**	**Year 2002**	**Sc in autumn**	**Year 2003**
Cer	Barley	(sc)	Oats	(sc)	Spring wheat
CerH	Barley + hoeing	(sc)	Oats + hoeing	(sc)	Spring wheat
Cer-Ley	Barley with ley	-	Ley	-	Spring wheat
Ley	Ley	-	Ley	-	Spring wheat
Bf-Cer	Bare fallow	-	Oats	(sc)	Spring wheat
Cer-Bf	Barley	(sc)	Bare fallow	-	Spring wheat
Hemp	Fibre hemp	-	Fibre hemp	-	Spring wheat

All cereal and fibre hemp plots were ploughed at the depth of 20 cm in every autumn. The whole experimental field was fertilised every spring with pig slurry (60–100 kg $N_{soluble}$ ha^{-1}) applied using a band spreader. The plots were drilled every year between 16–27 May.

The leys were mowed three times per summer. Bare fallow was cultivated with S-tine harrow as soon as *S. arvensis* reached 5–7 leaves (6–7 times per summer), which is regarded as an optimum time for cultivation (Håkansson 1995). Inter-row hoeing was performed 2–3 times per summer. It uses the row spacing of 18.0 cm compared to the normal of 12.5 cm. Half of the cereal plots were stubble-cultivated with S-tine harrow after harvesting. Prior to harvesting cereals the number and total dry mass of *S. arvensis* per area were assessed. The yields of ley and cereal were measured.

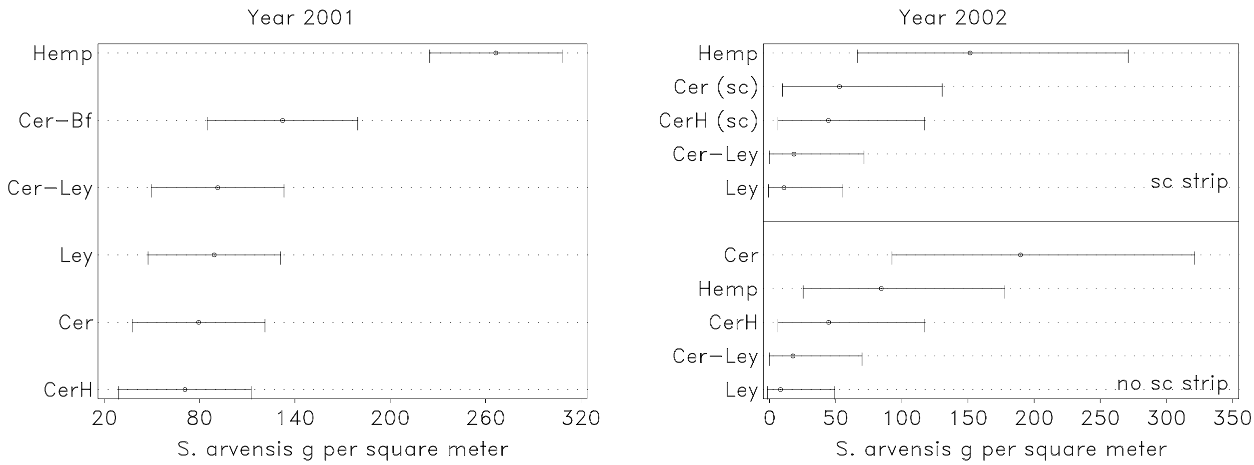
The statistical models were fitted to the data using PROC MIXED of the SAS System version 8.2. Model assumptions were checked graphically: equality of variances by plotting residuals against fitted values, and normality of the response variables by inspecting model residuals using the box-plot technique. The results are presented by plotting the estimated means and 95% confidence intervals of the means. Statistical differences are not presented in this paper.

Results

Several treatments had a significant effect on *S. arvensis* biomass (Fig 1). Bare fallow (Bf-Cer in 2001, Cer-Bf in 2002) reduced the biomass of *S. arvensis* considerably, destroying all or nearly all *S. arvensis* plants. The subsequent effect of bare fallow was also very good. Leys

(Cer-Ley, Ley) reduced *S. arvensis* biomass and had good subsequent effects, especially after the ley sown on bare soil (Ley).

Inter-row hoeing (CerH) was not as effective as the treatments mentioned above and its efficacy varied. The subsequent effect (in 2003) of hoeing was poor. The growth of hemp was unsatisfactory in the experimental field, and *S. arvensis* density was higher in 2001 in hemp compared with that in standard cereal (barley). *S. arvensis* biomass in spring wheat in 2003 was highest after poorly grown hemp.



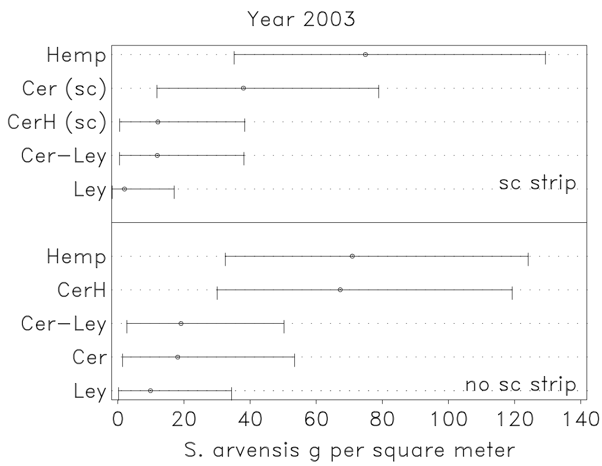


Fig. 1. Air-dried biomass (g m-²) of S. arvensis, showing the estimated means and 95% confidence intervals of the means. Due to zero or very low values, the treatments Bf-Cer and Cer-Bf were excluded from the analysis and graphs for 2002 and 2003. Key to abbreviations is in Table 1.

Stubble cultivation in the previous autumn reduced *S. arvensis* biomass in some cases but not always. The rating of the treatments based on the subsequent control effect in 2003 was: bare fallow > ley > cereal with or without inter-row hoeing > poor growth fibre hemp. Stubble cultivation was not directly comparable with the other treatments, but it seemed to fall between ley and inter-row hoeing.

The treatments had some effect on cereal yields either directly or through *S. arvensis* biomass (Fig. 2). In 2003, wheat yield after failed fibre hemp was significantly lower, and after the previous year's bare fallow and leys significantly higher than after standard cereal. Stubble cultivation slightly increased the yield of treatments, which had plenty of *S. arvensis* in 2002.

Conclusions

Overall, the results suggest that the following management measures could be implemented in order to suppress *S. arvensis* infestation: 1) Mowing the leys would suppress *S. arvensis* biomass production. 2) A crop should be selected that is competitive not only generally, but also under the conditions of a given field. 3) Bare fallow is an effective method to reduce S. arvensis infestation, but it is costly and can damage the soil structure. 4) Inter-row hoeing seems to impede *S. arvensis*, but it has not long-term effects. 5) Stubble cultivation in autumn may be used in order to reduce *S. arvensis* vigour in the next season. The advantages of synergy of different control measures, as well as long-term effects, should be taken into account when planning crop rotations to control *S. arvensis*.

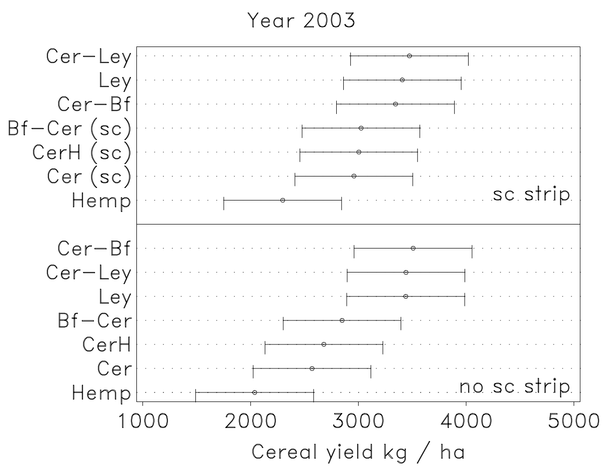


Fig. 2. Cereal yields in 2003 (converted to 14 % moisture), showing the estimated means and 95% confidence intervals of the means.

More information is needed for each control method to establish the optimal timing of control. The effect and importance of tillage methods on weed control should be studied. Tillage and other machinery should be developed with a view to manage perennial weeds. There are many new machine types suitable for stubble cultivation and bare fallow tillage that should be evaluated in field experiments.

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Intercropping of fabae beans (*Vicia fabae* L.) and spring barley (Hordeum vulgare L.) to reduce the incidence of the black bean aphid (Aphis fabae Scop.)

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Abstract

Spring field bean could be a popular break crop in organic agriculture but serious attack from the black bean aphid can reduce the yield significant.
Field experiments conducted as organic grown experiments at Research Centre Flakkebjerg in 2002 shows that 67% field bean intercropping with 33% gives 54% more economic outcome than growing 100% field bean and 25% more than growing 100% spring barley.

Keywords: Intercropping, resistant varieties, Aphids, *Aphis fabae*, *Vicia faba*.

Introduction

Spring field bean could be a popular break crop in organic agriculture but until now it is not common grown. One reason is the often variable yield. Climatic conditions have a considerable effect on growth and development but also influence the development of diseases and pests. Attacks of the black bean aphid are one of the important factors limiting yield.
The black bean aphid is generally considered to be a serious pest of spring-sown field beans in Northern Europe. It has a holocyclic life cycle, and over winters as an egg on spindle trees (*Euonymus europaeus* L.). Spring migrants developing on spindle fly to bean crops in early summer. The severity of infestations can vary considerably from year to year. The aphids are able to cause a large number of physiological changes in their host plants and in many cases reduce plant productivity. Aphid feeding is responsible for most of the direct damage, which arises because of nitrogen and carbohydrate removal and injection physiologically active substances in saliva. Field studies have shown that yield losses can exceed more the 50% because of attack from the black bean aphid
Present paper concerns of reducing the incidence of the black bean aphid by intercropping.

Material and methods

Field experiments were conducted as organic grown experiments at Research Centre Flakkebjerg in 2002. Sowing times were normal. Seed density for field beans and cereals in monocrop were about 45 plants/m² and 350 plants/m², respectively. The seed density of the mixtures was fixed according to the principle of replacement. Distance between rows was double (24 cm).
Two trials with three different treatments were carried out. 1. Monocrop of Colombo, 2. 2/3 Colombo + 1/3 Ferment (spring barley) and 3. 1/3 Colombo + 2/3 Ferment. The experimental layout was randomised block design with 5 replicates and plot size for the two experiments 4.8 x 12.0 m and 4.8 x 10 m, respectively. Black bean aphids were counted twice a week on 40 plants per plot. The harvest took place end of August and the yield from field beans and spring barley was separated. The yield was estimated and converted to 14% and 15% water content, respectively.

When calculated economic yield numbers from Landscentret 2004 are used. 18.7 and 14.7 EU/ha for field bean and spring barley respectively.

Aphid counting

Counting was started before aphid migration to the fields began. The counting started in sowing row no. 2 or 3 where the first plant was chosen by chance. Hereafter every 10th plant until aphids at a total of 20 or 40 plants per replicate were estimated. In 2002 in treatment 3 every 5th plant were selected because the small number of field beans in this treatment.

Individual counting of the black beans aphid were carried out up to 49 aphids/plant and hereafter in intervals as listed in table 1. Group mean is used in relation to data processing. Aphids attacking field beans are most damaging in the period from before flowering to end flowering. Population development after flowering has very little effect on yield reduction. Therefore, only aphid infestation until end flowering is included in the data processing.

The statistical analysis used a Duncan multiple range test from the GLM-procedure in SAS.

Table 1. Intervals for counting black bean aphids

Number	**Group mean**
0-49	Each
50-75	63
76-100	88
101-150	126
151-200	175
201-300	251
301-400	351
401-500	451
501-1000	751

Results and discussion

In table 2 the aphid infestation is shown. It is calculated as aphid days, which means number of aphid per plant multiplied with the number of days they were present. Also per cent plant with aphids are shown.

It is significant that plots with 100% field beans are much heavier attacked with aphids than plots intercropping with spring barley.

Table 2. Number of aphids days and percent field bean infected with A. fabae

Treatment	No. aphid days			Per cent plants infected with aphids		
	Reel		Relative	Reel		Relative
1/1 field bean	957	A	100	62	A	100
2/3 field bean 1/3 spring barley	424	B	44	48	B	78
1/3 field bean 2/3 spring barley	290	C	30	37	C	60
No. in same column with the same letter are not significant different, $p < 0.05$						

Yields are shown In table 3. In plots with 2/3 and 1/3 field beans there is a reduction at 20% and 53%, which is much lesser than the expected 33% and 67% respectively. It is probable that the difference mainly is an effect of lesser aphid attack.

The total yield for both field bean and spring barley is for the different treatments 24.4, 15.6, 27,1 and 25,1 hkg/ha, respectively.

Table 3. Yields of spring barley and field bean infected with A. fabae						
Treatment	Field beans (Hkg/ha)			Spring barley (Hkg/ha)		
	Reel		Relative	Reel		Relative
1/1 spring barley	0			24.4	A	100
1/1 field bean	15.6	A	100	0		
2/3 field bean 1/3 spring barley	12.4	B	80	14.7	B	60
1/3 field bean 2/3 spring barley	7.3	C	47	17.8	C	73
No. in same column with the same letter are not significant different, $p < 0.05$						

However, for the farmer the most interesting yield is the economic yield. In table 4 the economic yield is shown. It is significant that 2/3 field bean intercropping with 1/3 spring barley gives the best economic outcome.

Table 4. Economic yields of intercropping spring barley and field bean			
Treatment	EURO / ha		
	Reel		Relative
1/1 spring barley	358	A	123
1/1 field bean	291	B	100
2/3 field bean 1/3 spring barley	447	C	154
1/3 field bean 2/3 spring barley	397	D	136
No. in same column with the same letter are not significant different, $p < 0.05$			

Conclusion

67% field bean intercropping with 33% gives 54% more economic outcome than growing 100% field bean and 25% more than growing 100% spring barley.

Relevant literature

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Field surveys of Fusarium root rot in organic red clover leys

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Abstract

The prevalence of the root rot complex of red clover in forage and green- manure leys was determined on organic farms in seven provinces in south and central Sweden during 2003 and 2004. The results show that the injuries caused by root rot are widely distributed already in the seedling year. Average disease severity index (DSI) for internal root symptoms was 12 the seedling year, 28 in first year leys and 61 in second year leys.

Keywords: *Trifoleum pratense*, organic leys, Fusarium root rot, persistence

Introduction

Red clover (*Trifoleum pratense*) is the most important legume crop in Swedish forage production, and the major component in green- manure crops on many organic farms. However, red clover is infected by several fungal pathogens affecting growth, persistence and overwintering capacity. Clover rot (*Sclerotinia trifoliorum Erikss*) and stem nematode (*Ditylenchus dipsaci*) have been well known for a long time, and are handled with by resistant cultivars, whereas the importance of Fusarium root rot was practically unknown in Sweden in the early 1970s (Rufelt, 1986). Root rot is caused by several soilborne pathogens where *Fusarium spp* are most important. A nationwide survey undertaken in the mid 1970s showed that the occurrence of root rot was very frequent (Rufelt, 1979). During the past few years organic farmers and advisors have reported about poor establishment and sustainability in red clover leys. Recently premature ripeness of red clover seed crops are reported as well as poor growth the second ley year caused by severely infected roots (Wallenhammar, unpublished). In a co-operation project 2003 undertaken in three provinces in Sweden the prevalence of root rot of red clover in forage leys and green- manure leys was determined. This project was extended in 2004 to seven provinces in south and central Sweden, in order to facilitate a sustainable forage production.

Material and methods

In 2003 sampling was mainly undertaken in second year leys, whereas sampling in 2004 was evenly distributed between 15 first and second year leys in the beginning of July. At the end of October five fields of the seedling year were sampled. Sampling was carried out on ten positions, where four plants were dug out, along the diagonal of the field. In all 5567 plants were dug out and examined in 2004. The red clover plants were transported to a laboratory where they were rinsed in running water. The external root symptoms were read as lesions. The plants were splitted with a scalpel .The internal root symptoms were read as the degree of discolouration in the vascular tissues following Rufelt (1979). A disease severity index (DSI) was calculated. Information on crop rotation, fertilizing, soil type, management system etc was collected by a questionnaire.

Results

The results form 2003 show a general distribution of root rot since 93 and 97 % of the plants respectively were infected in the provinces of Örebro and Östergötland, while 78 % of the plants investigated in Skåne were infected. The corresponding DSI was 51, 59 and 18 respectively. The results from the survey 2004 show that the injuries from root rot are yet widely distributed on organic farms throughout the provinces investigated. 96 % of the plants in second year leys on average showed internal root symptoms (Table 1). Average DSI was determined to 61. First year leys also showed high levels of infection since 71 % of the plants showed internal root symptoms. DSI ranged from 19 to 33. External root symptoms are presented in table 2.

Table 1. Internal root symptoms seedling year, first year ley and second year ley 2004.

Province	Seedling year		First year ley		Second year ley	
	Infected plants %	Disease severity-index (DSI)	Infected plants %	Disease severity-index (DSI)	Infected plants %	Disease severity-index (DSI)
Örebro län	76	24	94	34	100	77
Östergötland	28	7	73	21	99	64
Skåne	1,5	5	80	31	90	56
Värmland	21	9	62	19	91	53
Halland	49	12	96	29	100	62
Uppsala	44	18	69	26	93	46
Södermanland	29	9	80	33	96	71
Average	**35**	**12**	**79**	**28**	**96**	**61**

The readings of the plants in their seedling year showed a greater variation in infection level ranging from 1,2 to 76 % infected plants. Average DSI was determined to 12.

Table 2. External root symptoms seedling year, first year ley and second year ley 2004.

Province	Seedling year		First year ley		Second year ley	
	Infected plants %	Disease severity-index (DSI)	Infected plants %	Disease severity-index (DSI)	Infected plants %	Disease severity-index (DSI)
Örebro län	97	32	91	35	100	77
Östergötland	31	9	69	25	99	64
Skåne	2	8	80	31	91	55
Värmland	19	8	82	40	100	76
Halland	93	25	99	36	100	63
Uppsala	19	7	63	24	100	74
Södermanland	5	1,25	89	44	99	76
Average	**38**	**13**	**82**	**34**	**98**	**69**

Information on field data (results not shown here) showed that many farmers grow ley on large acreages, the share in crop rotation ranged from 10 to 100 %. Many growers are pleased with the clover stand, despite large infections occurred, while several farmers have observed a degeneration of their clover leys.

Discussion

Many of the soil-borne fungi infecting red clover are considered as weak pathogens (Rufelt 1986). However, when disease- enhancing abiotic factors are prevailing, or when frequent cutting and harvesting occur, disease can be severe. This survey reveals that the root rot complex is a serious problem in Swedish organic clover leys. The results are well in line with the findings reported by Rufelt (1979) when average DSI of internal root symptoms was 6.1 the seedling year, 38 the first year ley and 61.6 the second year ley. However, these results did not prove that the root rot complex is a fungal disease. It was clear that the fungi isolated were pathogenic, but the results did not exclude that environmental stress was the primary cause of root rot.

Pathogen isolations from red clover and white clover collected on organic farms in central Sweden showed presence of a number of pathogenic fungi dominated *F. avenaceum* and *F.culmorum* (Lager and Gerhardson, 2002). Isolates of *F.culmorum* and *F.avenaceum* from white- and red clover roots reduced shoot dry weight of timothy and meadow fescue, (Lager and Wallenhammar 2002). Furthermore Lager(2002) showed that the growth of particularly wheat, peas but also barley and oats were significantly decreased in red-clover rotations. Several soil- borne pathogens that normally induce sublethal root rots, have wide host ranges. Hence, the build- up of soil- borne inoculum is inevitable in organic crop rotations increasing the pressure on red clover.

Conclusion

The survey show that injuries caused by the root rot complex is widely distributed on organic farms in south and central Sweden thus affecting the persistence of red clover. Recent greenhouse studies indicate that the pathogens affecting red clover have wide host ranges increasing the pressure on red clover in prevailing crop rotations. Access to red clover varieties with some degree of resistance to the root rot complex is necessary in order to improve the persistence of red clover stands.

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Plant health management in organic farming; an organic or an organismic challenge?

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Abstract

Plant health management in sustainable agriculture systems is considered from the concepts organic farming is based upon. It focuses on the role of systems regulation in living systems and what this means for the approach in plant health management in organic and sustainable farming.

Introduction

Agricultural sustainability is to a large extent threatened through the excessive use of artificial mineral fertiliser and relatively persistent synthetic pesticides with additional non-target effects. Current organic production regulations exclude the use of these agricultural inputs. Plant health management in organic systems aims, in principle, towards to be as little as possible forced to use reactive crop protection measures through supporting, and optimal exploitation of natural regulation of pests, weeds and diseases, embedded in good agronomy.
In contemporary organic practice in Western Europe and North America one can observe that crop protection often seems to become reduced to finding and applying alternative input factors to replace what is not permitted according to the rules for organic production. This is a one-sided approach that urges to consider more profoundly how plant health strategies should look like according to the concepts for organic and sustainable farming. These concepts act as the basis for the search for technologies that might be the most promising ones in developing sustainable agriculture.
In this paper plant health management in organic agriculture is the starting point in the debate. The vision expressed here is that there is a difference between an organic and an organismic approach (for explanation see next paragraph) for plant health management, and that the organismic approach is not exclusively useful for the organic sector. It can be the leading thought for all plant health management that focuses on sustainable agricultural production.
Organic or organismic
In Europe two main and different traditions in the development of organic thinking and organic agriculture can be distinguished; namely the English and the German-Swiss-Austrian tradition. This explains the somewhat cryptic distinction "organic-organismic" in the title of this paper.
In the English tradition the organic matter in agricultural production systems is the major focus as being crucial in the functioning of organic production systems. In the German-Swiss-Austrian tradition the consideration of a farm as an *independent self-organising organism* is the main line of thought, which fits in the general concepts of the organisation of living systems. Although it is important to keep in mind that living systems are organisationally closed, but energetically and materially open systems.

Organic agriculture is more than only an agricultural production system that excludes synthetic pesticides and artificial fertilisers. Organic agriculture in an organismic perspective focuses on a maximal degree of self-regulation. This means for plant health management that the necessity of reactive measures that "correct" undesired pest development is minimised.

Farm management is focused on selecting crops and compiling crop rotation schemes that result in a balanced resource use and prevent biotic crop damage.
Therefore a distinction is made between *crop protection in organic agriculture* and *organic (read organismic) crop health management.*

What is the consequence of this approach for the research questions we formulate? From a regulation perspective, the question “How has an organism or phenomenon grown to a problem?” is more crucial than the question “How to solve a specific problem?” An answer on the first question, which has the organization of the system as underlying process, gives a broader perspective for alternative strategies, both for preventing the problem in the future and for the perspective of any *ad hoc* reactive measure for reducing a specific problem.

Alternative pesticides and biologicals; not the primary focus

Today, increasing interest is seen for natural bioactive entities to be applied as a crop protection measure. These are used as alternative pesticides and as biologicals like fungal and bacterial antagonists, predatory insects and mites. Here, the crucial question is whether these inputs stimulate and support natural regulatory processes, or are they used in the same philosophy as chemical pesticides are applied by removing undesired populations?
Like in the case of chemical pesticides one may expect that alternative control measures also trigger counteractions from the pest population. These may make the alternatives less effective. Other undesired side effects cannot be excluded, as for example related to the increasing difficulties in human medicine with opportunistic pseudomonad bacteria. Therefore the primary focus in an organismic plant health management is not an alternative treatment but a maximal independence from reactive measures.

Tensions and challenges

The organic-organismic approaches carry many positive (value related and value free) elements in their concepts. However, choices have to be made to achieve efficient food production embedded in a sound agro-ecosystem management. Such choices unavoidable elicit undesired phenomena like pests and diseases. Additional regulatory measures may be necessary. Considered from an epistemological point of view, (organic) agriculture is forced to seek for compromises between natural regulation and active human intervention. Agriculture is anyhow a cultural phenomenon and not an element of pristine nature. What these compromises are or will be in the future is a challenge and part of an ongoing and never-ending debate. This may have consequences for the organic production rules.
In conclusion, in my view an *organic* approach in the sense of an *organismic* approach in the development of plant health management is most promising to achieve a sustainable plant health management in agriculture.

Outdoor pig systems in organic agriculture – animal environment, plant nutrient management and working environment

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Abstract

This paper presents parts of the results from a larger project, which aimed to identify strategies for simultaneously reaching a good animal environment, a resource efficient nutrient management and a good working environment in outdoor fattening pig systems on six commercial farms. Methods used were Work Environment Screening Tool in agriculture (WEST-agriculture), behavioural studies of the pigs including defecation and urination, and quantification of the N and P load in different sub-areas of the outdoor pen. Some proposals for the improvement of the mobile and stationary outdoor systems are discussed.

Keywords: risk for accident, ergonomic load, excretion hotspot, pig behaviour, phosphorus

Introduction

For several years in Sweden, the demand of organically produced pork has been larger than the production. Systems with outdoor pig production become interesting due to their benefits in terms of animal welfare and low costs of buildings and equipment (Andresen, 2000). In the beginning there was a development of an outdoor system with mobile huts and feeding places, and long rotation intervals for pig pasture areas. During the last years another system of outdoor pig production has been more common. A stationary system with stationary barns and an outdoor area including pasture, which is restricted to the area that can be connected to the barn. The working environment in these systems would be improved. A mail-in survey among experienced people in organic farming in Sweden (Lundqvist, 2000) found that among the negative aspects, an increased workload was the most common answer. It is also necessary to consider the effects on animal welfare when designing an outdoor system. The most important parameters are animal health and species-specific behaviour (Putten, 2001). One of the basic conditions for a resource efficient nutrient management is a balance between animals, the amounts of nutrients excreted by them and the area for spreading manure, which corresponds to an average application of 22 kg P/ha with manure (De Clercq et al, 2001). However, even with moderate animal densities, the excretory behaviour of pigs may create high nutrient loads locally in outdoor areas (Watson et al, 1998).

The overall objective was to identify and recommend strategies that simultaneously provide a good animal environment, resource-efficient nutrient management and a good working environment. Some of the specific goals were to: 1. investigate how well two outdoor systems fulfil the basic goal of having a safe and healthy working environment and to identify areas for further development. 2. compare animal welfare in two outdoor systems concerning behaviour and some health parameters in order to recommend strategies for future development. 3. quantify fluxes and balances of nitrogen (N) and phosphorus (P) in two outdoor systems, and quantify the load of N and P in different sub-areas within the pen, and carry out an environmental risk assessment.

Materials and methods

Comprehensive studies during two grazing seasons were conducted at two commercial organic pig farms producing 700-800 fattening pigs per year. At the farm with the mobile system each group of about 40 pigs had access to a rectangular pen. Only one pig group per year used the pen. The pigs used a clover/grass ley in a four-year crop rotation. On the farm with the stationary system each group of about 40 pigs had access to a long and narrow outdoor pen, which was used by two different pig groups per year. The pig groups, where nutrient loads were determined, used the pasture during the whole fattening period. The pigs used a clover-grass ley in a two-year crop rotation. The study was then extended during one grazing season, including six commercial farms representing both systems.

The WEST-agriculture method was used to make a screening of the working environment (Torén et al. 2004) during two different seasons at six commercial farms where three farms represented the mobile system and three farms the stationary system. The factors risk for accidents, ergonomic load, psychosocial factors, noise, chemical health hazards and physical work environment were screened. The method includes a model for the exposure-response relationship for each factor and a method to translate this relationship into health effects. This translation is based on the national statistics concerning occupational accidents and work-related diseases. The health effects are expressed as SEK per thousand working hours (SEK/1000 h). The work with pigs was categorised into three main tasks for the screening: 1. work in the presence of turning pigs out to the outdoor area in the spring. 2. daily work on feeding, watering and management of wallowing area, and 3. preparation for sending the pigs to slaughter.

Comprehensive studies of the general behaviour were made at two commercial farms representing each system, where 5 groups of pigs were included. The observation periods per day were 4 hours in the morning and 4 hours in the afternoon. The outdoor pens in the mobile system were divided into four sub-areas, corresponding to the pigs activity in each area: Feeding area, hut area, drinking area and grazing area. The pens in the stationary system were concrete pad area, wallowing area, transfer area and grazing area. Continuous recordings were made for defecating, urinating, drinking and wallowing. For eating, standing/walking, rooting, lying, grazing and spending time in barn/hut, observations were made every 5th minute. In the stationary system, eating and drinking behaviours were not registered because they were performed inside the barn. Each defecation and urination was also positioned on a map of the pen. A scanning of six commercial farms was conducted one year including for example rotation intervals.

Comprehensive studies of element flows to and from four outdoor pens were monitored during the fattening pig period at two commercial farms representing each system. The outdoor pen balance was calculated for N and P for a fattening pig group, Equation 1. The difference between nutrient input in kg and nutrient output in kg was nutrient in faeces and urine in kg.

Outdoor pen balance= Inflows to the outdoor pen-Outflows from the outdoor pen=Feed (purchased and home-produced)+piglets-pigs (Eq. 1)

The amounts of feeds and the pig weights were based on the farmers´ specifications. Feed components were analysed for their contents of N and P. In the stationary system, amounts of N and P excreted indoors were estimated by weighing and analysing the straw litter bed from two pig groups. The average N and P amounts were removed from the outdoor pen balance.

Using the number of defecations and urinations per 10 m2 and 10 pigs from the behavioural studies, it was possible to calculate the proportion of manure or urine load on the sub-areas in each system. It was then possible to compare the sub-areas independent of their size. The proportion of manure or urine load for each sub-area was used to calculate the proportion of the total amounts of N and P that loaded the sub-area.

Results and discussion

The screening of the work environment factors showed that the risk for accidents was about three times as large and ergonomic load was up to ten times higher in two of the farms with mobile system as compared to the other farms. The reason for this was the daily manually performed work with feeding and watering.

There were general behavioural differences between systems. In the stationary system pigs spent more time inside the barn (about 55% of total numbers of observations), which was partly due to the fact that feed and water were provided in the barn. In the mobile system pigs spent about 40% of total numbers of observation time inside the hut. A higher proportion of rooting (about 10%) and a lower proportion of lying (about 5%) were seen in the stationary system. Corresponding proportions in the mobile system were about 2% and 10%. The differences in rooting activity may be an effect of the soil type. In the stationary system the soil type was sandy loam and in the mobile system the soil type was clay. In the mobile system, the pigs were defecating and urinating when they left the hut on their way to the feeding area. Therefore, the highest concentration of faeces and urine was observed between the hut (0,44-0,55 numbers of defecations and urinations/10 m2 and 10 pigs) and the feeding trough (0,22-0,35). In the stationary system the pigs defecated and urinated on their way out to the fresh grazing area. Therefore the outdoor areas closest to the barn had the highest concentration of manure and urine. The wallowing area had a concentration of 0,94 defecations and 0,81 urinations per 10 m^2 and 10 pigs. At three farms with the mobile system the rotation interval for pasture was 3-6 years. At three farms with the stationary system the rotation interval for most of the pasture area was 1-2 years, but the areas closest to the barn were permanent.

Both outdoor systems had an acceptable pig density. The mobile system had about 71 fattening pigs per hectare and the stationary system had about 106 fattening pigs per hectare. A four-year rotation was recommendable (on average an application of 16 kg P/ha), while a two-year rotation built up nutrient surpluses over the year (on average an application of 34 kg P/ha). However, a rotation cannot balance out the effects of excessive net inputs of water-soluble nutrients such as N in a single year. In the mobile system the hut area had an application of about 0,20 kg N/m^2. In the stationary system the wallowing area had an application of about 0,24 kg N/m^2. In both systems the grazing area of the outdoor pen had an acceptable nutrient load. In the mobile system, on average 76% of the total area was grazing area, compared with on average 57% in the stationary system.

Conclusions

The risk of accidents can be much higher in the mobile system compared to that in the stationary system when the feeding and watering are performed manually. The semi-automatic feeding would be proposed for improving the working environment. Both the systems provided good opportunities for natural behaviour. In both the systems there was an uneven distribution of manure and urine in the outdoor pen. For the mobile system the hotspots may be evened out by regularly give the pigs access to a new grazing area. For the stationary system, the possible solutions are an increased rotation interval or a nutrient management technique for collecting the manure on the wallowing area and spreading it on other fields for crop production.

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Acknowledgements

This study was financed by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, the Swedish Institute of Agricultural and Environmental Engineering and the Swedish Farmers´ Foundation for Agricultural Research.

Reproduction and maternal behaviour in organic piglet production

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Abstract
In this report, preliminary results from a Swedish project on organic pig production (Projekt Ekogris) are presented, together with some results from the literature. The following traits are included: piglet survival, piglet growth, sow nesting behaviour, nursing behaviour, milk production, oestrus, ovulation and sow body reserves.

Keywords: piglet survival, piglet growth, oestrus, lactation, outdoor production

Introduction

Different traits differ in importance between organic and conventional production. Maybe traits like health and mothering ability should have higher weight and growth rate lower weight in genetic evaluation of animals for organic production? In some countries, AI-bulls are ranked in different ways for different production systems. The same milk recording scheme is used on all farms, but different records are included and different economic weights are used in the genetic evaluations. Organic pig production could also benefit from an alternative genetic evaluation, providing a "green list" of breeding values. However, before such an evaluation can be done, we need to know which traits characterize effective and thriving sows in organic pig production. One of the conclusions drawn by the European Network for Animal Health and Welfare in Organic Agriculture (NAHWOA) was: "Research is needed to define organic breeding goals" (Hovi, 2004).

Miao et al (2004) state that the ideal pig for a free-range system should "perform well under a very harsh environment, exhibit resistance to disease and have a high feed conversion efficiency, especially for fibrous materials". Sows farrowing outdoors should, according to Edwards (1995) have good mothering abilities, good temperament, high milk production and strong legs and feet. Although the piglet production is not always performed outdoors, these traits seem important for organic production in general. At an European workshop called "A vision on breeding for organic agriculture", the discussion led to a list of goal traits: feed efficiency, robustness, health, docile temperament and maternal ability (Nauta et al, 2003). In this report, we focus on reproduction and maternal behaviour.

Piglet production studied in 'Projekt Ekogris'

'Projekt Ekogris' is a research project on organic pig production, funded by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and the Swedish University of Agricultural Sciences (SLU). Reproductive traits of 100 sows in organic herds will be compared to results from their female relatives in conventional herds. The farmers weigh piglets at four days of age and at weaning. Sow behaviour and reproduction traits are recorded with questionnaires. Furthermore, treatments of diseases in sows and piglets are recorded. Three organic herds and four conventinal herds are included in this field study. The first gilts farrowed in March 2003. They will be followed during three parities.

At SLU's research station, Funbo-Lövsta, reproductive and behavioural traits difficult to record in the field are studied in 40 sows. The sows are followed until the weaning of the fourth litter. Recorded traits are: sow nest building and farrowing behaviour, piglet survival and growth, nursing behaviour, sow weight and fat loss during lactation, ovulation, oestrus, piglet health and sow health, especially udder health. During summer (April to August), the sows farrow outdoors in individual pastures with huts. Two weeks after farrowing, sows and piglets are moved to larger pastures with four families in each. During winter (October to February) the sows farrow in ordinary farrowing pens without crates indoors. From two weeks after farrowing, four sows and their piglets share a large pen with deep straw, in an unisolated building. Thus, first and third litters are born and raised outdoors and second and fourth litters are born and raised indoors. All piglets are weaned at seven weeks of age. The last litters were weaned in April 2005.

Piglets weaned late grow well

Preliminary results from Funbo-Lövsta indicate that less piglets are stillborn outdoors than indoors, but there seem to be no difference in mortality of live born piglets. According to the care takers' judgement of the sows in 'Projekt Ekogris', sows in organic herds are less aggressive and more careful towards the piglets, as compared to sows in conventional herds. Reproduction results for sows in organic production are rare in the literature, but there are comparisons between outdoor and indoor production systems. In general, number of stillborn piglets is lower outdoors than indoors but the piglet mortality from birth to weaning tend to be higher outdoors (ITP, 2001) or of the same magnitude as indoors (MLC, 2000).

Low temperature is mortal for newborn piglets. The ability to build a nest is thus very important for a sow farrowing outdoors or in a cold building. Nest building behaviour is also related to the calmness of sows around farrowing and consequently to the risk of crushing piglets (Thodberg, 2001). We do not know whether the variation between sows in nest building behaviour has a genetic background, but a large variation between sows has been observed at Funbo-Lövsta and in our field study.

The organic rules state at least seven weeks lactation. High weaning age is beneficial for piglet health and growth. Average growth during the week after weaning is 390 g/day in 'Projekt Ekogris' at Funbo-Lövsta, and no cases of diarrhoea after weaning have been observed on the 1777 weaned piglets. A previous study at Funbo-Lövsta showed that piglets born outdoors can achieve a high growth rate without any piglet feed. In that study, piglets from gilt litters had access to sow feed and were weaned at nine weeks of age. The average growth rate was 240 g/day from birth to five weeks and 440 g/day from five to nine weeks (Leufvén, 2004). According to Wülbers-Mindermann et al (2002), piglets born outdoors have a higher growth rate than piglets born indoors, but the seasonal effect on growth rate is large outdoors (Miao et al, 2004).

Sow milk - the organic piglet feed

NAHWOA concludes "Because of the benefit to animal health, the feeding of young mammals should be based on natural milk" (Hovi, 2004). Furthermore, piglets have high protein demands, which are difficult to fulfil with organic piglet feed. Nursing behaviour and milk production are thus important in organic production. We study the influence of nursing behaviour on piglet growth, but also the long-term effect of a high milk production. Large weight loss during lactation is correlated to high piglet growth and piglet survival

(Grandinson et al, 2005), but what are the consequences for life time reproduction and sow longevity? Preliminary results from Funbo-Lövsta show that sows with large litters have lower nursing frequency, spend more time away from their piglets and spend less time lying down, as compared to sows with small litters (Wallenbeck et al, 2005). This indicates that sows with large litters avoid their piglets to a higher degree, in order to prevent severe loss of their body reserves.

Valros (2003) found that nursing frequency is related to piglet growth and the behavioural study at Funbo-Lövsta shows a large variation between sows in nursing behaviour (Björklund, 2003). There is also variation between sows in the willingness to give nurse (Thodberg & Jensen, 2005). In organic herds, sows and piglets are often kept on pasture or in large family pens. When the sow can move away from the piglets, nursing motivation might be more crucial. We have observed some cross-suckling at Funbo-Lövsta, but none of the sows has weaned the litter spontaneously, according to the udder examination performed at weaning. Preliminary results from the field study in 'Projekt Ekogris' show that sows in organic herds are classified by the care takers to be better to nurse and to have better maternal behaviour than sows in the conventional herds. Concerning the use of body reserves, the organic sows are more often described as thin at weaning, as compared to the conventional sows.

Oestrus before weaning splits the sow batch

'No detected oestrus' or 'Not pregnant' are frequent culling reasons for sows in Danish outdoor production (Larsen & Kongsted, 2001) and the interval from weaning to next successful insemination seems to be longer outdoors than indoors (ITP, 2001). Since nursing inhibits ovulation, sows are not expected to show oestrus during lactation. Most sows ovulate within a week after weaning. But when sows and piglets are held in family pens, some sows ovulate and show oestrus already during lactation (Hultén, 1997). These sows fall out of the mating scheme and decrease the possibility to keep sows in farrowing batches. Handling animals in separate batches is a way to improve health status and reduce the need of antibiotics, which is especially valuable in organic production. Thus, oestrus during lactation is regarded as a problem by organic piglet producers in Sweden.

Hultén (1997) found that ovulation during lactation is more frequent in older sows and that there is a large seasonal effect. At Funbo-Lövsta, 9 of 40 sows ovulated before weaning during the 1st lactation and 16 of 36 sows ovulated before weaning during the 2nd lactation. The interval from weaning to next oestrus was much longer for sows ovulating during lactation than for sows not ovulating during lactation (Hultén et al, 2004). Ovulation and oestrous records will be analysed together with records on piglet growth and nursing behaviour, to see whether oestrus during lactation influences the piglets.

Conclusions

It is too early to draw conclusions from 'Projekt Ekogris', but this project will give us a better knowledge about the weakness and strengths of organic piglet production. Furthermore, we believe that this project will identify traits that characterize successful sows in organic production. This knowledge will help us to answer questions like: Are the best animals in conventional production also the best ones in organic production? Can data from the conventional litter recording scheme be used for an alternative genetic evaluation, aimed for the organic production? Which traits should be included in a genetic evaluation for organic production, and how should these traits be recorded in the field?

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Studies on housing alternatives for organic pork production

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Abstract

To promote an increased organic pig production there is a need for presenting different production alternatives and "good examples" to the producers. In an ongoing project an uninsulated stable for organic slaughter pigs, with different production systems (deep litter vs. straw flow pens), has been built. In this paper results from behaviour and hygiene studies are presented. It was concluded that age of the pigs and temperature in the building had a significant influence on the activity of the pigs. Comparing the 2 pen types no significant effects on total pig activity were observed. Also, access to pasture and access to roughage on the outdoor pen area did not change the total pig activity. Having access to pasture or roughage, however, did affect occupation area and behavioural repertoire of the pigs when they were active.

Pen hygiene was better during summer time than during winter. Access to pasture improved the hygiene on the outdoor concrete area during the pasture period. The hygiene on the indoor concrete area tended to be better in the deep litter pen than in the straw flow pen.

Keywords: organic slaughter pig production, pig behaviour, hygiene studies

Introduction

In Sweden, organic pigs are generally produced only according to the rules of the economic association KRAV (2001). According to these rules, the pigs shall be held outdoors on pasture during the so-called pasture period, whereas indoor housing in a simple barn with access to an outdoor pen is permitted during the so-called stabling period. The KRAV-rules have been established to increase animal well-being, for example, by offering more possibilities for the animals to express their specific needs and behaviour patterns. However, animal well-being is only one of several objectives in organic farming, and the requirement for pasture production also affects other important decisions, such as, feed utilisation, nitrogen losses, energy requirements, animal durability, etc.

The EU permitted systems for organic slaughter pig production (EU directive 1804, 1999) with indoor housing and year round access to an outdoor pen with solid flooring and without additional access to plant covered soil, are not permitted by KRAV in Sweden. One argument presented by KRAV is that the pigs cannot root in a normal way. Other arguments are that the consumer needs to see clearly that organic pig production is different to conventional production systems. Similar discussions are also heard in Denmark (Aarestrup Larsen & Kongsted, 2001), and it is expected that consumers in Denmark may also demand that the animals have access to yards with pasture for organic slaughter pig production.

To promote an increased organic pig production there is a need for presenting different production alternatives and "good example" to the producers. In an ongoing project an uninsulated stable for organic slaughter pigs, with different production systems, has been built. The aim of the project is to analyse and describe the consequences that different production systems for organic pig production will have on animal behaviour, animal production and health, labour and working environments, manure management, crop nutrient utilisation, structural field damages, and economy. *The project is still going on and in the present paper preliminary results from behaviour studies and hygiene studies are presented.*

Materials and methods

Research building

An uninsulated building for 128 organic slaughter pigs in 8 pens (16 slaughter pigs per pen) has been built with two different pen designs; four pens with "straw flow" and four with deep straw bedding. All pigs have access to an outside pen area with concrete flooring. Two pens with deep straw bedding and two pens with "straw flow" also have access to a yard with pasture during the summer (May-September). One group has access to the entire yard at once, whereas the second has access to a new small pasture area once weekly.

Behaviour studies

Both interval and continual studies were performed. Interval studies were made twice during the growth period; at 17 and 21 weeks of age, in 4-6 pens per batch in all four batches. Every 5th minute the activity of each pig (active or passive) and the occupation area in the pen of that pig (lying area, eating area, slats, outdoor pen area or pasture) were registered manually between 07.30 in the morning and 16.30 in the afternoon. The pigs were fed twice daily at 08.30 and 15.30.

Continual studies were made during one batch (batch 4) on ten "focal" animals per pen in 4 pens (2 pens with deep litter and 2 pens with straw flow). The "focal" animals were chosen randomly from the total of sixteen pigs per pen and were coloured with numbers from 0-9. The behaviour of each pig (with start on pig zero) was registered continuously for a period of 2 minutes by means of a hand held computer. After 2 minutes the behaviour of pig number one was registered for 2 minutes and so fort. In each pen the pigs were followed continuously for two hours after morning feeding (about 09.00-11.00).

The observations per pen were used for the statistical analyses, thus pen was the statistical unit. The following model (using PROC GLM) (SAS, 1985) was used:

$Yij = \mu + Ai + Tj + Pk + Rl + e_{ijkl}$

where μ is the overall mean, Ai the effect of age (i = 17, 21 weeks), Tj the effect of temperature (j = 5, 10, 16, 22 °C), Pk the effect of pasture/no pasture, Rl the effect of roughage/no roughage and e_{ijkl} the error.

Hygiene studies

Each pen was divided into 16 different areas and the hygiene of each area was evaluated according to a three grade scale;

0= completely clean
1= small amount of dung and dirt
2= large amount of dung and dirt

Results and discussion

Behaviour studies

From the interval studies it was shown that younger pigs were significantly more active than older pigs (table 1). It was also concluded that the temperature in the building had a significant influence on the activity of the pigs. With a higher temperature in the building the pigs were more passive. On the other hand there was no significant differences in total activity of the pigs between the two pen types, and whether the pigs had access to pasture or not or whether they had roughage or not on the outdoor pen area (table 1).

Table 1. Result of statistical test for total activity

Factor	Sign
Age (17, 21 weeks)	< 0,001 ***
Temperature (5, 10, 16, 22 °C)	< 0,001 ***
Pen type (deep litter/straw flow)	n s
Pasture (yes/no)	n s
Roughage (yes/no)	n s

Even though access to pasture did not affect the total activity of the pigs, this parameter significantly influenced the occupation area. If the pigs had the possibility to be on pasture they chose this possibility in favour of being on the outdoor concrete pen area (figure 1).

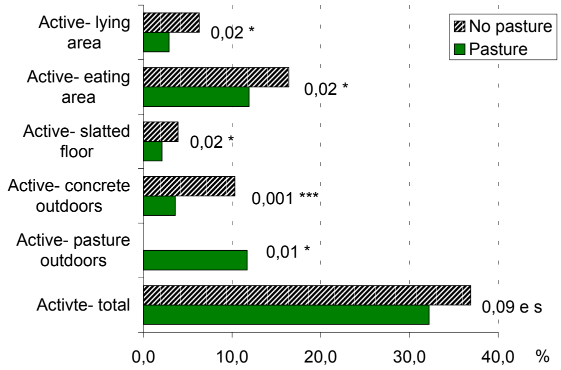

Figure 1. Pig activity on different areas in pens with or without pasture, batch 3 (LS Means)

The results concerning roughage were similar to those concerning pasture. Access to roughage did not affect total activity of the pigs but had a significant influence on where the pigs stayed in the pen. Since the roughage was given on the outdoor concrete area this meant that the pigs were seen significantly more often on this area in the pens with access to roughage (figure 2).

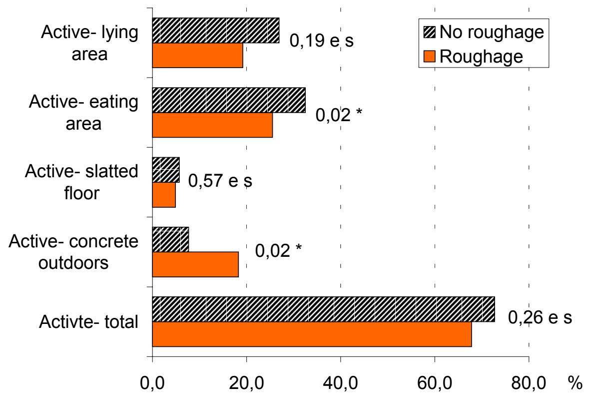

Figure 2. Pig activity on different areas in pens with or without pasture, batch 4 (LS Means)

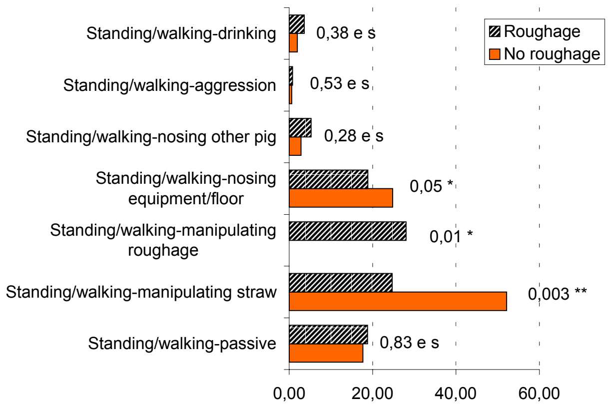

Figure 3. Distribution of different behaviours in pens with or without roughage, batch 4 (LS Means)

Results from the continual studies are presented in Figure 3. It is shown that pigs in the pens without roughage manipulated straw and nosed the floor and the equipment to a greater extent than the pigs in the pens with roughage (figure 3).

Hygiene studies

Both indoor and outdoor concrete areas were cleaner during the summer period (figure 5) than during the winter period (figure 4) probably due to the natural differences in climate. The hygiene on the indoor concrete area tended to be better in the deep litter pen than in the straw flow pen both during the summer and the winter period (figure 4, 5). Access to pasture improved the hygiene on the outdoor concrete area during the summer period (figure 5)

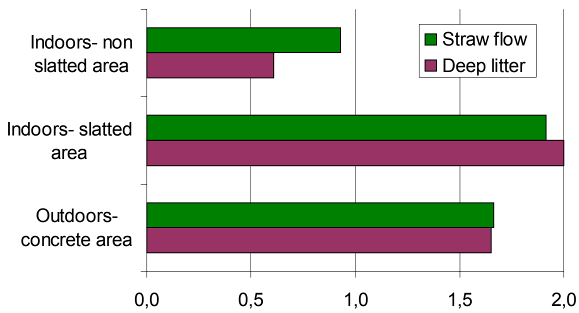

Figure 4. Results from hygiene studies during the stabling period (batch 2)

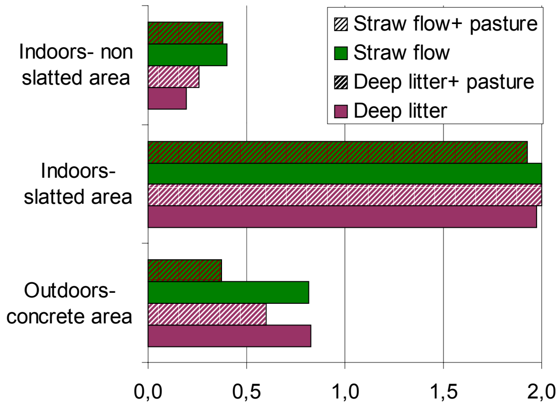

Figure 5. Results from hygiene studies during the pasture period (batch 3)

Conclusions

There were no clear differences in behaviour between the two pen types compared.
The total activity of the pigs significantly depended on their age and the environmental temperature whereas having access to roughage or pasture did not affect total activity. However roughage and pasture did affect their choice of pen area when active and their behavioural repertoire. There were considerable hygiene differences in the pens between summer and winter. During the winter period it is necessary to improve the hygiene of the outside solid concrete area in both pen types, which means undesireable manual work with cleaning. Access to pasture improved the hygiene on the outdoor concrete area during the pasture period. The hygiene on the indoor concrete area tended to be better in the deep litter pen than in the straw flow pen.

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Amino acid supply to pigs and poultry in organic farming

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Abstract

In organic animal production, addition of pure amino acids (aa) are not allowed, which will complicate the feeding of organic pigs and poultry. Requirements for aa differ between species and with age within species, being higher at younger ages. Growing animals have comparable high requirements for lysine, which normally is the first limiting aa for growing pigs. For poultry first limiting aa is sulphur aa, methionine and cystin.
In order to avoid deficiencies in essential amino acids in organic pig and poultry production, high dietary inclusion of protein is necessary. An excessive protein inclusion will result in a poor utilization of ingested protein and will also increase the losses of nitrogen to the environment.
The influence of different levels of aa on performance, carcass and technical meat quality of growing/finishing pigs, have therefore been studied. Our results showed that for organic growing/finishing pigs it is possible to lower the recommended aa level as a possible way to lower the content of crude protein in organic feed.
In poultry studies with laying hens include feedstuffs, methionine levels and bird genotypes. Results show that rapeseed cake may be a local produced important protein source, mussel meal may replace fishmeal, methionine levels may be lowered, but not enough. There are important differences between genotypes in reaction to low methionine levels, especially concerning feather pecking behaviour.

Keywords: lysine, methionine, requirements, deficiencies

Introduction

An optimal biological balance between amino acids (aa) in conventional diets for pigs and poultry is generally achieved by the use of pure (synthetic) aa. In organic animal production, however, such additions are not allowed according to international and Swedish organic standards (IFOAM, EU, KRAV). This imply dependence of access to special protein sources, rich in the content of the first limiting aa for pigs and poultry, respectively. Also as an effect of the GMO-ban there is a limited access to such KRAV-approved feedstuffs, which will complicate the feeding of organic pigs and poultry.

Lysine for pigs and methionine for poultry

Requirements for aa differ between species and with age within species, being higher at younger ages. Growing animals have comparable high requirements for lysine, which normally is the first limiting aa for growing pigs followed by methione and/or threonine. For poultry sulphur aa, methionine and cystin (methionine can be converted to cystin in the body) are first limiting. Most feedstuffs used in practice have low contents of sulphur aa in relation to the birds requirements, with a few exceptions, such as fishmeal, maizegluten and potato protein. However, there is no KRAV-approved production of these feedstuffs.

Expected pros and cons with organic diets

Concerning animal health, welfare and production efficiency we cannot se any obvious advantages resulting from the organic standards regulating access to feedstuffs. Pros are related to the long term effects organic crop production and processing may have on sustainability. Also until today, according to our knowledge, no studies have shown any significant effects on product quality favouring organically produced pig and poultry meat and eggs. In environmental system analysis of pig production Strid Eriksson (2004) found that feed choice has an impact on the environmental effect of pig meat production, both via features such as crude protein content and via the raw materials used, since the feed production generally has a large impact on the system as a whole. Optimization for low acidification and eutrophication favoured low protein diets with high inclusion of synthetic aa. Similar conclusions were drawn by Binder (2003) in a life-cycle analysis of DL-methionine. Drawbacks of the effects of the aa-supplementation-ban are also risk of animal metabolic disturbances due to un-balanced diets and aa deficiencies, with implications for animal welfare and production efficiency.

Standards regulating organic animal production were originally mostly based on assumptions but are regularly reviewed and adjusted according to achievements in the field of science. This should preferably be based on a holistic approach. The use of synthetic methionine for poultry lacks a such approach, since it seems to be based on the assumption that it is used as a feed supplements to increase production (NOSB, 2001) only, neglecting its importance for animal health.

Further, in order to avoid deficiencies in essential amino acids in organic pig and poultry production, high dietary inclusion of protein seems necessary. An excessive protein inclusion will result in a poor utilization of ingested protein and will also increase the losses of nitrogen to the environment. This is contradictory to the aim of KRAV to work for reduced danger of nutrient leaching that can result in over-fertilization of waterways, seas and lakes.

How can we go forward?

Pigs:
In pig production it should, in theory, be possible to reduce the dietary content of digestible crude protein and essential amino acids in the diet by allowing ad libitum intake of food. Thereby, a sufficient total daily intake of these nutrients would be assured. The food provided should have a lower energy density than used conventionally in order not to get too fat carcasses. In a study performed by Håkansson et al. (2000), it was shown that growing pigs could increase their voluntary feed intake, to maintain a high daily energy intake, when the diets had been diluted with straw meal.

It is therefore of interest to study the influence of different levels of amino acids in the diet on performance, carcass and technical meat quality of growing/finishing pigs. In one experiment, three different levels of amino acids (recommended, 7% and 14% lower levels) in a phase feeding system, with a low-energy diet provided *ad libitum* was studied. During two years, a total of 192 outdoor born pigs ((Landrace*Yorkshire) * Hampshire) were raised indoors in conventional pens or outdoors on pastures. Live weight and feed consumption were recorded continuously during the experiment and carcass parameters were assessed at slaughter. Amino acid level did not influence growth rate, feed conversion ratio or lean meat content. Not either was technical meat quality traits such as internal reflectance (FOP) or pH affected.

Poultry:
For poultry recommendations of aa levels have increased considerably over years aiming to maximise yield and economic return. This is partly an effect of increased animal production capacity, but implies also a margin which may be decreased before animal welfare implications will occur. Also questions have been raised whether differences between genotypes could be used to develop special organic hens (Aerni et al., 2005; Hoffmann, 2005). In this spirit research is carried out at SLU aimed to, a) identify and study protein feed resources with potential to sustain the organic standards, b) revaluate minimum requirements of sulphur aa, c) identify differences between bird genotypes. So far studies have mainly been carried out with laying hens, but studies also with meat chickens are in progress.

Conclusions

The use of feed protein is higher in organic than in conventional pig production, as pure amino acids are banned in organic production. However, our results showed that for organic growing/finishing pigs with a 2-phase feeding system it is possible to lower the recommended amino acid level. This could contribute to lower the content of crude protein in organic feed, as a way to reduce the nitrogen leakage to the environment.

From the studies with laying hens the following conclusions may be drawn.
a) Access to approved rapeseed cake is essential.
b) Permission for synthetic methionine would solve most problems since 100 % KRAV-approved diets could be based on cereals, rapeseed cake, and peas with the addition of ca 0.2 % methionine.
c) Mussels have been identified as a potential source to replace fishmeal.
d) Recommendations for essential aa to hens could not be lowered enough without causing animal health problems.
e) There are differences between genotypes to cope low levels of essential sulphur aa, and they use supplementary pasture differently to compensate.

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Acknowledgements

Studies referred to were funded by Formas, Stiftelsen lantbruksforskning and Jordbruksverket.

Organic egg production in Finland: management of animal welfare and food safety

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Abstract

In Finland, as in many other countries, the demand for organically produced eggs as well as the number of organic egg producers has increased. Even though organic poultry are given greater possibilities to species-specific behaviour, e.g. by allowing access to outdoors and by housing in free range-systems, maintenance of high welfare status is challenging. Commercial free range or organic egg production systems are not common in Finland but reports from free range and organic egg production systems in other countries have revealed some problems concerning animal welfare and food safety. A total of 20 out of 23 commercial organic layer farms (in excess of 80% of all commercial Finnish organic farms year 2003) took part in the ongoing research, which identifies risk factors and potential solutions for laying hen welfare and food safety. Data was collected during two farm visits by interviewing the producer, using a semi-structured interview guide, making environment and animal-based observations and collecting samples. The study report will be completed by the end 2005.

Keywords: organic laying hen, animal welfare, food safety, risk factors

Introduction

Consumers are increasingly interested in the safety and origin of their food and the ethical issues within the production chain. This has lead to a rapid increase of both free range and organic poultry production in many countries. The trend is strengthened by the current plans to phase out conventional battery cages for layer hens in the European Union by 2012. In Finland, the demand for organically produced eggs has increased, as well as the number of organic egg producers. Organic eggs are within the top three organic products in Finland, when measured as market shares. In 2003, the market share of organic eggs was 4.2% (Finfood Luomu, 2005), and there were 46 organic farms with organic laying hens (36% had >1,000 hens; 42% <100 hens). Between 2000 and 2004, the number of organic farms has increased by 18%, the number of organic laying hens by 156% and the number of hens/farm by 118%. In 2004, there were 53 organic farms in Finland, with a total of 74,418 organic layers (KTTK, 2005).

Even though organic poultry are given a greater possibility to species-specific behaviour, e.g. by allowing access to outdoors (at least between May and October in the Finnish organic

systems) and by rearing them in free range-systems, maintenance of high welfare status in organic poultry flocks is challenging. Feather pecking, foot problems, external parasites and poor utilisation of outdoor areas have been recognised as problems in organic layer systems (Lampkin, 1997; Berg, 2001; Kjilstra *et al*, 2003). Inexperience might cause imbalances in feed rationing due to the absence of synthetic amino acids and use of home-grown feed (Gordon & Clarke, 2002; Zollitsch & Baumung, 2004). Furthermore, birds with outdoor access have a potentially greater risk for exposure to bird or zoonotic human pathogens, such as salmonella, campylobacter and certain parasites than birds in indoor systems. Good stockmanship and experience of free range systems have been identified as key elements to a high welfare status in organic poultry systems (Bestman, 2001). Thus, organic egg production poses major challenges for producers in countries like Finland, where free range egg production is not common; where climatic conditions limit both outdoor access and building design; and where biosecurity and exclusion of zoonotic pathogens from the food chain has been one of the main aims of conventional egg production.
This paper describes preliminary findings from a project that was designed to assess welfare and food safety in Finnish organic egg production systems.

Materials and methods

A total of 20 out of 23 commercial organic layer farms (in excess of 80% of all commercial Finnish organic farms) took part in the research. One flock per farm was chosen and flocks were visited twice (19 farms in Aug-Oct of 2003 and 17 farms in March-Apr of 2004). Data were collected through observation and by interviewing the producer, using a semi-structured interview guide. Laying hen welfare was estimated using environment-based and animal-based methods. Environment-based measures included ANI 35L-2001 -laying hens (Bartussek, 2001), housing environment and litter moisture and animal-based measures hen scoring (20–50 hens/flock, all together 911 hens) (Gunnarsson *et al*, 1995), hen body weight and flock-level fear of humans. Fresh faecal samples were collected from the floor for analysis of campylobacter and salmonella bacteria (5-50 samples per farm) and for internal parasite identification (4-10 pooled samples per farm). Gastrointestinal parasite eggs and oocysts were studied by flotation. For the prevalence study of poultry red mites (Dermanyssys gallinae), six cardboard traps per henhouse were placed into the walls of a henhouse for 2-3 days as described by Höglund *et al*, (1995). In addition, 10 untreated eggs/flock were collected for campylobacter and salmonella studies. Altogether, 38 dead hens from 12 farms were examined pathologically through post mortem. Management practices, welfare measures and measures related to animal health and food safety will be analysed, using e.g. risk factor analysis and triangulation of data to identify farm-specific and overall risk factors for welfare and health status and carrier status of the flocks with regard to zoonotic bacteria.

Some preliminary results

The hen number at farms varied between 150 and 5,072, and 55% of farms had fewer than 1,000 hens/flock. Hens were not beak trimmed. The two most popular hen breeds were Lohmann white LSL (40% of flocks and 67% of hens in 2004) and Hy-Line Variety Brown (35% of flocks and 13% of hens). Mortality ranged from 0–3.9%/month between flocks (average 0.85%/month, median 0.5%/month).
In 2003 and 2004, there were 10 and 8 tame, 7 distant and 2 fearful flocks. In 2003, 16 flocks (567 hens) and, in 2004, 12 flocks (344 hens) were clinically scored. Ages of the scored hens were on average 47 (19–148) weeks and 53 (31-156) weeks, respectively. Over 90% of the hens were in lay. Feather status and skin status were, by and large, good. Moderate wear of feathers at back, wings and/or tail were seen in 1.4–16.9% (2003) and 2.3–29.4% (2004) of

scored hens and featherless areas were seen in 0.7–8.1% (2003) and 0–9,6% (2004) of scored hens on average. Pecks at the skin of back, wings, tail, belly and/or cloacca were found in 0.4–3% (2003) and 0.6–6.1% (2004) of the scored hens on average. Feather pecking and/or cannibalism were seen in three (2003) and two (2004) different flocks. The overall ANI score of single farms varied between 15.5 and 31 points and the average values were 24.8 points (2003) and 23.9 points (2004). The score was lower in the winter-spring period (mainly because of worse indoor air) than in the autumn 2003. Preliminary results suggest that the short outdoor period in Finland decreases the overall ANI score markedly.
Between 71 and 90% of the flocks were *Campylobacter* spp. positive, the results did not differ significantly between seasons. The most common species detected was C. *jejuni*. Two of the farms were campylobacter-negative, both in the autumn and the spring. No specific factors either in the environment or in the management of the animals could explain why the farms did not have campylobacter-positive animals. Campylobacter positive egg shell sample was detected once. Salmonellas were not detected either from faecal samples or eggs.
Only 0-10% or 0-15% of the farmers had recognized endoparasites or ectoparasites, respectively, in their flocks, but 42–77% or 48–90% of the flocks were *Nematoda* spp. positive or red mite positive, respectively. The post mortem results are biased, as only 60% of the farms sent some hens for post-mortem and 42% of the hens came from one farmer. However, red mites were detected on 58% of these farms sending hens for post mortem, which corresponds well with the trap results from all farms. A number of hens that had died due to cannibalism were diagnosed from 50% of these 12 farms.

Discussion

Flock sizes of Finnish organic layers are smaller than in many other countries. Feather pecking and cannibalism found during farm visits and mortality seem to be at a lower level than in some other investigations, even though the hens were not beak trimmed. The parasite and cannibalism (post mortem samples) results compare well with results found in free range/organic poultry in Denmark (Permin *et al*, 1999), back yard flocks or alternative systems in Sweden (Höglund *et al*, 1995), hens in alternative systems in the UK (Green *et al*, 2000) and organic laying hens in the Netherlands (Bestman & Wagenaar, 2003).
Campylobacter jejuni colonises commonly the intestines of wild birds and poultry. Our results showed that organic laying hens are more often colonized by campylobacters than broilers, as in certain Finnish studies approximately 4% of the broiler flocks were contaminated by campylobacters when studied at slaughter. Campylobacter colonization did not apparently lead to contamination of egg shells, as only one sample was positive of a total of 36 samples studied. *Campylobacter* on egg shell surface is not likely to survive, as it is very sensitive to dryness. These facts together indicate that the risk of transmission of campylobacters on eggs to consumers is small. Intestinal colonization by campylobacters may lead to contamination of meat at slaughter, as seen commonly in chickens. Meat of used organic hens is not commonly used as food, further decreasing the possibility of meat to transmit campylobacter infection to humans.

Conclusions so far

Further data analysis is in process. There seem to be comparable prevalences with other studies of organic or free range poultry. Parasites are common in organic layer flocks. Salmonella is rare in Finland and there are no public health risks with regard to salmonella or cambylobacters since spent hens are not eaten in Finland. More conclusions are expected after the analysis is completed.

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Acknowledgements

This project is funded by a three-year Research Program of Organic Food and Farming of the Finnish Ministry of Agriculture and Forestry. Collaboration will be done with organic poultry producers and the following institutes: EELA (the National Veterinary and Food Research Institute of Finland), Finlands´ Poultry Association and the University of Reading, UK, Veterinary Epidemiology and Economics Research Unit.

Laying hens in a mixed grazing system with cattle and geese

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Potatoes or barley silage to ewes?

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Abstract

Forty-two ewes in each of two years (2003 and 2004) were divided into two groups and fed either commercial organic concentrate (control) or potatoes and fish (2003) or barley silage and fish (2004) in addition to roughage *ad libitum*. The ewes' weight changes were measured at the beginning of the experimental period and during the grazing season. Average daily gain for lambs was measured from lambing and during the grazing season to slaughter. Within years, no significant differences between groups on ewes weight changes or on lambs' daily weight gain or lambs slaughter data were found. We conclude that both potatoes and barley silage with additional fish meal are good alternatives to commercial organic concentrates.

Keywords: lamb; growth rate; alternative supplements;

Introduction

Ewes in the Norwegian sheep production are traditionally fed with grass silage and commercial concentrates during the winter and the lambing season. Due to expensive organic concentrates, concentrate feeding is a major cost in organic sheep farming. The regulations for organic animal production in Norway is changing from August this year to only include organic feed. This is a challenge in parts of Norway where the growing season for grain to mature is too short. Norwegian sheep production is characterized by low incomes. To meet the demand for 100% organic feeds to the sheep, the farmers must use more homegrown feeds as an alternative to commercial concentrates.

A large project on sheep feeding started at Tjøtta Rural Development Centre in 2001 to adapt to the new rules to come into effect in 2005. The project is initiated by the Norwegian meat cooperation. In 2003 we replaced commercial concentrates with potatoes and fishmeal. In 2004 we replaced the concentrates with barley silage and fishmeal. The study investigates the effects of different types of alternatives to concentrates on food intake before and after lambing, weight changes of the ewes before and after lambing, and daily weight gain of lambs from birth and throughout the grazing season.

Materials and methods

The study was carried out at Tjøtta Rural Development Centre in Northern Norway (65º50'N, 12º28'E). All ewes in the study were of the breed Old Norwegian Short Tail Landrace (Spælsau). Each year 42 ewes of 2 years of age and older were randomly selected into two treatment groups. The groups were balanced for expected number of lambs (ultrasound scanning) and in 2002 for expected lambing dates. The 21 ewes of each treatment group were kept in three expanded metal floor pens of seven ewes each. Both groups were fed round bale silage *ad libitum* and additionally offered either commercial concentrates (control group) or in 2003 raw potatoes (assorted potatoes not suitable for human consumption) and fish meal (leftovers from dried codfish that was sawn in pieces for dog consumption) (experimental group). In 2004 the experimental group was offered barley silage and the same fish meal as in 2003. Table 1 shows the feeding values of the different food types.

Table 1. Feeding values (dry matter (DM) %, Scandinavian Feed Units (SFU) per kg DM and g crude protein (CP) per kg feed) on roughage, concentrate and supplements in 2003 and 2004

	2003			2004		
	% Dry matter	SFU per kg DM	g crude protein per kg feed	% Dry matter	SFU per kg DM	g crude protein per kg feed
Silage	33	0.78	138	23	0.80	22
Concentrate	88	1.05	138	86	0.93	40
Supplement*	28	1.19	21	48	0.56	125
Fish meal	84	1.11	678	80	1.1	658

* Potato in 2003 and barley silage in 2004

In the morning, leftovers from the day before were collected and once a week they were weighted. In the morning and in the afternoon, the ewes were fed concentrates or supplements after Norwegian recommendations additional to roughage *ad libitum*. The amounts of concentrate and supplements were adjusted to the production level of the ewe (before or after lambing). Initially, all ewes were weighed at the start of the feeding treatments on March 20th in 2003 and on March 29th in 2004. Table 2 shows average birth date, date when put out to spring pasture, dates of spring weighing, date of autumn weighing and date on average when sent to slaughter for the different groups the two years. Due to the weather, lambs in the concentrate group in 2004 were put out on pasture very late compared to the barley silage group.

Table 2. Average dates in 2003 and 2004 on lambing, put out to pasture, spring weighing, autumn weighing and at slaughter according to feeding group

	2003		2004	
Date	Potato	Concentrate	Barley	Concentrate
Lambing	3. May	6. May	5. May	3. May
Out to pasture	13. May	17. May	15. May	24. May
Spring weighing	10. June	10. June	23. June	22. June
Autumn weighing	7. September	9. September	12. September	12. September
Slaughter	14. October	21. October	25. September	24. September

Statistical analyses were carried out with GLM (Minitab, 2000). All results are means ± SEM.

Results

Both concentrate and supplements had no effect on roughage intake in either study year. Neither supplement nor concentrate affected lamb growth (Table 3) despite the fact that ingested crude protein was higher in 2004 in the barley silage group.

Table 3. Lambs birth weight (kg) and average daily gain (g/day) from birth to put on pasture (indoor feeding), from put on pasture to spring weighing (spring grazing), from spring to autumn weighing (summer grazing) and from birth to autumn weighing in 2003 and 2004

	2003			2004		
	Potato	Concentrate	P value	Barley	Concentrate	P value
Birth weight, kg	5.4 ± 0.1	5.0 ± 0.2	0.05	4.7 ± 0.1	4.6 ± 0.1	0.07
Daily gain, g/day						
Indoor feeding	290 ± 22	291 ± 22	0.49	351 ± 20	277 ± 12	0.38
Spring grazing	256 ± 16	242 ± 10	0.57	312 ± 14	312 ± 14	0.75
Summer grazing	309 ± 10	283 ± 11	0.11	303 ± 12	314 ± 17	0.48
Birth to autumn	296 ± 11	287 ± 10	0.52	324 ± 9	322 ± 9	0.27

There were no significant differences on ewes weight at the start of the experiment, at outlet and at spring weighing (Table 4). The ewes gained weight from the beginning of the experiment and to lambing, but lost the weight again after lambing until the sheep were sent on pasture.

Table 4. Ewes weight (kg) at the beginning of the experiment, when put to pasture and at spring weighing in 2003 and 2004.

	2003			2004		
	Potato	Concentrate	P value	Barley	Concentrate	P value
Weight, kg						
Start	65 ± 3	61 ± 2	0.20	76 ± 3	72 ± 2	0.19
Put to pasture	65 ± 2	63 ± 2	0.25	72 ± 2	68 ± 2	0.27
Spring	63 ± 3	61 ± 2	0.32	70 ± 2	68 ± 3	0.18

There were no statistical differences in slaughter values between groups within years (Table 5).

Table 5. Date of slaughter, carcass classification, carcass weight and fat classification on slaughtered lambs in 2003 and 2004.

	2003 Potato	Concentrate	P value	2004 Barley	Concentrate	P value
Date of slaughter	14. October	21. October		25. September	24. September	
Carcass classification*	5.0 ± 0.3	5.1 ± 0.2	0.53	5.5 ± 0.3	5.6 ± 0.5	0.93
Carcass weight	19.4 ± 0.8	18.6 ± 0.6	0.99	18.5 ± 0.5	20.4 ± 0.9	0.10
Fat classification**	5.5 ± 0.3	5.0 ± 0.3	0.37	7.5 ± 0.4	7.5 ± 0.3	0.82

* EUROP-classification P- = 1, P = 2, P+ = 3 etc

** Fat-classification 1- = 1, 1 = 2, 1+ = 3 etc

Discussion

Seventy percent of the growth of the ewe's foetus occurs during the last six weeks prior to lambing. The importance of high quality feeding during this period is critical. Additional to the foetus production, the level of milk production is founded. This is important for the lamb's growth after lambing. Lambs growth rate the first weeks after lambing is important for the growth rate during the summer (Bekken, 1995). The ewe's milk production depends on the quality of the feed from lambing to the beginning of the grazing season. The quality on spring grazing is also important for the milk yield. Lambs with a low growth rate (< 250 g/day) during the first weeks after lambing achieve lower live weight at autumn and poorer carcass weights than lambs with a high (> 350 g/day) daily weight gain (Bekken, 1995).

In this project, lambs daily weight gain in 2004 was between 277 g/day and 351 g/day in the indoor feeding period. The reason for this could be the length of the indoor feeding period. However, there were no significant differences between groups within years on ewes weight changes or on lambs daily weight gain or lambs slaughter data.

Conclusion

Feeding ewes potatoes and fish or barley silage and fish instead of commercial concentrates did not affect ewes weight changes or lambs average daily weight gain in the experimental periods. Further studies during lambing 2005 will secure the results from 2003 and 2004. To date, it is promising to use alternative feeds to commercial concentrates as a supplement to ewes during lambing.

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Sweden in a green economy

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Organic farming, food quality and human health

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Joining resources to improve organic food and farming research

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Abstract

The public European Research and Development effort in organic food and farming is characterised by small research communities; often scattered and fragmented both geographically and institutionally. This produces a need for gathering the dispersed expertise to a critical mass for keeping and increasing the competitive quality and relevance.

CORE Organic is a 3-year Coordination Action in organic food and farming funded by EU under the ERA-net scheme. Initially the project comprise11 partners, but it is open to include all countries with a national research programme for research in organic food and farming. The overall objective of CORE Organic is to gather the critical mass and enhance quality, relevance and utilisation of resources in European research in organic food and farming. It is the goal to have established a joint pool of at least 3 million € per year by the end of the project. This will be accomplished by implementation through four objectives:

1. Increased exchange of information and establishment of a common open web based archive
2. Coordination of existing research and integration of knowledge
3. Sharing and developing best practice for evaluating organic research
4. Identification and coordination of future research

(see www.core-organic.org for further info).

Introduction

European agriculture and food productions are in a state of flux. Society makes ever-increasing demands for a reduction in the use of many traditional agricultural inputs, such as pesticides, synthetic fertilisers and prophylactic medicines. At the same time there is scepticism amongst many consumers with regard to the intensification and specialisation that has characterised the development in agriculture and food production in recent decades.
In this context, organic farming represents a possible alternative with a more holistic view of agriculture and food production, and directly addresses the problems faced in many areas of conventional agricultural practice. Concerns for environment, biodiversity, rural development and social aspects, animal welfare, product quality and safety are thus essential ingredients of the philosophy behind organic farming.

The acknowledgement of these benefits has since 1993 resulted in an annual growth of 25-30 % in organic agriculture and trade with organic products, as described in the DG Agriculture report, 2002 on Organic Farming in the EU (http://www.europa.eu.int/comm/agriculture/qual/organic/facts_en.pdf), and in 2001 organic agriculture covered about 4.6 million hectares, equivalent to 3.7 % of the total EU agricultural area. In conjunction to this growth in agriculture several countries has set up comprehensive programmes for research in organic food and farming.

As organic farming is a fairly new research field with small national research communities, especially on specific fields, there is a special need for gathering a critical mass in research in organic farming.

Although research of relevance for organic farming can be undertaken by many different research groups and in different disciplines, organising organic farming research within the currently completely segregated agricultural research structures is not appropriate.

The prerequisite to strengthening research in the field of organic food and farming is thus to have strong and efficient core structures or schemes (national or regional hubs), which support specialists in research programmes of complex systems.

For a European research programme for Organic Farming it would be necessary to have the complete information about existing programmes.

Collaboration and coordination is essential in strengthening the overall performance of European research in organic farming. Among others, it is important to establish networks in organic research and it is important to utilise possibilities for cooperation between national research programmes. Collaboration in education and extension as well as participatory or farmer-driven research should also be possible.

Finally, identification of common evaluation procedures relevant to organic farming is seen as crucial for safeguarding and enhancement of research quality.

It is therefore desirable to establish a coordination network at the European level, which can secure collaboration, quality and relevance of research. The network, should compile the research projects in progress; project results and scientific publications throughout Europe, making them accessible via common databases and Internet portals to the interested public and to policy makers.

On this background the present ERA-NET project: "Coordination of European Transnational Research in Organic Food and Farming (CORE Organic)" was set up and initiated October 1st 2004 for a 3-year period.

Joining resources through coordination

The objectives of the ERA-NET scheme is to step up the cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through the networking of research activities conducted at national level and the coordination of future national and regional research programmes.

CORE Organic will support the described objectives and contribute to strengthen the foundation of the European Research Area for research in organic food and farming by:

- Setting up of a common Internet portal for communication
- Building open common Internet databases for publications, research programmes, etc.
- Mapping and analysing existing research programmes, activities and facilities
- Coordinating existing research and integrating knowledge within organic research
- Sharing and developing best practice for evaluating organic research
- Identifying and prioritising future research topics in organic food and farming
- Coordinating and implementing future research topics with joint funding

The present total input in organic farming research carried out by the 11 CORE Organic partners is approximately 60 million € per year (see table 1). Over the 3-year period of the CORE Organic project at least 180 million € will be invested in organic research in these countries. The CORE Organic will ensure optimal utilisation of this money.

The CORE Organic will develop synergy between the existing activities within research in organic agriculture and lead to the development of mutual opening and mutual access to research results. It will lead to the development of common evaluation criteria and joint identification and coordination, as well as joint funding of selected research topics in organic food and farming.

Table 1. Estimated national financial input into organic farming research in the 11 countries that cooperate through CORE Organic.

Estimated input into organic farming research in each country, million €/year											
	DK	**CH**	**D**	**UK**	**FI**	**AT**	**SE**	**NO**	**NL**	**IT**	**FR**	**Total**
Existing (AV. 2000-2004)	8	10	10	3.2	2	0.7	5.7	3	8	1.5	5.7	57.8
Future (2005-2010)	7	15	7	3.9	2	1.5	5.9	2	8	2.0	5.7	60

Baltic Ecological Recycling Agriculture and Society (BERAS project) -A case of Juva milk system

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Abstract

The aim of the study was to determine the potential, impact and prerequisites of localization and enhanced recycling in a rural food system, illustrated by the case of Juva milk. An interdisciplinary scenario based on the increase of local, organic milk to 50% of milk consumption was created and the sustainability was compared, on the basis of the statistics and data collected from the actors, with the present milk system. The nutrient loads, farm and local economy,, and using LCA interactions between the actors, and the constraints were studiedfarm and s. There is potential for localization, which promotes sustainability, of the Juva milk system through conversion to organic production of milk for local processing, increased recycling of nutrients between farms and from the demand chain, enhanced reliance on local energy and closer cooperation. This would decrease the nutrient loads to waters and enhance the local economy and partnership. Compensation for farms the income relinquished by reliance on recycling, and information for consumers are central prerequisites. The conclusions may be generalized for rural Baltic milk systems, although the structural challenges may often be greater.

Keywords: localization, recycling, food system, milk, sustainability

Introduction

Food production has played a central role in rural vitality. Rural regions have, however, increasingly specialised in producing and exporting raw material for food production, while at the same time satisfying the local demand with food imported from outside the region. Therefore, the added value of input production, food processing and food distribution has moved to urban areas resulting in unemployment, removal and disintegration of social structures in rural regions. Similarly, recycling nutrients and carbon, between plant production and animal husbandry within the regionally specialised agriculture, and within the vertically distanced food system, has become difficult. This, besides the use of non-renewable energy for imported, industrially manufactured fertilizers and for long-distance food transportation, has increased the environmental hazards caused by food systems. In addition to the development tasks of recycling agriculture supplying local, organic food the BERAS project aims to find out, whether localization and increased recycling in Baltic rural food systems would enhance sustainability and especially decrease the nutrient load which is destroying the Baltic sea. This presentation focuses on this research task by half of one illustrative case, the Juva milk system. Does localization of milk in Juva enhance sustainability, what kind of localization is required, and what are the prerequisites?

Conceptual framework

Food system is the conceptual framework which integrates the different organizational levels and different stakeholders focused on in the BERAS project. The food system includes here both the material, financial, social and value systems linked to food. It includes input production, agriculture, food processing, transportation, trade, consumption and waste management. Locality of the food system is seen as a relative concept, varying from the county to municipality level, whereby the Juva milk case represents the latter. The less and more local, recycling food systems are in this presentation compared by focusing on the milk subsystems of each. Due to the focus on rural food systems, localization (i.e. increased degree of locality; localization vs. globalization) is understood as an increased share of the local demand being met by local production based on local resources - not as a decrease in food export from the system. Recycling of organic matter is seen as a central means of localization of the inputs, and also a central motivation for localization of food systems.

The conceptual framework which integrates the different disciplines of the BERAS project is sustainability. The indicators for ecological sustainability are nutrient balances, N and P load to waters, gaseous emissions and use of non-renewable energy. The economic sustainability is studied on the basis of enterprise economy, local economy and environmental economy, and social sustainability by means of the quality and quantity of interactions in the food chain, farmers' possibilities to influence, justice of the division of benefits and vitality of local communities. A systemic concept of sustainability is applied, meaning that the challenge to improve sustainability is considered simultaneously in terms of the different dimensions.

Materials and methods

Research in BERAS (2003-2006) is based on case studies of various food systems (Seppänen, 2004) including recycling organic farms in eight participating countries around the Baltic sea. Two food systems, one in Sweden, and one in Juva, Finland, are focused upon. The cases are studied as potentially good examples, the impact of further localization and improved recycling is investigated, and obstacles and alternative solutions identified. A conscious intensification of the interdisciplinarity (ID) of BERAS was initiated after the first third of the project. The Finnish team performed an ID pilot study to create a scenario on a local, recycling Juva milk system, as one illustrative example, and to learn more about the process and potential of ID. Milk was chosen on account of the existing local, organic milk chain, which makes the scenario relatively realistic. The ID process, with a great challenge for commitment and learning, was based on a classic generic model of an ID research process (Klein, 1990) and quality criteria proposed by Mansilla & Gardner (2003).

Juva is a rural municipality rich in lakes, with agriculture and forestry playing a vital role in its economy. It has 7500 inhabitants, half of them populating the central village with no agriculture. It is a pioneering municipality in terms of organic farming in Finland and has demonstrated spirited activity developing local food since the end of the 1990's, started by the local actors of the food chain and supported by the municipality. In Juva, 20% of the active field area is cultivated organically, a third of which on dairy farms, and an organic dairy. The organic dairy collects most of the raw milk from Juva and the rest from the neighbouring municipalities. It produces all liquid milk products except sour whole milk. The availability of local, organic milk is good and its origin is well-known in Juva. Of the liquid milk products bought from retailers in Juva, below 2% originate the dairy. The corresponding proportion in the municipal institutional kitchens is somewhat higher, e.g. in the secondary school 4%.

A scenario of increasing the proportion of local, organic milk to 50% of the total milk consumption in Juva, combined with increased localizationrecycling and increased use of local, renewable energy in the milk system, was created. This scenario was then compared with the present status of the Juva milk system. Farming, transportation, processing and consumption were taken into account. The scenario was based on the data collected from is analyzed three local, organic milk farms, from the organic dairy and other actors of the local milk system. The present dominating milk system was studied on the basis of the available statistics and data collected from the actors. The nutrient loads were investigated on the basis of the primary production balance which indicates the ratio between harvested nutrients and input nutrients from outside the system to crop production (Seuri, 2000). , and using LCAThe impact on the economy of the case farms wasis investigated by linear programming. The gains and income forgone resulting from enhanced recycling and localization of N input were modelled, and the need for incentives to ensure the economic viability of farms was estimated. The sensitivity of farm activities to changes in prices and support were studied indirectly, e.g. on the basis of validity ranges. The quantity and quality of the interactions and obstacles for localization were studied on the basis of interviewsfarm and s. and tThe consumption habits and constraints experienced for use of local, organic milk were also monitored (Hannula & Thomsson, 2004).

Results and discussion

Two alternatives to cover an increase in consumption of the local, organic milk were considered both from the agricultural and processing viewpoints: compensation of the present level of production by more local production or an increase in production. Alternatives with increased recycling in agriculture and food system were also considered: to increase recycling within a farm, between the farms, and from the demand chain either in the present waste management system or after improvement. All the alternatives were preliminarily studied, and the scenario based on conversion to organic farming, increase in dairy production as well as recycling complemented between farms and from the improved waste management system, was focused on. Both current and new organic farmers would contribute to the increase in production. The choice was made, because this scenario coincided best with the aim to simultaneously increase sustainability in all of its dimensions, and was also realistic enough. Preliminary results of studies focusing on specifically on the milk subsystems are presented.

On account of the relatively diversified agriculture and existing processing capacity and logistics, localization of the milk system would not require marked structural changes. An increase in the proportion of organic milk production would improve the nutrient efficiency and reduce the nutrient load, especially per area but also per product unit and overall in Juva. This is achieved by nutrient recycling within the agricultural system. There is still potential to enhance recycling further, which decreases the nutrient load. The highest potential is for increased recycling between farms, the next for recycling from processing and consumption back to agriculture, but recycling within the farms can also be improved. Recycling from the demand chain has least obstacles in rural systems with no industry and close vicinity of fields. Effective nutrient recycling causes, however, income forgone for farms due to the lost production increase by nutrients imported into the system in fertilizers and feed. The income forgone can be reduced by focusing on recycling between the farms instead of within farms, as well as recycling from the demand chain. There is, however, a need to compensation.

Localization of the milk system would decrease the requirement for non-renewable nutrient and energy sources. Reliance on local, renewable energy would be increased due to compensation of nitrogen (N) fertilizers by recycling and biological N fixation. There is also a high potential for increased use of local, untapped wood energy or biogas, especially in the dairy and for production of electricity at farms. The decrease in transportation would also reduce energy consumption. Increased reliance on local recycling, resources, processing and transportation which compensate import to and activity outside Juva, would increase economic activity in Juva being beneficial for the local economy in the sense of improved employment and public finance. This is true even if localized consumption would be satisfied through farm conversion instead of increased milk production at farms.

The primary production and processing sector of the organic milk chain is heavily based on community ties and trust between actors, whereas the marketing and consumption end of the chain operates mainly within market and hierarchic relations prevailing between actors. If the organic milk chain would increase by volume, this could occur in a context of farmers adopting the partnership as a mode of working in the chain, thus replacing the hierarchical and market relations present in the conventional primary production and processing. As far as consumers are concerned, the growth of partnerships on the level of realising the organic concept/idea would need to be exhibited more extensively than is currently the case.

Prominent challenges for localization and recycling, based on the results of actor interviews, were closer cooperation between the farms - an example of win-win relations between all the dimensions of sustainability, compensation of imported milk powder, berries and energy in processing with local production, and partnership with the marketing enterprise. Some consumers had specific dietary requirements or the price as constraints for use.

Conclusions

There is potential for sustainable localization of the Juva milk chain through conversion to organic milk production for local processing, increased recycling of nutrients between farms and from the demand chain, enhanced reliance on local energy, and closer cooperation. This would decrease the nutrient loads to waters and enhance the local economy and partnership. Incentives to compensate the income forgone caused by efficient recycling is, however, a prerequisite. Information to consumers, e.g. on the basis of the present study, is a precondition for their commitment and partnership. The conclusions may be generalized for rural Baltic milk systems, although the structural challenges may often be greater.

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Organic Farming in a global perspective – our way into the future

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More than 26 million hectares of farmland in 108 countries are currently under certified organic management, an increase of 10 % only since last year. The leader in acreage is Australia, and counting the percentage of the arable land Lichtenstein is world leading with 26 % of the farmland while Denmark, Finland and Sweden are all among the top ten. Just to mention one specific examples of this enormously strong development, the number of organic enterprises in Italy increased from 54 000 in 2004 to 80 000 in 2005. IFOAM1, The Swiss research institute FiBL and the German Foundation for Ecological Farming (SÖL) together yearly publish a study on the development of organic faming, country by country and globally, including an analysis of trends and mechanisms behind the current development.

The development of organic farming is to a great extent market driven. A look at the market situation is therefore relevant in this context. The global market for organic products shows the same upgoing trend, uneven between years and regions, but with no signs of changing direction. The market value in 2003 was USD 25 Billion. Leading consumers of organic products are North America and Europe with Germany in the lead. But the organic market is not only something for rich countries in the North. China with its 300 000 hectares of organic farmland is making strides to become a major power in the organic food industry and in Brasil where a hot GMO discussion has triggered a race for alternatives, organic is gaining space with already 2 % of the market. Another sign of the tremendous market interest is that the successful market fair BioFach has multiplied in Japan, USA and Brasil.

The market is developing thanks to a diversity of sales channels from supermarkets to box schemes and farmers' markets. And from being very down-to- earth, informing about organic production, and the general positive environmental and animal welfare values, marketing strategies are becoming more and more sophisticated from fashion shows and wine tasting to the OTA film Store wars – a travesty of the popular movies Star Wars (will it cause a debate in the US similar to the Änglamark commercial in Sweden?).

Each country has its own organic story, of struggle and difficulties and of victories and positive development. One strong reason for success is the fact that organic farming worldwide, despite geographical, political, economical, social and cultural differencies, has a common value ground sharing the same goals and basic principles. But while organic stakeholders in our rich part of the world highlight goals like environment, food/health and animal welfare, the driving force of organic farming in the third world lies in other goals. Nitrogen leakage and grazing pigs do not have as high priority for the Brasilian eco-farmer as the social situation with poverty and severe health problems in the family, scarcity of clean drinking water and other resources.

Organic agriculture and its impact on food security in the poor parts of the world is far too little discussed and analysed with too little information on a global scale. It is surely an engaging topic however, and opinions are not always based on facts and reality. Since it is perhaps the most important goal of organic farming altogether, it's urgent to look seriously at the concrete effects of organic farming on the people and places which suffer most from the lack of possibilities to grow, eat or buy food, and the lack of health and environmental protection. Some evidence does exist however, and I would like to bring to your attention one scientific report and one practical example to give a picture of the potential of organic farming.

The SAFE2 World Project at the University of Essex in UK has carried out the so far most serious and extensive survey of worldwide organic/sustainable agriculture (Pretty& Hine, 2001), and shows a great potential for organic farming.3 The survey is an analysis of the impact of sustainable/organic agriculture on food security with 208 cases in 52 countries in Asia, Africa, and Latin America, and it goes through the mechanisms for the improvements achieved, as well as limits and constraints. The main conclusions are:

- Significant increases in food production per household at a relatively low cost due to yield improvement or diversity or density of produce. This result means increased consumption and improved health situation for women and children.
- Positive impacts on the natural capital, like increased water retention in soils, improved water table, reduced soil erosion and increased biodiversity.
- Positive influence on health which allows adults to be more productive and children to attend school. Children are seen as the main beneficiaries.
- Social learning processes. Participatory learning is more often used and more relevant than the conventional model of one-way diffusion, when it comes to learning about ecological complexity and to change behaviour. It leads to greater innovation, and the new technologies are more likely to persist.
- Soil improvement which was achieved through a wide variety of measures like the use of legumes and green manures, cover crops, use of compost and animal manure and careful tillage.
- Better use of water where better harvest and conservation techniques were key factors to improved productivity.

This survey as well and numerous other studies, links organic farming to the economical opportunities. Organic farming has proved to give lower production costs, more employment opportunities, access to new internal or export markets, more fair prices and a better family economy. Organic farming is also worldwide ascribed a production of public goods which cannot be delivered in any other sector such as clean water, wildlife, carbon sequestration in soils, on-farm biodiversity and landscape quality, services which are not yet valued enough.

I would like to illustrate these findings with a concrete example. I will take you to Brazil, the land of contrast of rich and poor, of affluence and malnutrition. Rio Grande do Sul, south-east Brazil, greened by the Green Revolution and the golden crop, the soybean, not produced to satisfy the need of protein and energy of a local population, but to feed cows and pigs in Europe. A few decades ago this was a mixed landscape of agriculture and forestry with a diversified polyculture providing the basic needs of thousands of family farms. Today the rich agriculture landscape has turned into a soya desert. The forest is gone, heavy erosion from inappropriate farming techniques is rapidly turning the soil infertile, small farmers cut off from technology, infrastructure and market possibilities are going bankrupt and forming the exodus from the rural areas into the slums of the big cities.

Those who stay on in agriculture have been forced into the high tech agriculture production intensely managed with agrochemicals. Lung and skin problems, cancer and malformed babies are the results of the heavy pesticide use. The WHO accounts for 220 000 deaths caused by pesticides and another 3 million acute poisonings in the world every year. This is a

low estimate however. Only in Nicaragua a recent study showed a 98 % under-reporting in the best surveillance system of Latin America. In Rio Grande do Sul in the end of the 1980ies there was hardly a family who did not suffer from the damages of the pesticides.
Centro Ecologico was founded in 1985 in a farm south of Porto Alegre by 4 young agronomists who decided to look for solutions to this miserable situation and to develop practical alternatives. They decided to work out a new model for agriculture based on knowledge and understanding of the ecosystems, protection and preservation of the soil, and building on human relationships between people occupied in agriculture. With the help of a Swedish friend-group in the organisation of Future Earth they succeeded in initiating an ecological development of agriculture.

The Centro Ecologico spent four laborious years educating, training and discussing with the most interested farmers and at the same time building trust starting organic production on their own farm. They got some unexpected help from the priests in the area, who were extremely concerned with the bad health situation among the rural population. The priests used the sermons to promote ecological agriculture and this was a turning point where farmers were inspired to try new possibilities. The situation changed completely. More and more farmers came to the courses and meetings, converted their farms and started a close cooperation through Centro Ecologico in processing and marketing. Farmers became advisors for other farmers as the interest grew bigger.

The strategy Centro Ecologico had from the beginning was to work with the farmers and their products all the way and with completely participatory approaches. It was important to get the farmers organised in groups, marketing and sale of the products was as prioritised as learning how to control pests and weeds without chemicals. In 1989 the organic farmers entered the street market in Porto Alegre run by the consumers' cooperative Colmeia. They immediately experienced a great success which led to the opening of small cooperative shops run by consumers selling the organic farmers' products through the week. A year later there were already 8 farmers cooperatives selling their products in as many markets. Small home industries on a farm level, took care of the surplus of the growing production of tomatoes, garlic, grapes and other products from the organic fields. The following years Centro Ecologico helped to start farmers' organisations and markets in 7 more cities.

The cooperation grew into a network where the farmers could work together to improve the quality and range of their local products, solve problems of seasonal variation, connect to schools and consumers and educate women. They learned book-keeping, improved their preservation and exchanging recipes, and they were inspired to take responsibility not only for their own lives but for the society they live in. 10 years after the difficult start Centro Ecologico had become a driving force for social and economical change in the state of Rio Grande do Sul. When in the year 2000 the state elected a new government and the president Dutre who had a positive attitude to the work of the environmental movement, Centro Ecologico and three more organisations were engaged to create a new agriculture policy with four goals: ban the GMOs, conversion of the state into organic agriculture, support of small-scale processing and new channels for organic products into the supermarkets and the public sector.

Today the work of Centro Ecologico has developed into a network covering also the states of Santa Catarina and Paraná. There are more than 150 groups of farmers working in and around 170 cities supported by 20 NGOs and 10 consumers' cooperatives. La Red Ecovida is a strong political factor in the development of agriculture in South Brazil. Together with the farmers, and now in Ecovida, Centro Ecologico also has developed a guarantee system which like the cooperative learning and marketing enhances nearness and participation. The system builds on trust and social control, and the main stakeholders in setting criterias and performing the control are producers and consumers. The almost 20 years of experience of Centro Ecologico is currently used in a recently started work on an international level to develop a Particpatory Guarantee System as an alternative better suiting some groups in third world countries than the third party construction with independent certifiers which is the most common in the so called developed world, like the EU-legislation and KRAV .

Centro Ecologico is only one example of how it is possible, with the tools of organic farming, to empower people to take their lives in their own hands. In Sweden we know best the cases where Future Earth, the SSNC4 (Svenska Naturskyddsföreningen) and Grolink, a Swedish organic consultancy company., are supporting and collaborating this kind of organisations and thus can make known their efforts and results, and give name and meaning to some of the goals of organic agriculture which are less elaborated in our part of the world. There are of course many other examples like this.

Organic agriculture also has limitations in solving the big underlying constraints for food security and food sovereignty. There are many other problems which are not solved by agriculture techniques, neither organic nor conventional. But organic farming can surely give a substantial contribution to improving the situation in local contexts in poor areas.

Organic farming is about taking the big global issues and problems seriously and working on solutions and improvements, changing the trend and showing new ways forward. And we do have big challenges ahead of us, except feeding the world. Climate changes and the dependence on oil and other non-renewable energy sources are the next ones already knocking on the door. Who should look these challenges in the eye and start a constructive and concrete discussion if not the devoted and creative actors within the organic movement.

Organic agriculture is not a ready recipe written in stone, it should rather be seen as an experimental workshop with a solid foundation of basic values, not perfect but always looking for more knowledge, better understanding and improved strategies. An open attitude to the world around us, recognising potentials and shortcomings, is what makes organic farming a dynamic model for change towards sustainable food production. It's part of the relevance of organic farming and part of the successful development worldwide. With this attitude and all the positive results and experiences to build on and move forward with, we can be confident that we are on the right way.

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4. WHO = World Health Organisation
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EU Network for Advisers on Organic Farming

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Abstract

The Danish Agricultural Advisory Service is preparing a European seminar for advisers on organic farming, to be held from August 28 – 30 2005. The scope of the seminar is to establish a European network for organic advisers and prepare an application for EU funding of the network.
Advisers and others working with dissemination of results from research in organic farming are invited to participate in the seminar and the network.

Keywords: adviser, network, dissemination, EU funding, seminar.

Aim
- To strengthen advisory services provided to organic farmers in Europe on the basis of research in organic farming

Goals
- To establish a network of and contacts between organic farming advisers.
- To convert results of organic farming research into practical, applicable information and guidelines
- To communicate converted research results, advisory material and 'best organic farming practise' in a common language
- To develop new methods of dissemination of research results and advice as well as new methods of training for organic farmers
- To exchange experience (internationally at seminars and workshops) on how to advise organic farmers and disseminate research results

Activities (some examples)

- Common Internet platform in English with selected professional material derived from the network
- Newsletters with practical farming advice derived from research in organic farming
- Exchange of project results between the participants of the network
- Collection and dissemination of advisory guidelines and tools in English
- Survey of suppliers of advice on organic farming and their knowledge sources
- Workshops and seminars on specialised topics for specialist advisers and experts
- Experience exchange and network meetings between the partners
- Generation of project proposals for further international development of organic farming and knowledge dissemination

Project proposal submission: January 2006
Project launch at the earliest: July 2006

Measurement of nutrient leakage from organic crop rotation in Finland

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Abstract

Water discharge and nutrient leakage studies were conducted in an experimental field on organic farming practices for 20 years. Water discharge was measured and flow-weighted water samples were taken from mixed crop rotation.

Keywords: water discharge, nutrient leakage, crop rotation, drainage flow

Introduction

Organic production may reduce nutrient leakage because of low external inputs of nutrients and high internal recirculation. There is, however, a risk of high losses from organic fertilizers, e.g. farmyard manure and legume biomass (Ylivainio et al., 2002). Few direct measurements have been made of nutrient leakage in organic agriculture in Finland.

Methods and preliminary results

Water discharge from drainpipes was measured from organic crop rotation since January 2005. The experimental field is located on a moraine soil in Juva, eastern Finland (61°53’ N, 27°53’ E). Organic farming practices were followed since 1985. The crop rotation (5.87 ha) is consisted of spring cereal and grass seeds (1st year), grassland (2nd), grassland (3rd), winter cereal (4th), green manure (5th), and spring cereal (6th). One of the plots was not included in the drainage measurement area of 4.87 ha. Approximately 30 t/ha cattle sludge was spread on the 1st year plot which equals about 0.3 LU/ha for the whole crop rotation per year. Harvested grain yields as net yields amounted to about 2,000 kg DM/ha and grass yields to about 6,000 kg DM/ha. Water discharge was measured automatically and flow-weighted water samples were taken manually once a day to once a week. The water samples will be analysed for both total and soluble nitrogen and phosphorus particles, total solids, pH and conductivity.

The first water discharge results from January to April are now available. The water flow was almost constant but minimal (< 0.1 l/s) throughout the winter. The spring flow occurred in April with a maximum flow of about 6 l/s and total flow of about 4,000 m^3 or 80 mm.

Conclusions

The organic farming practices were applied in the experimental field during 20 years and the soil profile was undisturbed since drainage in 1989. The aim of the farming practices is to maintain the productivity of the area, and the steady-state assumption is valid.

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Primary nutrient balance as a new tool to evaluate nutrient utilization

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Abstract

A new tool, utilization rate of primary nutrients (UPN), is introduced to evaluate parallel nutrient load and efficiency of nutrient utilization. It is independent of the quality and quantity of final products and therefore allows comparison between any production systems or farms.

Keywords: nutrient balance, nutrient utilization, nutrient load, efficiency

Introduction

From an ecological point of view there is only one production process in the agricultural system, i.e. crop production or primary production. Primary production can be utilized either directly as human food or fed to animals. Nutrient load and nutrient utilization, i.e. efficiency to utilize nutrients, are two separate dimensions. If only crop products are produced, the nutrient load is less than an equal amount (kg nitrogen) of animal products.

Materials and methods

In order to reduce the nutrient load there are two choices: either to produce less or to improve the efficiency of nutrient utilization. Since the amount of primary production is highly dependent on the priorities in the human diet, it can be taken as a given constant. According to this assumption, the harvested yield (Y) to external nutrient input (=primary nutrients, P) ratio alone indicates the nutrient utilization in any system. Seuri (2002) derived two identical equations for the utilization rate of primary nutrients (UPN):

(I) UPN = Y/P where Y = harvested yield and P = external nutrient input

(II) UPN = U(P+S)/P = U*C where U = Y/(P+S) = surface efficiency, C = (P+S)/P = circulation rate, S = recirculated nutrient in crop production (secondary nutrient)

On the other hand, the absolute nutrient load (L) is always:

(III) L = P+S-Y = (1-U)(P+S)

Conclusions

UPN is able to separate between nutrient load and nutrient utilization, i.e. the efficiency to utilize nutrients, unlike the surface balance method or the farm-gate balance method. Pure crop production causes less loading than mixed production despite equal UPN.

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Effect of barley preservation method on milk production and milk quality in organic farming

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Abstract

The demand of 100% organic feed in organic animal production (to be introduced in 2005 in Norway) may lead to an increased interest in growing and preserving cereals on the farm. Another possible strategy in organic milk production is to reduce the amount of concentrate.

The effect of dried vs. ensiled barley (cv. Arve) on feed intake, milk yield and quality in organic production was tested in two experiments in Northern Norway in 2003-04. In the first experiment, two groups, each of 16 cows (66 ±20 d.i.m.), were given either a normal (N; 5.7 kg barley DM/d) or a low (L; 1.0 kg barley DM/d) feed energy level, for 10 weeks. The two levels equalled 40% and 10% concentrated feed (barley) per cow and year, calculated on energy basis. At each feed level, half of the cows were given dried barley, and the other half ensiled, high moisture (64.0 ±1.03% DM) barley. During ensiling, the barley was rolled and molasses were added (22.4 kg/t) before portions of about 1000 kg were filled into tight plastic bags. All animals were offered roundbale grass silage (additive: Ensimax, 7-8 L/t crop; Borregaard Industries, Sarpsborg, Norway) from the first cut *ad libitum* (NIRS grass silage, per kg DM: 0.835 ±0.0252 FEm (5.76 MJ Net Energy lactation); 73.8 ±0.50 g AAT; -20.8 ±9.29 g PBV). Both drying and ensiling preserved barley properly and resulted in approximately the same feed intake and milk production. Grass silage intake was lower (12.8 vs. 15.3 kg DM/d) and milk yield higher (21.6 vs. 17.5 kg ECM/d) for cows on N, than on L. All feed rations had low protein contents (in average 11.7% CP in DM), which lead to extremely low values of NH_3 in rumen fluid (in average 0.33 mM) and low contents of milk urea (in average 1.17 mM). Cows in group L had lower milk protein concentration (2.91 vs. 3.20%) than cows in group N, possibly due to the lower feed energy level. The palatability of barley was in general low, and several cows refused parts of their allowances throughout the experiment. In the beginning, 9 cows in group N and 2 cows in group L were treated with a glucogenic feed supplement (Energy Balance, Felleskjøpet, Norway) and 3 cows in group N and 1 cow in group L were treated by a veterinary against ketosis.

The second experiment involved 12 cows in a cross over design with three treatments and three one-week periods. The trial was designed to evaluate the effect of preservation method for barley on sensoric milk quality. The cows were fed well-preserved grass silage *ad lib.* and supplemented with 5.8 kg DM of either dried barley, barley ensiled with molasses, or barley ensiled with a propionic acid-containing additive (additive: Eng-silage 2000, 2.5 L/t crop; Agil ltd. Hercules; Freyasdal Norsk Kjemi AS, Kristiansand, Norway). Only one sample of evening milk from one cow that got barley ensiled with molasses had a reduced sensoric quality. Thus, no negative effect of ensiled barley was observed.

Organic farmers in marginal climate may choose to ensile barley due to the advantage of earlier harvesting time and lower energy cost for post harvest drying. A disadvantage is that ensiling of cereals is time consuming, and, due to its consistency, the end product may be difficult to handle by automatic feeding equipment.

Imported feed increases the nitrogen emissions from dairy farms

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Abstract

The use of import of feed can in theory allows a improvement of the N-efficiency of a farm, since N losses connected to the production of imported feed stuff are excluded from the farm N-balance. We have tested this hypothesis using data from surveys of commercial and prototype farms.

Data were collected from a number of studies (Bleken *et al.*, 2004). The farm surveys included 7 organic or integrated farming systems and 14 conventional systems, and covered a wide range of environmental conditions (from Northern Italy to Southern Norway) and yield intensity (from 3000 to 13000 l milk $ha^{-1}y^{-1}$). All fluxes were expressed in kg N $ha^{-1}y^{-1}$. The products considered were net milk and livestock sale (**P**). The net purchased feed (**$F_{off\text{-}farm}$**) was calculated by subtracting crop sale. Systems with net crop sale were not considered. The apparent N surplus at the farm (**S)** was estimated as the sum of all inputs (mainly fertilizer, biological fixation and atmospheric deposition) minus P. The ratio S_{farm} / P = **E_{farm}** gives the emission factor, that is the amount of N (in kg kg^{-1}) that is dissipated from the farm system or accumulated in the soil organic matter, in order to produce 1 kg of N in milk + livestock.

A strong positive correlation was found between the proportion of feed that was imported and the N emission factor. The produce increased significantly with the amount of $F_{off\text{-}farm}$. However, since also other N inputs increased together with feed imports, the N emission factor increased significantly with the ratio of net feed imports ($F_{off\text{-}farm}$) to the farm own plant production. There were no statistically significant differences between organic and conventional farms. We tentatively suggest that an excessive load of animal manure, compared to what can be sustained by the farm own plant production, dramatically reduces its efficiency for crop production.

Keywords: emission factor, life cycle analysis, nitrogen efficiency

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Bleken, M.A., S. Hansen and H. Steinshamn (2004) The nitrogen efficiency of dairy production is determined by the production intensity of the system. Grassland Science in Europe, 9, 672-674.

Green manure as a multifunctional tool in vegetable production I Nitrogen (N) efficiency

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Abstract

A comparison of N efficiency was conducted between direct incorporation of red clover and fermented, composted or fresh red clover used as a mulch. The N efficiency from harvest of red clover to harvest of a leek crop was highest with direct incorporation, with 8% of the N taken up in the leek crop compared to between 3 and 5 % in the other treatments.

Key words: N-efficiency, red clover; direct incorporation, fermented, composted, mulch,

Introduction

Green manuring with legumes supplies N to the cultivation system. However, in vegetable crop sequences, it is a disadvantage to include a crop that does not provide a direct economic return. Incorporation of fresh green manure biomass can also cause losses if the release of nutrients is not synchronised with crop requirements. Within the project, we studied some alternative ways of using green manure crops that provide the potential to remove and store nutrients between sites and growing seasons.

Field trial with red clover and leek

The field trial was carried out in Uppsala, Sweden. In addition to a treatment with direct incorporation of fresh red clover, three doses of fermented residue, compost and mulch were included. The trial also included a mineral fertiliser treatment and an unfertilised control. N losses between harvest of the red clover and time of fertilization were 22 and 54% for fermented and composted red clover respectively, or 8% when the red clover was used as a mulch. The uptake of N in a leek crop as a percentage of total N input was between 5 and 10% for the red clover-based fertilizers compared to 20% in the treatment with mineral fertilizer. However, not all of the fertilizer N was accessible to the leek crop during the cropping period. Uptake of accessible N was 30% in the treatment with direct incorporation of the red clover, 30-50% with fermented red clover, 40-60% with composted red clover, between 50 and 80% when red clover was used as a mulch and 25% in the treatment with mineral N. The amount of mineral N left in the soil profile after leek harvest was high in the treatment with mineral fertilizers and in the treatment with the highest input of fermented red clover, 164 and 105 kg ha^{-1} respectively compared to between 30 and 50 kg ha^{-1} in the other treatments. Due to low N uptake, the difference in yields between treatments was low. The leek yield in comparison to harvested red clover acreage was highest in the treatment with direct incorporation and in the treatments with the lowest inputs of fermented red clover and mulch.

Conclusions

As the N efficiency was highest with direct incorporation, other forms of using green manure must confer additional benefits such as lower N losses, the potential to be applied as a topdressing and the possibility to use less attractive areas for growing the green manure crop.

Green manure as a multifunctional tool in vegetable production II Impact on soil microbial community structure and function

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Abstract

A study on long-term effects of different fertilizers showed that 47 years of green manure amendments have changed the microbial community structure, such as the abundance of mycorrhiza and fungi, compared to other inorganic and organic fertilizers. Green manuring also affected soil enzyme activities, but had no profound effect on substrate-utilization potential. Further studies will focus on short-term microbial dynamics after green manure amendments and on soil food web interactions after incorporation of fresh red clover.

Keywords: BIOLOG; Organic fertilizer; Phospholipid fatty acid; Soil C; Soil enzyme activity

Introduction

Green manure is an important alternative to mineral fertilizers and farmyard manure to sustain soil nutrient and soil organic matter status on stockless organic farms. Inputs of crop residues can have large impact on soil microorganisms, but the influence on microbial community structure and function is not well understood. In this study we investigate the effect of green manure on (1) microbial biomass and community structure, estimated with the phospholipid fatty acid analysis (PLFA), (2) activities of soil enzymes, active in the cycling of N, P and S and (3) microbial substrate-utilization potential determined by the BIOLOG test.

Results and future studies

The results from a long-term field trial showed that 47 years of green manure amendments increased the abundance of some microbial groups and total microbial biomass compared to soils without organic amendments. The impact of green manure was similar to that of other organic fertilizers, but differed in some aspects such as mycorrhizal and fungal biomass. For example, mycorrhizal biomass was lower in green manure amended soil compared to farm-yard manure and sawdust amended soil, but higher than in sewage sludge amended soil. The activities of different enzymes showed a varying response to green manure; protease and aryl-sulfatase activities were not significantly higher than in a mineral fertilized soil whereas phosphatase activity was increased. There were no differences in substrate utilization between the treatments, except for the sewage sludge treated soil, which had a reduced capacity to utilize different substrates. All microbial variables except substrate utilization were closely correlated to soil C content when the sewage sludge soil was excluded. Two additional field trials have been performed, where short-term impact of different green manure forms (direct incorporation, mulch, slurry and compost) on microorganisms and fauna will be studied.

Conclusions

Long-term green manure amendments have changed soil microbial community structure and enzyme activities, but no concomitant effect on microbial substrate-utilization potential was observed.

Green manure as a multifunctional tool in vegetable production. III Impact on the content of alkyl cysteine sulphoxides in leek and glucosinolates in cabbage

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Abstract

Leek and white cabbage fertilised with different types of green manure were obtained from a field trial and from growers. The content of alkyl cysteine sulphoxides and glucosinolates were lower in organically fertilised leek and white cabbage than conventionally fertilised leek and white cabbage. The content of ascorbic acid was unrelated to fertiliser regime

Keywords: green manure, alkyl cysteine sulphoxides, glucosinolates, leek, white cabbage

Introduction

Health-promoting effects of organic foods are often related to a higher amount of secondary metabolites. Research has shown that organically produced food contains higher levels of phenolic compounds than conventionally grown food. However, the knowledge about how other secondary compounds than phenolics are affected by organic fertilisers is rare. The aim of this study was to investigate how different organic forms of green manure and the availability of minerals affect the concentrations of vitamin C and glucosinolates in white cabbage, and vitamin C and alkyl cysteine sulphoxides in leek.

Materials and methods

Leeks were harvested from a field trial and white cabbages were obtained from growers. Both crops had been fertilised with different types of green manure: 1.Direct incorporation of green manure in spring season, 2.Use of fermented green manure, 3.Use of composted green manure, 4.Use of green manure as a mulch. Mineral fertilised leek and white cabbage were used as control.

Results

The levels of alkyl cysteine sulphoxides and glucosinolates were related to the total sulphur content of leek and white cabbage respectively, but unrelated to the yield. The highest content of alkyl cysteine sulphoxides in leek and glucosinolates in white cabbage were found when mineral fertilisers were used. The systems where green manure either was used as mulch or was direct incorporated showed the lowest content of the two S-containing compounds. An additional fertilisation with chicken manure to white cabbage increased the content of sulphur and glucosinolates. The ratio between aliphatic and aromatic glucosinolates distinguished between variety and site.

The level of ascorbic acid in white cabbage was unrelated to fertiliser regime and site. In leek, the content of ascorbic acid was correlated to potassium level and the relationship between ascorbic acid and alkyl cysteine sulphoxides was affected by the ratio between nitrogen, potassium and sulphur.

Green manure as a multifunctional tool in vegetable production IV Intercropping as a pest management strategy against the turnip root fly

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Abstract

A large scale field experiment demonstrated that the turnip root fly (*Delia floralis*) laid less eggs on cabbages grown with a red clover intercrop than in those grown in monoculture. Further, *D. floralis* laid less eggs on intercropped cabbages growing near the border with the monoculture than those which were growing in the centre of the plots. Within the monoculture plots, the flies laid more eggs near the border of the plots compared to the centre of the plots. This effect appears to extend for approximately 4 metres linearly from the border between the treatments. Predation reduced numbers of the turnip root fly equally in intercropped and monoculture cabbages.

Keywords: Intercropping, Turnip root fly, (*Delia floralis*), predation, cabbage

Introduction

Intercropping has been shown to reduce attacks from several insect pests, either by acting as a barrier or by enhancing the population of natural enemies. An insect that might be controlled with intercropping is the Turnip root fly, *Delia floralis* Fall. (Diptera: Anthomyiidae). The larvae feed on the roots of Brassica crops, resulting in reduced yield or death of plants. The turnip root fly can be a large problem for vegetable farmers in Northern Europe.

Field trial with intercropping of cabbage and red clover

In a large scale field trial we found that the egg laying of the turnip root fly was reduced by approximately 50% when cabbages were grown together with red clover, compared to those grown in monoculture. Detailed study of the distribution of the eggs found that egg laying was lower near the border of the intercropping with the monoculture. This effect on egg laying extended for around 4 meters into the plots and could account for a further reduction in egg laying of 26%. Contrary to this, the plants at the border of the monoculture received approximately 10% more eggs than the plants in the centre of the plots. Using steel barriers to exclude predators from the cabbages led to a 30% reduction in the number of pupae at the end of the season. The predation effect size did not differ between monoculture and intercropped plots.

Conclusion

Intercropping has the potential to reduce the damage caused by some insect pests. If cultivation systems are designed with the behaviour of the pest species in mind, then it may be possible to optimise the benefits of intercropping. The boundary effect which we found here, demonstrates that a form of trap crop may enhance the impact of intercropping. The results of our study indicate the predation pressure on *D. floralis* was maintained by natural enemies, even when egg laying was reduced by the presence of a clover intercrop.

Green manure as a multifunctional tool in vegetable production V Reducing competition in intercropping systems

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Abstract

Screening of a number of species as intercrops between rows of white cabbage (understorey crops) showed that burnet and birdsfoot trefoil were the most suitable species. Root pruning of the understorey crops increased cabbage yield by approx. 20%, to between 70 and 75% of the yield in a mono-cropping system.

Key words: Intercropping, understorey crops, root pruning

Introduction

The many positive effects of intercropping are well documented but they are overshadowed by the main drawback of the system; interspecific competition. Intercropping systems with vegetables and green manure crops have often resulted in dramatically decreased yields of the cash crop due to competition for nutrients, water and light. This project aimed to develop methods of decreasing competition between the cash crop and the understorey crop by choice of understorey species and by root pruning.

Field experiment with white cabbage and understorey crops

The experiment was carried out at Årslev in Denmark. Based on the results of observation trials, red clover, birdsfoot trefoil, burnet and winter rye were selected as understorey species. One week before planting of the white cabbage crop, the first root pruning of the understorey species was carried out using a specially constructed machine. This involved pulling knives along the edge and below the rows of understorey crop to a depth of approximately 0.2 m. Two weeks after planting, the understorey species were root pruned a second time.

The most promising understorey species were burnet and birdsfoot trefoil. For these species total cabbage yield was between 50 and 65% of the yield in the monocropping system, though the percentage saleable yield was somewhat lower. By pruning the roots of the understorey species the total cabbage yield was increased to between 70 and 75% of the cabbage yield in the monocropping system, and as root cutting increased the saleable yield by a higher percentage, the saleable yield reached around 70% of the yield in the monocropping system.

Conclusions

Choice of understorey species and root cutting seem to be promising ways to reduce competition in intercropping systems. Optimisation of these parameters should be followed up with studies of how fertilisation and irrigation affect the system.

Optimization of organic nutrient supply to tomato plants

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When plants are grown in the presence of organic fertilizers, a main challenge is the synchronization of nutrient availability with plant nutrient demand. In greenhouses where plants are often grown in limited amounts of substrate in beds or containers, the timing of nutrient release is particularly important. The aim of the present study was to optimize the nutrient supply to organically grown tomato plants in limited volume containers.

In the first part of the study, the ability of the substrate to supply nutrients to young tomato (*Lycopersicon esculentum* Mill. cv Delito) plants was investigated in a climate chamber experiment during four weeks after transplantation. Different amounts of composted farmyard manure (FYM; 10, 15 or 25 vol %) and pelleted poultry manure (PM; 10 or 15 kg m^{-3}) was mixed with granulated clay (5 or 15 vol %), mineral soil (15 vol %) and sphagnum peat.
The plants were grown in 3.5 l pots and the soil solution was collected by mini-lysimeters inserted into the pots. In the second part of the study, the substrate where the best plant growth was observed was used to compare different strategies for supplemental fertilization during a growth period of three months after transplantation. Bi-weekly fertilization with poultry manure (PM) or vinasse at four different rates were compared for tomato plants grown in 25 l pots in controlled climate greenhouse chambers. The same fertilizer treatments were also applied to smaller (12 l) pots during the first six weeks of the experimental period.

In the first experiment, the best plant growth was observed in the substrate containing the lower amount of clay (5 vol %) and the highest amounts of FYM (25 vol%) and PM (15 kg m^{-3}). The total uptake of N in the shoot was not affected by the amount of FYM added, but was higher at 15 as compared to 10 kg m^{-3} of PM. None of the substrates were able to fulfil the N requirement of the plants during the four weeks experimental period. Addition of the higher amount of clay to the substrate led to even lower shoot contents of N and also reduced plant growth and the K concentration in the soil solution. In contrast, addition of PM or FYM increased the concentration of K in the soil solution. In the second experiment, where supplemental fertilization with different rates of vinasse and poultry manure were compared, vinasse increased shoot uptake of N, K and Na but reduced the contents of Ca and Mn as compared with PM. The three higher amounts of vinasse strongly increased plant growth parameters including fruit number and total fruit yields. However, individual fruit weight was reduced and about 50% of the fruits showed symptoms of blossom-end rot. In the 12 l pots, the highest amount of vinasse also reduced shoot dry weight. The highest yield of marketable quality was obtained when the higher amounts of PM was added. However, the availability of N and/or K were probably limiting the growth and yield of plants fertilized with PM.

High electrical conductivity in the substrate and risk of osmotic stress and blossom-end rot may be a problem when animal manures and industrial by-products containing high amounts of Na or Cl are used as organic fertilizers. The substrate volume is a crucial factor affecting the risk for salt stress problems when plants are grown in the presence of organic fertilizers in limited volume containers.

Keywords: farmyard manure, poultry manure, *Lycopersicon esculentum* Mill., substrate, vinasse

Clover rot (*Sclerotinia trifoliorum*) and *Fusarium* fungi in organic red clover in Finland

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Sclerotinia trifoliorum is economically one of the most important pathogens of red clover in Europe and North America, while many *Fusarium* species can cause root rot in red clover in certain environmental conditions. During the years 2003-2004 *S. trifoliorum* was found only in the Northern and Eastern part of Finland, although in 1960's (Ylimäki, 1969) it was common everywhere in Finland. This is probably due to the decrease of red clover cultivation in western and southern parts of Finland. *Fusarium* fungi can live saprophytic or in other plant hosts, when red clover is not available. So, they are not as dependent on clover plants and clover rot. The most aggressive *S. trifoliorum* strains were found in Northern Finland. The cultivars Betty and Bjursele were more resistant than cultivars Jokioinen and Ilte. It was possible to slow down the development of red clover rot in red clover by using microbe preparates and chemical control. The best protectional action had the chemical preparate Rovral (biological effectiveness 65 %) and biopreparate Alirin B containing *Bacillus subtilis* (biological effectiveness 52 %). Also the biopreparate Mycostop slightly slowed down the killing of red clover by *S. trifoliorum*.
There were differences in the composition of fungal isolates in the root samples from young red clover during the first growing season as compared to those of older red clover. *Gliocladium* and *Trichoderma sp.* and *Rhizocotonia* sp. isolates were more common in older organic red clover fields than in the young ones. In the young red clover fields *Cylindrocarpon sp*. isolates were more common than in the older fields. In the nonorganic fields with a long history of cereal growing *Fusarium avenaceum* and *F. culmorum* were more common than in organic fields. These fungal species were also among the most common ones in the previous study of Ylimäki et al. (1967). Only one of the tested 14 *Fusarium* isolates was clearly pathogenic to germinated red clover seedlings. The identification of some of the difficult *Fusarium* and *Sclerotinia* isolates could be confirmed by comparing their ITS (internal transcribed spacer region between ribosomal DNA units) sequences to known sequences in GenBank, while the success of artificial inoculation could be confirmed by comparing the fingerprinting patterns of RAPD-PCR products from the fungus from diseased seedlings to those from the isolate used for artificial inoculation.

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Acknowledgements
This project was funded by the Ministry of Agriculture.

The test results of cereal varieties suitable for organic farming in Latvia

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Abstract

The field experiments that focus on crop rotation for cereal production and varieties testing concerning organic farming were started at the State Stende Plant Breeding station in 2000.
Due to lack of winter wheat and rye varieties suitable just for growing under organic farming conditions in Latvia, testing suitability of conventionally grown winter wheat varieties to organic conditions of growth is necessary. Eight winter wheat and 6 rye varieties were tested at the State Stende Plant Breeding Station during 2002- 2004. According to results suitability for growing in organic conditions show middle intensive local winter wheat varieties 'Krista', 'Sakta'. The rye varieties 'Duonai', 'Amilo', 'Voshod', 'Kaupo' have more stable grain yield level.

Key words: winter wheat, rye organic farming, varieties

Introduction

From January 2006, Latvian organic farmers will have to use only organically produced seed. In connection with that the demand of field crop organic seed is rapidly increased. Good seed is the base of good yield. The right crop variety is of very great importance in organic management system. Cereal crop variety, which is plastic enough, capable of utilizing natural soil fertility, competitive with weeds, resistant to diseases and lodging, is able to provide yield and stable quality of grain under diverse conditions of growth. Winter wheat and rye is one of most demanded crops in Latvia.

Material and methods

The total area of field experiments was 3.4 ha. All acreage is certified. 8 winter wheat varieties test was established on a field with 1st year red clover as previous crop. The field was sown to winter wheat in autumn between 5 and 10 September. The seeding rate was 550 germinating seeds per 1 m2.6 rye variety testing was arrange in the field were the pre-crop was potatoes; the field was sown to rye in autumn September 6. The seeding rate was 500 germinating seeds per 1m2.

Results

During 2002 – 2004, 8 winter wheat varieties: 'Krista', 'Sakta', 'Banga' (Latvia), 'Pamjati Fedina' (Russia), 'Ibis' (Germany), 'Cobra' (Poland), 'Belina', 'Garmonija' (Byelorussia) were tested. The 3-year results could lead to the conclusion that local varieties of mid-intensive type, such as 'Krista' and 'Sakta', characterized with good winter hardiness, grain yield and stable quality were suitable for growing under organic conditions. Rye varieties 'Kaupo' (Latvia), 'Amilo' (Poland), 'Valdai' (Russia), 'Duonai' (Lithuania), 'Jorge' (Germany) had not a big grain yield variance between 3 years - the grain yield were from 2.36 t ha^{-1} until 4.21 t ha^{-1}. Varieties 'Kaupo' and 'Voshod' characterized with good winter hardiness and more stable grain yield (3.10-3.51 tha^{-1}) and falling number.

Yield and plant growth of organic strawberries

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Abstract

Strawberries were planted in rows with or without plastic mulch. The aim was to investigate how degradable plastic mulch affected plant establishment and yield. The results showed increased total yields and little or no effect on plant growth.

Keywords: Fragaria x ananassa, plant growth, yield, plastic mulch

Introduction

In Sweden only a few percent of the strawberry production is organic. One of the reasons for the low percentage is that the options to control pests and weeds are limited and expensive. To use shorter rotations is one way to avoid that large number of pests and weeds infest the crop. In Sweden, the perennial matted row system with three to four years of cropping is the most common practice in conventional strawberry production. In organic production no more than two years of harvesting is recommended. With shorter rotations it is essential to have a successful plant establishment to reach a high total yield. To use plastic mulch in organic strawberry production could improve nutrient availability and affect soil temperature and moisture, which improves plant establishment and leads to increased total yield.

Trials with degradable plastic mulch

In two different trials strawberries were planted in rows with or without degradable plastic mulch in August and harvested for the first time in June the following year. The harvest was divided into four categories: marketable yield, berries with powdery mildew (*Sphaeroteca alchemillae*), berries with grey mould (*Botrytis cinerea*), and berries with other damages. Number of runners and crowns were counted and dry weight was measured after the harvest. The results show increased total yields by 60 percent the first harvesting year with plastic mulch and 25 percent the following year. The second year there were some differences between berries with powdery mildew, there were more damaged berries in plots without plastic mulch. The first harvesting year there was significantly more runners with plastic mulch in one of the studies but there were no difference between the treatments in the other study. The second harvesting year there was significantly more runners in plots with plastic mulch. The number of crowns and dry weight were not affected by the plastic mulch.

Conclusion

The use of degradable plastic mulch is one way of increasing the yield in organic strawberry production.

Natural regulation and field releases of predators in apple and pear

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Abstract
A series of experiments were conducted to assess the potential for inoculative releases of *Anthocoris nemorum* and *A. nemoralis* (Heteroptera: Anthocoridae) in apple and pear as a supplement to the regulation provided by naturally occuring beneficials.

Keywords: *Anthocoris nemorum*, *Anthocoris nemoralis*, biological control, natural regulation

Introduction

Natural enemies can often keep pest infestations at a tolerable level. Predatory bugs and spiders, the early generalists in orchards can control or delay outbreaks sufficiently for control by the later arriving specialists. Some years, however, natural regulation does not do. Interactions between climate and life-conditions for pest and beneficials can lead to outbreaks as seen with Rosy Apple Aphid, *Dysaphis plantaginea* in 2004.

Ecological infrastructures

Ecological infrastructures such as hedgerows and flowering strips provide alternative habitat and prey for beneficials. Actively increasing functional biodiversity to protect against insect pests it is termed conservation biological control. *A. nemorum* occur in high numbers in apple orchards and in mid-summer when prey is scarcer in the trees, it can be found in higher densities in orchard and hedgerow annuals, often in stinging nettle, thus conserved in the orchard until in late-summer when more insect pests again occur in the trees (Sigsgaard *in press*). The species composition of hedgerows also affects their value for natural enemies.

Releases of predators

In cases of serious attacks conservation biological control does not suffice. In Europe several approaches are tested. Supported by the Danish Veterinary and Food Administration KVL in collaboration with Danish Institute of Agricultural Sciences, Fejø Experimental Orchard and fruit growers assess the possibilities for releases of *A. nemoralis* (already commercially available), and *A. nemorum*. Based on oviposition (Sigsgaard 2004) and prey preference experiments and a preliminary release against Pear Psyllid *Cacopsylla pyri*, *A. nemoralis* was selected for further study in pear, and *A. nemorum* in apple. Experimental field releases of *A. nemoralis* in 2003 and 2004 were promising with approximately 40% reduced early psyllid infestation. In 2005 field releases of *A. nemorum* against apple aphids will be assessed.

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Can the hens work and hide in their feed?

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Abstract: See conclusions

Keywords: behaviour, environment, harvest, resources, rapeseed, sunflower, weeds

Introduction

An experiment with laying hens in mobile houses in rapeseed and sunflower crops was performed in the summer 2003. The hypotheses were that the hens would have a regulatory effect on weeds in these crops, that the hens would regard crops higher than themselves as protective, and that sunflower seeds could be part of the hens' feed intake harvested by the hens. From an ecological perspective, such interactions could mean smaller resource costs for feeds and weeding and an appreciated environment for the hens.

Materials and methods

One hundred 16 weeks old hens of Lohman Selected Leghorn (LSL) were equally distributed between 2 mobile houses, and each house (flock) was moved between four 200 m^2 experimental plots for 3 weeks on each plot (in total 8 experimental plots). The plot crop in periods 1 and 2 was rapeseed, in periods 3 and 4 sunflower. Before and after the presence of the hens, the number and mass weight of crop and weed plants was estimated from 6 subplots of 0.25 m^2 from each of the two parallel experimental plots and were compared with a control plot without hens. Twenty measurements of the height of the crops were taken along the diagonals of the plots. The hens were fed whole wheat and oats, a fishmeal-calcium-vitamins/minerals blend in the relations 7:2:1, and shells, all in free choice *ad libitum*. The distribution of the hens in the crops was studied during 8 days at 514 occasions. Distances of 5, 15 and 25 m from the houses were marked. Every other hour between 7h and 19h the number of hens in the different zones was counted. The observer was outside the plot.

Results

On average, 25% of the hens were more than 5m from their house during the time studied. The biggest difference was between periods 1 and 3, 14 and 37 % respectively ($p<0,001$). Most hens were out between 14h and 17h in periods 2 and 3. In period 1, the growth of the weeds was equal in the experimental plots and the control, but the rapeseed grew significantly less than the control. Thus, the hens had no influence on the weeds but a negative influence on the growth of the crop. The height of the crop was lower than the hens. In periods 2, 3 and 4 the hens had a significantly decreasing effect on the weeds in number and mass weight but no difference in crop growth compared to the control. The crop was higher than the hens. The harvest of rapeseed was low in both experiment and control plots, corresponding to 360 kg ha^{-1}. In the experiment, 7% of the harvest was weed seeds, in the control 45% was weed seeds.

Conclusions

The hens can regulate weeds in row sown crops. The hens harvest sunflower seeds from the plants, starting at an earlier stage than harvest time. The hens can move around in these crops without trampling them. The hens were out more when the crop was higher than the hens.

Different standing crops for organic layers

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Abstract
In typical organic egg production systems nearly all the feed is imported and fed inside the henhouse. Moreover, most of the hens stay inside the house or predominantly use the area just in front of the hen house. In consequence many systems are exposed to an unacceptable accumulation of nutrients in the most utilized areas in the hen yard. It is the hypothesis that this drawback can be affected if the feeds for a higher degree are based on foraging within the hen yard.
The purpose of this study was to estimate the effect of including staying crops in the hen yard on feed intake, production parameters, recirculation of nutrients in the system and the welfare of the poultry.
Two experiments with different staying crops for laying hens were conducted at Research Centre Foulum in 2004. Each experiments was carried out as a 2x2 factorial split plot experiment with two different crops as the main plots, two types of feed as subplots (concentrate for organic layers versus wheat) and three replications. Each plot totals 200 m^2 and in all plots oyster shells and grit stone were added to the feed. 20 hens and 1 cock of the breed "Lohmann Silver" were inserted into each plot for about 4 weeks. In the first experiment the crops consisted of clover grass and a mixture of herbs (buckwheat, tansy-leaf phacelia and flax). In the second experiment crops consisted of clover grass and chicory (Grassland Puna).
Preliminary results show that the feed consumption was significantly different of the two types of feed. Hens consumed approximately 90g wheat daily in both experiments whereas they consumed 129g concentrates in exp.1 and 155g concentrates in exp.2. This probably indicate a higher retention time in the gizzard + a higher consumption of green fodder among the hens fed wheat. Hens fed wheat had a significantly higher intake of oyster shells compared to those fed concentrate. No differences in the intake of grit stone were seen. The hens had a significantly lower egg production per hen per day in the first experiment (LS-means 0.90 vs. 0.70) when hens were fed wheat only, however no difference were seen in the second experiment with LS-means at 0,82 egg/hen/day for both types of feed. In both experiments a significantly lower egg weight were seen when hens were fed wheat. The type of crops had no effect on the egg production. Clinical welfare assessments of all hens that were made at insertion and postponement showed an excellent plumage condition, food health and colour of the comb irrespective of treatment.
Results of feed intake will be interpreted in the light of observations of roughage content in the crop.

Steaming in narrow bands to control weeds in row-grown organic crops

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During 2003 and 2004, the Department of Landscape Management and Horticultural Technology carried out trials on steaming of soil in narrow bands before sowing of organic sugarbeet. These trials were carried out in collaboration with Stockholmsgården, Löderup and were funded by the Swedish Board of Agriculture. Final reporting of the project will be in December 2005.

During steam treatment, the soil is heated to over 80°C. When the soil has cooled, the crop, e.g. sugarbeet, onion, carrot or parsnip, can be sown in the 'weedfree' strip. Steam treatment gives the crop a great advantage over weeds, which leads to greater competitive ability than if sown in untreated soil. Steaming of the soil in narrow bands reduces the need for weeding in the rows.

The trials were carried out on different fields with sandy soil at Österlen (Scania). The fields were sown with organic sugarbeet immediately after steam treatment. The most frequently occurring weeds were fat hen (*Chenopodium album,* L.), groundsel (*Senecio vulgaris*, L.), black nightshade (*Solanum nigrum*, L.) and green nightshade (*Solanum physalifolium*, Rusby). The treatment was applied using a diesel-driven steamer from Regero (RJ Maskiner, Bjuv). The hot steam was conducted down to nine applicators. Each applicator treated a ~10 cm wide band and the total working width was 5.10 metres. The amount of steam used per hectare, and thus the temperature of the steamed strip and the diesel consumption, varied with the driving speed of the tractor.

The results of the trials from 2003 and 2004 indicate that the steaming method is very effective against e.g. fat hen, groundsel and the nightshade species, since the soil is heated to over 80°C. The method also proved to have good potential to radically reduce the need for costly manual weeding in organic sugarbeet growing. The need for hand weeding of sugarbeet was only 40 hours per hectare in the steam treated trial plots, which can be compared with approx. 110 hours in non-steam treated plots in 2003.

Steaming of the soil in narrow strips is a considerably more energy-saving method than heating the entire seedbed with steam before sowing. The method is also a suitable alternative for conventional growing when chemical treatment is not possible for some reason.

Pre-steaming of soil before organic sugarbeet in 2004 also demonstrated a positive effect on emergence rate of the crop. The sowing rate was 8 seeds per metre and, on the areas of the field that were not steam treated, emergence was around 3 plants per metre. On the steamed areas, however, the emergence rate averaged over 7 plants per metre.
More studies are needed to investigate how steam treatment affects various soil-borne pests.

Keywords: emergence, manual weeding, soil, steam treatment, sugarbeet

The ØkoTek-project - developing new technology for organic farming in Norway

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Abstract
The ØkoTek-project runs 2003-2005 in Norway. The aim is to test new technology in organic farming such as steam-treated seeds, control of perennial weeds, machines for spreading of green mulch and machines for in-row weed control in vegetables.

Keywords: mulching techniques, row crops, weed seed inhibiting crops, slurry seeding.

Introduction

Development of an efficient and economically sound organic production requires research on and introduction of new technology for small-scale as well as large-scale farms. In the ØkoTek-project in 2005 we have five sub-project;

1) to construct a green mulch spreader for vegetable production

2) to study the use of mustard, lupines, barley and buckwheat as weed sanitary crops.

3) to investigate the possibility to control cereal seed-borne diseases by hot humid air

4) to test the German in-row weeder 'Phneumat' in carrots and onions.

5) to study the slurry seeding technique in peas, oil-seed rape and spring wheat.

These studies will be carried out in cooperation with farmers, private companies and advisory service organisations in Norway. A main goal is to give accurate advice and new machine technology for use on organic farming systems in Norwegian conditions. Results will be presented in spring 2006.

Conclusions

The project is a combination practical testing/development of new technology in organic farming and information/demonstration of new tools and cultivation technique. Hedmark University College are establishing a centre for agricultural technique during 2005, and the ØkoTek project will participate here with experience and science on organic farming technique. The ØkoTek project will finish in December 2005.

Acknowledgements

The project is funded by the Norwegian Agricultural Authority

Poster no. 20

Specialisation through co-operation between farms in organic farming

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Abstract
Co-operation in organic production provides the potential for production specialisation with the help of co-operation in machinery use, input integration, crop rotation, shared buildings and marketing. Co-operation models provide the opportunity to optimise production between different lines of production from environmental, economic and functional perspectives.

Keywords: specialisation, co-operation, crop rotation, environmental impacts

Introduction

In organic production, specialisation has been feasible only up to a certain point. Appropriate crop rotation means, in practice, that in addition to the main production line, the farm engages in supplementary production. Co-operation can bring even greater benefits in organic production than in conventional production. On animal and cereal farms co-operation between two farms would allow both farmers to specialise in their respective lines while safeguarding an adequate nutrient rotation.

Methods and preliminary results

Technical, subsidy-related, legal, social and ecological hindrances and advantages and obstacles and opportunities for close co-operation between farms have been recorded by a literature study. The first stage of the field study studied existing co-operation models in five co-operating rings of farms. The effectiveness of co-operation was assessed with the help of nutrient balances and cost accounting. The second stage of the field study will create co-operation models between different lines of production. The models aim at optimising production from the environmental, economic and functional perspectives compared to that of farms operating alone. Five different forms of co-operation were identified according to farm interviews: co-operation in 1) machinery use and contracting, 2) input integration, 3) crop rotation, 4) shared buildings for production, and 5) marketing. According to both the literature study and the farm interviews the benefits of the co-operation were reflected in terms of lower production costs and better profitability, specialisation of professional skills, more free time, better or wider crop rotation, more efficient use of green manure as fodder and animal manure as fertiliser. However, increases in road transport and machine weights, the need for social skills, and problems in machinery maintenance were identified as drawbacks.

Conclusions

Specialisation through co-operation is practised amongst organic farms in Finland. However, the types and scales of co-operation are not always well planned. The scepticism of farmers towards co-operation could be altered by advice services and training.

Developing organic farming in Norway through systemic action research

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Keywords: Agroecology, systemic action research, agroecosystem, multicriteria

Contextual background

To reach the governmental goal of 10% organic certified area in Norway before 2010 our knowledge about organic production needs to be developed further. At present a regionalised animal and plant production is the dominating situation in Norway. In the research programme "Organic cropping systems for higher and more stable cereal yields" the main goal is to achieve new knowledge about sound production of cereals in organic farming with few animals. Without compromising the overall goals of multifunctional and diverse agroecosystems our partial goal is to improve cereal production in organic farming.

Multicriteria, multiperspective and systemic research

A systems analysis is carried out as one part of this programme. The major goals of the systems analysis are to build up competence in agroecology and to improve complex agroecosystems. Agroecosystems, with multiple goals and criteria that often are in conflict with each other, need an analysis that encompasses this complexity (Rickerl & Francis, 2004). Pathways towards a strong ecological sustainability have to be socio-cultural acceptable and economically viable as well, which is why a systemic research approach is applied when creating and evaluating alternative solutions (Checkland & Scholes, 1999). Therefore, an important issue is how to develop sound agroecosystems as seen in terms of resource and environmental perspectives without compromising agronomic, economic, social and cultural perspectives.

Systemic action research – how to handle complexity in agroecosystems

A case study of an organic farm in combination with field trials at an experimental research station is done. In close contact with stakeholders of this agroecosystem the study will define key issues using a systemic action research approach (Reason & Bradbury, 2001). In-depth studies to learn about the system as a whole, its components and dynamics are done in order to develop scenarios for improvement of the agroecosystem.

The objective is two-fold: To develop a research design that is capable of handling multiple criteria, multiple perspectives and multiple methods in concert and in dialogue with stakeholders in order to develop sound agroecosystems.

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Potential for conversion to organic farming in Norway

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Abstract
About 22 % of the conventional dairy and cash crop farmers in Norway are considering or are planning to convert to organic farming during the next four years. For these farmers higher soil fertility, professional challenges, profitability, and organic farming payments were important motives for conversion.

Keywords: conversion, motives, goals, attitudes

Introduction
In 1999 the Norwegian Ministry of Agriculture launched the goal of ten percent organic area of the agricultural area for the end of 2009. In 2004 3.3 percent of the agricultural area were certified for organic production.

Materials and methods
The data originate from a survey of dairy and crop farmers in Norway (Koesling et al., 2004). This study was based on the results from 1.018 farmers, and descriptive statistical analyses were used to examine the data.

Results and discussion
Four percent of the conventional respondents planned to convert to organic agriculture by the year 2009. Eighteen percent of the farmers were not sure what kind of production system they would practice. These farmers and those with plans to convert are called “potential converters” in this study.
For potential converters, higher soil fertility, professional challenges, profitability, and organic farming payments were important motives for choosing organic production. Ideological and philosophic reasons and production of high quality food were for them of less importance than for the existing organic farmers. Although the motives for conversion were influenced by economic and political forces, the two most important goals for for potential converters were to “continue to be a farmer” and to have “reliable and stable income”. Out of fourteen goals for farming, they placed “profit maximising” on place ten.

Conclusion
Several of the mentioned factors influencing the farmers decision on the production system were influenced by agricultural policies, which thus represent an important factor for farmers‘ decision regarding to convert to organic farming or not.

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Acknowledgements
The Research Council of Norway, grant 151264/110, provided financial support for this research. The authors thank the farmers participating in the survey for their co-operation.

Are organic crop farming more risky than integrated and conventional crop farming?

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Abstract
Risk is important for farmers' choice of cropping system. The aim of this study was to compare production, price and policy risk of organic, integrated and conventional cash-cropping systems in Eastern Norway.

Keywords: organic, integrated and conventional crop farming, stochastic simulation, multivariate kernel estimator, risk aversion

Introduction
The effects of different cropping systems on environment, agronomy and economic aspects are important attributes in a sustainable agriculture context. There are reasons to believe that different cropping systems behave differently given the same weather situations and thus have different impacts on production risk. For example restrictions on pesticide and fertiliser use may give different production risk in organic farming than in conventional farming. Smaller organic markets may mean greater price fluctuations. These types of risks should be considered when comparing economic viability between cropping systems, because most farmers are risk-averse, and there is a need to account for downside risk. Earlier studies have however mostly looked exclusively at profitability by analyzing average net farm income. In this study we compare the production risk between conventional, integrated and organic cash-cropping systems in Eastern Norway, and quantify the importance of specific organic area payments and price premiums on economic viability in organic systems.

Materials and methods
Experimental cash-cropping system data (1991-1999) from Apelsvoll experiment research station in Eastern Norway were combined with budgeted data. Empirical distributions of total farm income for different cash-cropping systems were estimated with a simulation model that uses a multivariate kernel density function to smooth the sparse experimental data. Stochastic efficiency with respect to a function (SERF) was used to rank the cropping systems for farmers with various risk aversion levels.

Results
Compared to the conventional system, the average yields were lower for all individual crops in the integrated system, and lowest in the organic system. The relative variability in yields between years in general and the income risk were highest for the organic system. Under existing Norwegian price and public payment schemes the organic cropping system stand out as the most economic viable alternative for growing conditions at Apelsvoll, independently of farmer's degree of risk aversion. Even if the specific organic area payments disappear organic farming still are most economic attractive for moderate risk-averse and risk-neutral farmers.

Conclusion
The results show that the organic system was riskiest, but the existing payment system and organic price premiums makes it the most economically viable alternative today.

Risk perceptions and management responses of organic and conventional dairy farmers in Norway

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Abstract
This study was conducted to explore organic and conventional dairy farmers' perceptions of risk and risk management, and to examine relationships between farm and farmer characteristics, risk perceptions, and strategies.

Keywords: Risk, risk management, questionnaire, multivariate analysis

Introduction

Few studies have examined how farmers perceive risk and manage it in practice, particularly in organic farming. Organic farmers are exposed to additional and different sources of risk compared to conventional farmers, due to production restrictions, smaller organic markets and additional government payments. This study was conducted to explore organic and conventional dairy farmers' perceptions of risk and risk management, and to examine relationships between farm and farmer characteristics, risk perceptions, and strategies.

Materials and methods

The data originate from a survey of conventional (n = 363) and organic (n = 162) dairy farmers in Norway in the spring of 2003. Descriptive and multivariate statistical analyses were used to examine the data.

Results

Organic farmers had the least risk averse perceptions. Institutional and production risks were perceived as primary sources of risk, with farm support payments at the top. Compared to their conventional colleagues, organic farmers gave more weight to institutional factors related to their production systems. Conventional farmers were more concerned about costs of purchased inputs and animal welfare policy. Organic and conventional farmers' management responses were more similar than their risk perceptions. Financial measures such as liquidity and costs of production, disease prevention, and insurance were perceived as important ways to handle risk. Even though perceptions were highly farmer-specific, a number of socio-economic variables were found to be related to risk and risk management. The study is further described in Flaten et al. (2005).

Conclusion

The primary role of institutional risks implies that policy makers should be cautious about changing policy capriciously and they should consider the scope for strategic policy initiatives that give farmers some greater confidence about the longer term. Further, researchers should pay more attention to institutional risks.

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Differences in health and health handling between organic dairy farmers in Norway depending on time of conversion

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Abstract: Animal health and health handling were studied in organic dairy farms separated into three groups according to time of conversion. The study showed differences in both health and health handling between the groups and especially so for the earliest converters.

Keywords: animal health, health handling, organic dairy farming, time of conversion

Introduction: Padel (2001) concluded that motives for conversion to organic farming have changed from the earlier philosophical ideals and husbandry reasons towards an increasing focus on environmental and economic concerns, and the perception of organic farming as a professional challenge. With changing motives health and health handling may be affected.

Animal health and welfare is regarded as a core element in organic production (IFOAM, 2000), therefore it was of interest to investigate for differences in health and health handling in organic dairy farms depending on time of conversion.

Materials and methods: The data originate from a survey focusing on risk and risk handling of conventional and organic (n = 162) dairy farmers in Norway in the spring of 2003 (Flaten et al., 2005). Respondents were categorized into three groups: (1) those who had farmed organically since 1995 or earlier (*early converters*, the "old guard"); (2) those who were certified in the years 1996 to 1999 (*mid converters*); and (3) those who started farming organically in 2000 or later (*late converters*, the newcomers). Descriptive statistical analyses were used to examine the data.

Results: Differences between the three groups were found with respect to the total number of disease treatments per 100 cow years, 29, 43 and 54 for the three groups "old guard", mid converters and newcomers, respectively. Also amount milk delivered to dairies was different 4112, 4417 and 4588 litres, respectively. Among diseases treatments per 100 cow years, chronic and sub-clinical mastitis were lowest in the first group (2 versus 8 and 7 in the two later groups) while treatments for ketosis and for teat tramp per 100 cow years were higher in the first group compared to the mid group (1.4 and 2 versus 0.3 and 0.6). The newcomers were separated from the two earlier groups by having recorded treatments for lack of heat while such treatments were not recorded in the two first groups. The geometric somatic cell count was lowest among the newcomers.

The old guard showed a tendency towards using more time on milking cows with signs of mastitis before calling the veterinarian, and both the old guard and the mid group used alternative treatments more often compared to the newcomers. The old guard less often used advisory services.

Conclusion: Most differences for health related parameters were found between the "old guard" and the two later converting groups. The latter were closer to the conventional health management systems they had converted from.

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Transmission of zoonotic diseases through manure disposal on arable land - an animal and human health problem?

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Verotoxin producing *Escherichia coli* (VTEC) is a human pathogen and has been implicated in numerous outbreaks of hemorrhagic colitis and a life-threatening haemolytic uremic syndrome. The Swedish situation concerning human pathogenic VTEC is around 100 reported cases each year among a population of 9 million people. Cattle represent the main reservoir of VTEC and in Sweden, around 10% of the herds are carriers of the pathogen with a geographical concentration to the south and south west of Sweden (23% in Halland and Skåne).

Food, water and person-to-person spread of VTEC accounts for a significant proportion of human cases. However, there is a growing concern about the number of sporadic cases and outbreaks connected to direct contact with cattle or their faeces. In a policy regarding the control of VTEC, signed by five Swedish authorities, manure management has been identified as being important in the spread of the pathogen. Cattle manure may transmit VTEC to arable land and to associated water systems by the land-based disposal of cattle manure and manure slurry. However, while soil and vegetation can be expected to directly influence the survival of this pathogen, relatively little is known concerning the transmission routs of VTEC in arable land.

The present study was undertaken to evaluate the survival of VTEC in cattle manure and manure slurry, amended in soils with different texture. Thus, three soils; clay loam, sandy loam and a loamy sand, were collected from field (upper 10-30 cm), air dried, and sieved at 4 mm. Fresh cattle manure and manure slurry (corresponding to a dose of 30 ton/ha) were inoculated with a nontoxigenic VTEC strain of *E. coli* O157 and incorporated to each soil. The manure-amended soil were adjusted to 80% of water holding capacity by adding the necessary amount of water and composite samples of 300 g were placed in aerated microcosms (0,5 dm^3). In total, 6 treatments were set up, each combination done in triplicate. The microcosms were incubated at 15°C and the survival of *E. coli* O157 was determined at 8 occasions during the incubation period of 70 days. Bacterial survival was quantified by direct viably counting on selective media.

We found the reduction rate of *E. coli* O157 to be significantly lower in the clay loam compared with the sandy loam and a loamy sand soil. Thus, soil texture seems to be one important factor for the persistence of VTEC in manure-amended soils. Further, using manure slurry instead of manure also resulted in a significantly lower reduction rate of *E. coli* O157, regardless soil type. This indicates that the type of manure storage systems is of importance for the pathogenic survival in the manure.

The present study has identified some factors of importance for the persistence of VTEC in soil. The persistence and leaching of VTEC due to the soil texture and structure will be further evaluated in a recently initiated outdoor lysimeter study. This knowledge is of great importance in order to give the farmers appropriate recommendations for handling and use of cattle manure so that transmission of pathogens such as e.g.VTEC and *Salmonella* spp. can be minimized.

Organic pig production based on one-unit pens in climate tents

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The most commonly used system for organic pig production in Denmark is sows kept on pasture all the year round and growing-finishing pigs reared in stables with access to an outdoor concrete area. Production of finishing pigs reared under such conditions is constrained by considerable building cost and it may be questioned whether it comply with the consumers' expectations of organic farming. Corresponding, to keep sows on pasture is often associated with a high risk of nutrient leaching, especially during winter.

An alternative system for organic pig production is the one-unit pen system in twelve-sided climate tents as described by Andersen et al. (2000). The conceptual basis of this system is to combine animal welfare with a low environment impact. So far, this system has only been employed for housing of pregnant sows and finishers. However, whether the concept is suitable for housing of lactating sows and weaned pigs has not been investigated.

The purpose of the project was to document the production performance of lactating sows and weaned pigs housed in twelve-sided climate tents and to identify the most critical obstacles to an efficient production. In this abstract focus will be on the performance of the lactating sows and their offspring until weaning.

Each tent included four farrowing pens with access to separate outdoor, deep-bedded run. Only 2nd to 4th parity sows were employed. The male pigs were not castrated and the sows were not ringed. At approximately eight weeks of age the piglets were weaned and the sows were moved whereas the weaned pigs stayed in the tent until slaughter. The farrowings took place in March-April and in September-October. The sows and piglets had access to pastures during the summer.

Preliminary results from 20 litters showed productivity on a per-litter basis comparable to indoor and outdoor conventional Danish pig production. For instance, total number of born piglets was 13.8 and number of weaned pigs was 11.1. The total piglet mortality was thus 20 % for the entire lactation period. At weaning the piglets weighted in average 22.4 kg.

The one-unit pen system for housing of lactating sows makes it possible to combine animal welfare with a low environment impact and the results of this study indicate that it is possible to obtain production results comparable to conventional outdoor production. However, future studies are needed to develop the concept further, especially with respect to control of endoparasites and improvement of the working environment.

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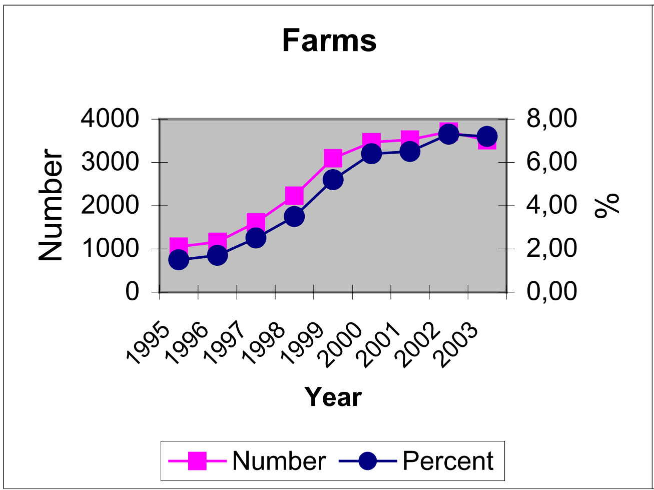
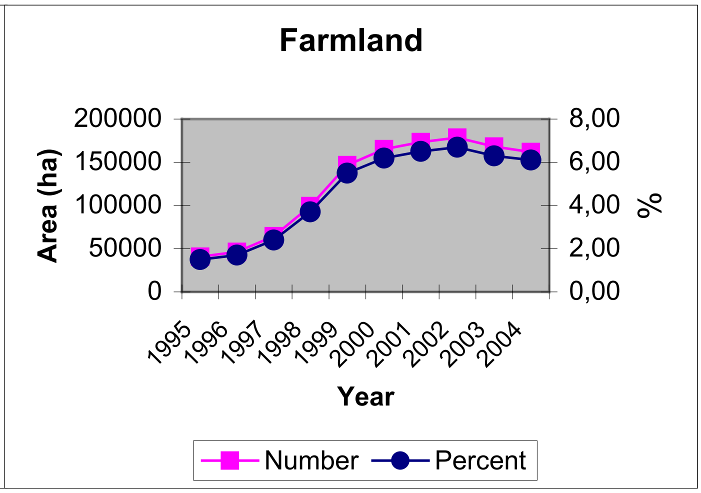
Organic production
In Denmark

Some historical highlights

1936: The Biodynamic Association was established (http://www.biodynamisk.dk/)
1981: The Danish Organisation for Organic Farming (LØJ and later ØL) was established (www.okoland.dk/)
1982: The Danish Organic Agricultural College was established to educate farmers (www.oekoskolen.dk)
1985: Advisory service for farmers was established (www.lr.dk/)
1987: The Danish Parliament adopts a comprehensive legislation on organic farming.
1987: State certification and inspections were introduced
1995: Action plan 1 was designed to propel organic farming
1999: Action plan 2 was designed to support the development of organic farming



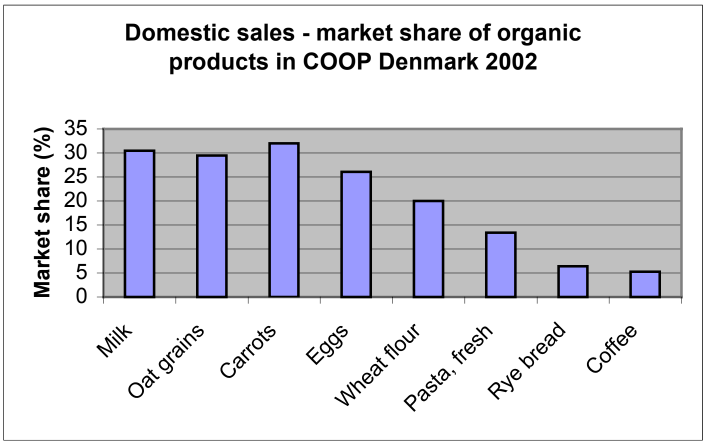


The Danish Plant Directorate conducts **certification and inspection** and gathers statistics about organic farming (www.pdir.dk/Default.asp?ID=4600). The "Ø"-label is an inspection label launched in 1990. The regulations associated with the Ø label are based on EU legislation.

Research is coordinated by DARCOF (The Danish Research Centre for Organic Farming), with the aim to elucidate the ideas and problems faced in organic farming through the promotion of high quality research. DARCOF is a "centre without walls" where research is performed in interdisciplinary collaboration between research groups (www.darcof.dk/).

Organic Eprints is an international **open access archive** for papers related to research in organic agriculture (orgprints.org/).

Higher education: KVL (www.kvl.dk) offers bachelor courses in organic farming (kursus.kvl.dk/ea/) and PhD courses in organic agriculture and food systems in collaboration with DARCOF (www.soar.dk/).



Produced by Jesper Rasmussen, (jer@kvl.dk), KVL (DK)

Organic Agriculture in Estonia

1989 Estonian Biodynamic Association

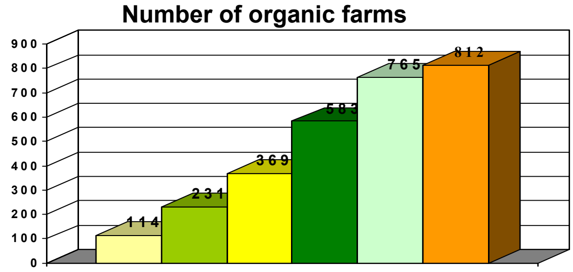
1997 Estonian Organic Farming Act;

2001 harmonizing with EU 2092/91

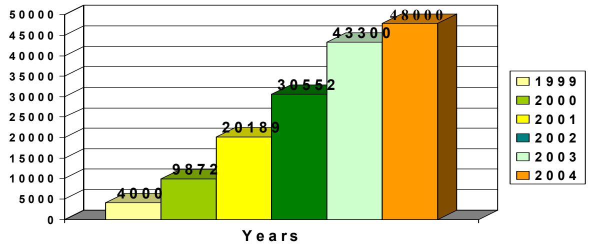
Inspection:

- Estonian Biodynamic Association 1990-1999
- Estonian Plant Production Inspectorate (TTI) since 2000

Number of organic farms



Organic area (ha)

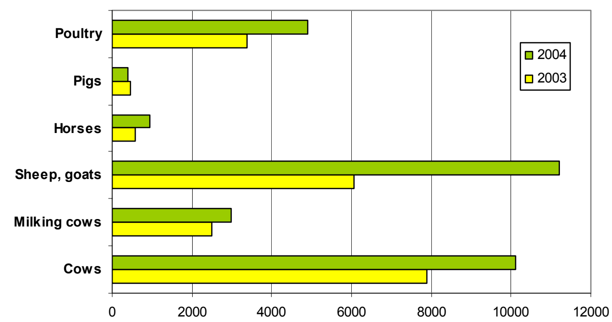


Dominating mixed farms with average size:
2000 - 43 ha ; 2003 - 56 ha; 2004 - 59 ha

Land use (ha) in 2004:

annual and perennial grasses	28 209 (15 644 converted)
natural meadow	8 990 (4 347)
cereals	5 421 (3 564)
green manure and black fallow	1 524 (797)
fruit and berries	660 (217)
legumes	253 (179)
potato	280 (179)
vegetables	56 (41)
technical crops	54 (44)
herbs and medicinal plants	35 (33)
greenhouse crops	0.64 (0.20)

Number of certified livestock



Name of inspection: producers by TTI and processors by Estonian Veterinary and Food Inspectorate - governmental bodies

Education : some courses in the Estonian Agricultural University (EAU) and Agricultural Technical Schools; Newspaper in Organic Agriculture since 1996; Organic Farming handbook 2001

Research: parts of projects in EAU and Estonian Agricultural Research Centre

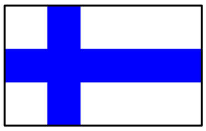
Export : none at this moment (2004-2005)

Present status of the policy and market environment of the Estonian Organic Farming Sector:

- ***Since 2000 national organic farming support for conversion and production***
- ***Organic area is covering almost 5 % of agricultural area but processing is purely developed and limiting market development***
- ***Direct marketing form farms is dominating, a lot of products are sold as conventional products without labelling***
- ***Insufficient public awareness in organic food***
- ***Very limited financial support for research and small processors***
- ***Underdeveloped advisory service***

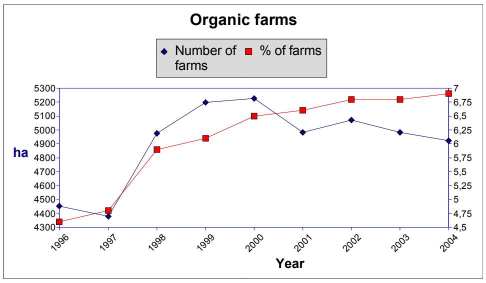
Production and layout: Anne Luik(EAU), statistical information from the Estonian Plant Production Inspectorate

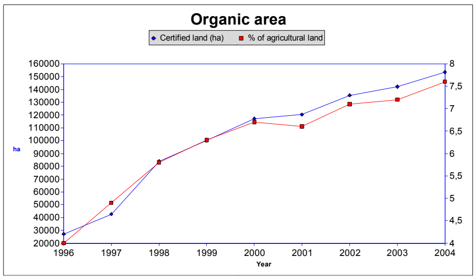
Organic production in Finland

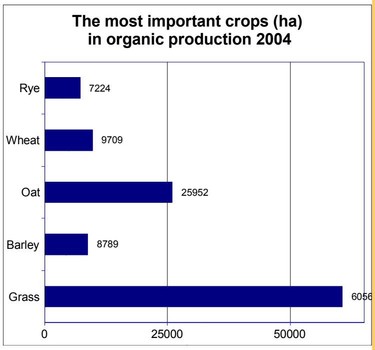


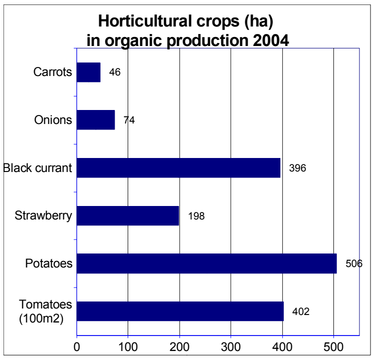
- First farm started in 1927
- First still existing organic farm started in the 1960s

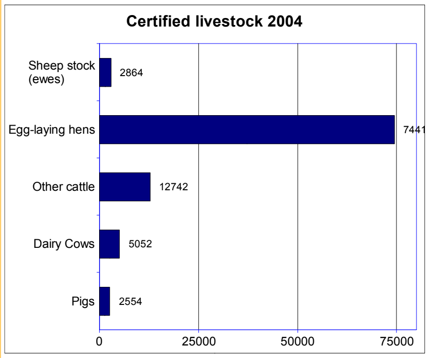
- **First years of inspection:**
- Luomuliitto - The Finnish Association for Organic Farming since 1986,
- Ministry of Agric. and Forestry since 1994











Name of inspector: KTTK – Kasvintuotannon tarkastuskeskus (The Plant Production Inspection Centre)

Education, 100%: University of Helsinki, Institute for Rural Research and Training: degrees in Bachelor of Science (BSc) and courses in Ecological Agriculture. The degree consists of studies at the University of Helsinki and at universities.• Master courses (MSc) in the Nordic NOVA European cooperation cooperation network.

Research: The main research institute, MTT – Agrifood Research Finland uses approx. 3,6% of its financing on organic production research projects .

Export : Cereals to other EU countries and the US approx. 15 million kg per annum. Shitake mushrooms, forest berries (2004-2005)

Present Status of the Policy and Market Environment of the Finnish Organic Sector:

- *Target of 10% surface area has been set for organic production in 2006.*
- *Organic production receives public subsidies. The sum during the initial five years is €147/ha and €102/ha thereafter. The subsidy is equal to every culture . Also, as from 2005 organic animal production has received a subsidy of €90/ha.*
- *So far, Finland has a surplus of organic cereals and grasslands. About 10% of the cereals have been exported and a great share of organic grasslands and cereals used for feeding conventional animals.*
- *The total market share of organic products is approximately 1%. The most important organic products are vegetables (24%), milk (17%) and bakery products (11% share of total organic sales).*

Text: Mikko Rahtola, Central Organisation for Finnish Horticulture

Organic production in Iceland

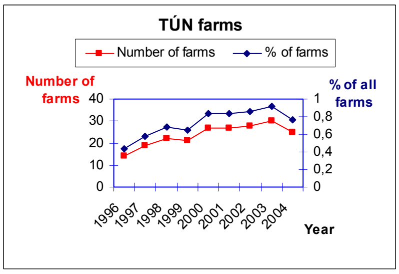
First farm started: 1930

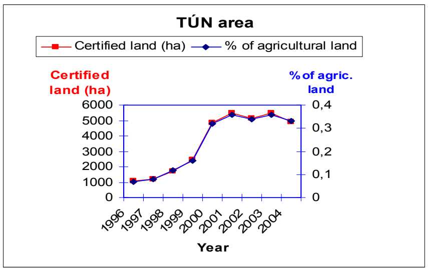
- **Sólheimar í Grímsnesi**

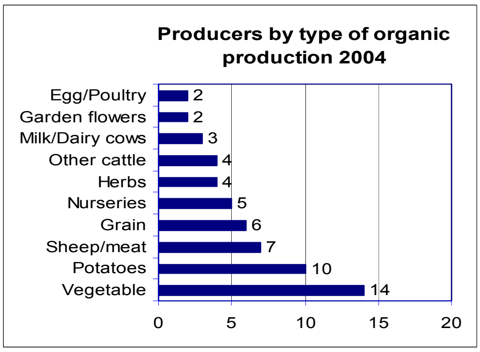
EES-ESB vottun IS-1

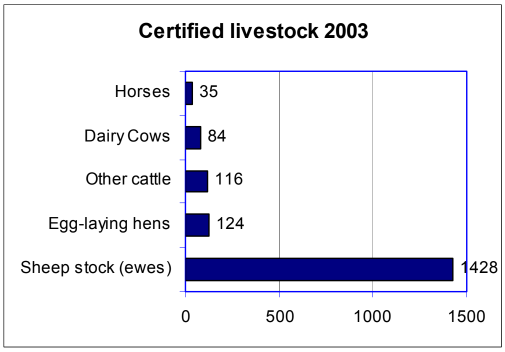
First year of inspection:

- **Soil Association 1994**
- **Vottunarstofan TÚN 1996**









Name of inspection:	**TÚN – Vottunarstofan Tún (IS-1) – Non governmental**
Education, 100%:	**No. There are a few courses in the Agricultural University of Iceland – (also in adult education and distance education)**
Research:	**Agricultural University of Iceland (LBHI). Little at this moment.**
Export :	**None at this moment (2004-2005)**

Present status of the policy and market environment of the Icelandic Organic Sector:

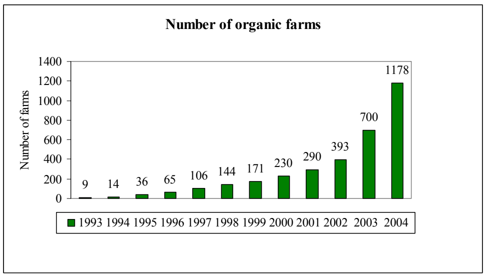
- ***No official targets have been set for organic development.***
- ***The sector is purely market driven and without public support.***
- ***Marketing and production of plant products successful and growing.***
- ***Marketing of livestock products not so successful, partly due to dependency on large processing firms and abattoirs who are uninterested.***
- ***No publicly funded conversion scheme is yet in place.***
- ***The overall agricultural budget offers small support for some aspects of organic farming but insufficient to make an impact on conversion.***

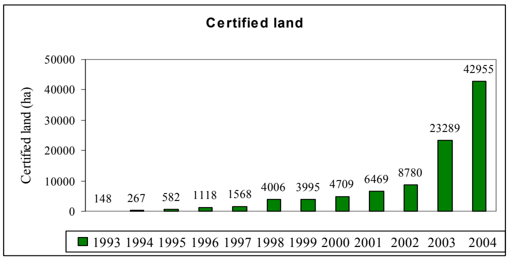
Production and layout: Ásdís Helga Bjarnadóttir (LBHI), statistical information from Vottunarstofan Tún

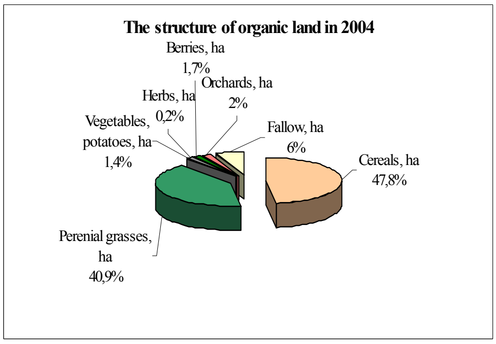
Organic production In Lithuania

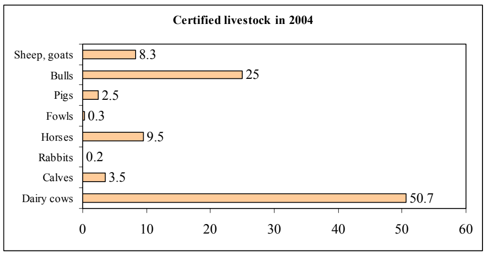
➢First farm started: 1992

First years of inspection:
- ➢ Lithuanian association of organic Farming Gaja 1993
- ➢ Certification body Ekoagros 1997









Name of inspection: Certification body Ekoagros - Non– Governmental

Education, 100 %: Lithuanian University of Agriculture, a Bachelor degree courses - Ecology. Master courses – Agroecology.

Research: Lithuanian University of Agriculture, Lithuanian Institute of Agriculture, Lithuanian Institute of Horticulture, Lithuanian Institute of Economic.

Export : None

Present status of the policy and market environment of the Finnish Organic Sector:

- ➢ ***Production of organic products is constantly growing.***
- ➢ ***Official target – 5 percent share of organic farming in the total agricultural land by 2006.***
- ➢ ***Significant financial support for organic farmers.***
- ➢ ***Lack of research, advice and information.***
- ➢***Demand of organic products more than supply.***
- ➢ ***Lack promotion of organic products and information to consumers.***

Organic production in Norway

NORSØK
Norwegian Centre for Ecological Agriculture
www.norsok.no

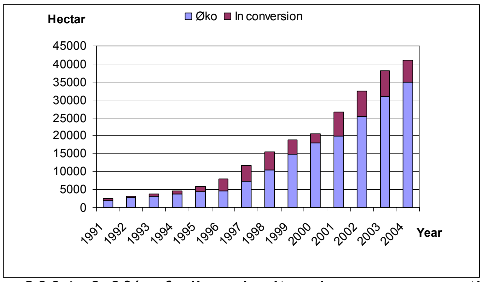
First farm started:

- **1931, still organic**

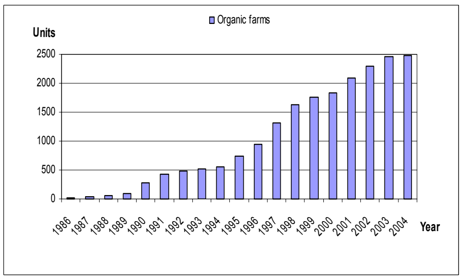
First year of inspection:

- **1986, Debio**

Area under organic management



Number of organic farms



In 2004, 3.3% of all agricultural area was certified organic

Plant production (ha) in 2004

Plant product	Ecological	In conversion	sum
Meadow	28444,4	4313,3	32757,7
Cereales	5533	1592,4	7125,4
Pea/bean	134,7	58	192,7
Seed	213,9	56,8	270,7
Potato	174,3	6,6	180,9
Greenhouse	2,2	0,1	2,3
Vegetables	103,3	3,1	106,4
Herbs	21,1	0,8	21,9
Fruit	76,4	9,7	86,1
Berries	44,9	6,5	51,4
Other	208,8	31,9	240,7

Certified livestock 2004

Species	Ecological	In conversion	sum
Dairy-cows	5643	142	5785
Other cattle's	13006	1387	14393
Pigs	749	3	752
Horses	211	24	235
Sheep	33375	698	34073
Goats	2230	0	2230
Laying hens	57511	25	57536
Broilers	7037	0	7037
Turkeys	1214	0	1214
Other birds	137	0	137
Rabbits	24	0	24
Bee hives	187	105	292

Inspection agency :

Debio, appointed by Mattilsynet, a governmental institute.

Education — **Nordic MSc in agroecology, 2 year program** (www.agroasis.org)
Bachelor in ecological agriculture, Hedmark University College
Norwegian Agricultural Economics Research Institute
The Norwegian National School for Organic Farming and Gardening

Research: — **Norwegian Centre for Ecological Agriculture**
Norwegian Crop Research Institute
Norwegian University of Life Sciences
Norwegian Agricultural Economics Research Institute

Export : — **Very limited**

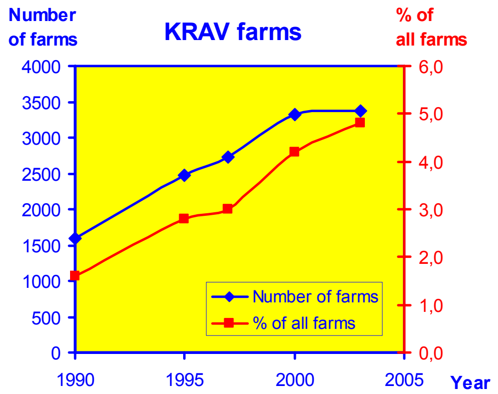
Present status of the Norwegian organic sector:

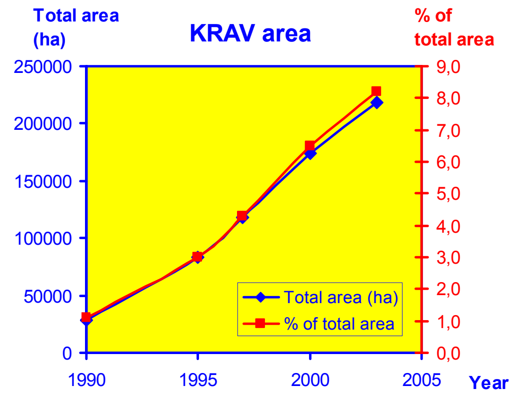
- O*fficial target of 10% production in 2009.*
- ***Organic production receives public subsidies***
- ***Marketing and production of organic plant products show extended grow.***
- ***Marketing of organic livestock products show extended grow.***
- ***Large portion of ecological products are sold unmarked together with other products***

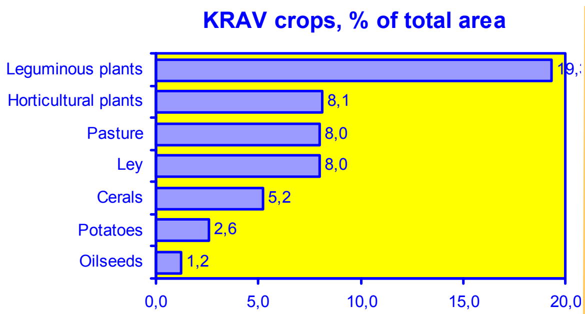
Organic production in Sweden

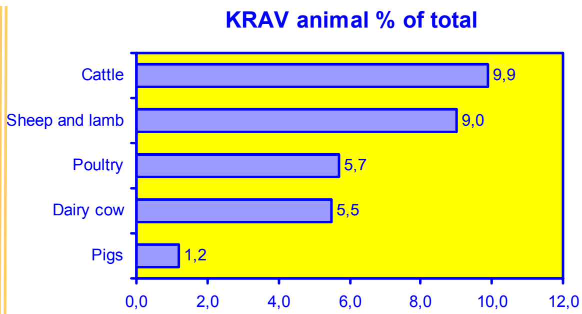
First garden started: 1935
First farm started: 1940th

First year of inspection:
Demeter 1959 KRAV 1985









Name of inspection:	**KRAV and Swedish Demeter Association**
Education, 100%:	**Rudolf Steiner Post - secondary school**
Research:	**Swedish University of Agricultural Sciences (SLU).** **Biodynamic Research Institut**
Export of organic prod:	**Half of the cereal production is exported**

Comments – the vision for the Organic Farming in Sweden

Present and past targets
for organic plant husbandry have been focused on the total part of arable land in Sweden which has environmental compensation for organic production. 15 per cent of the arable land has environmental compensation for organic plant husbandry, which is a high figure in an international comparison. Less than half of the organic plant husbandry area in Sweden is certified or undergoing reorganization. It is only the certified arable land which results in products which are classified as organic.

The government has
left a target proposition for the organic farming up until 2010. The result must be measurable and the production must fulfil the national target for the environment, the welfare of the animal must be observed along with the condition for a market development where the demand of the consumers is a driving force for the development of organic farming.

Propositional contents until 2010:
-at least 15 per cent of the arable land organic
-at least 10 per cent of dairy cattle, heifers and lamb for slaughtering
-at least 1 per cent of pigs and poultry
must be certified production or undergoing reorganization.

Production Gärd L-Baeckström, Layout Ulf Hanell 2005

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