Health and herd health planning in organic dairy herds

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Abstract

The status in European organic dairy production does not in all aspects, meet organic principles with regards to the aims of good animal welfare and health, and consumers' expectations, and therefore needs to be improved. The aims of this thesis were to; assess the status of animal health in organic dairy herds; assess the structural characteristics, and their relation to implementation, of animal health plans; and to investigate a structured participatory and farm-centric approach.

In total, 218 farms in Germany, Spain, France and Sweden were included in the study. All farms were visited, and general characteristics were collected through an on-farm protocol. Common procedures for calculations were made to arrive at comparable herd level indicators. A sample of the lactating cows on each farm was scored for lameness. Data for the analysis of farm structures (192 farms), contained a battery of farm and farmer descriptors from which typologies were derived. Three farm clusters were identified and rates of implementation of health improvement actions were explored. Actions, as part of a health plan, were identified during a structured participatory approach, with farmer, veterinarian and advisor, by use of an impact matrix analysis, on 122 farms in France, Germany and Sweden.

The prevalence of animal health indicators varied widely between farms and countries. The odds of lameness were five to six times higher in France and Germany, and slightly higher in Spain, than in Sweden. This may be particularly true in large herds with cows of the Holstein breed and zero-grazing herds. Farms in the different clusters implemented different strategies towards animal health planning. The degree of implementation of the actions was good. At follow-up (by data), no direct associations were seen between change in animal health indicators and the structured participatory approach.

The great difference in prevalence of production diseases implies that there is room for improvements. The need to enhance the quality and availability of data is reinforced by the fact that there is no unified recording in European organic dairy herds. The results may be used as a background for tailored advisory service strategies, i.e. different types (clusters) of organic dairy farms needs different type of advisory approach to reach improvements (adapted to the specific farm situation).

Keywords: Prevalence, characteristics, participatory approach, production diseases

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Hälsa och hälsoplanering i ekologiska mjölkkobesättningar

Sammanfattning

Statusen i europeisk ekologisk mjölkproduktion behöver förbättras eftersom den inte alltid möter de ekologiska principerna med mål som god djurvälfärd och hälsa. Inte heller uppfylls konsumenternas förväntningar. Målen med denna avhandling var att bedöma status på djurhälsan i ekologiska mjölkkobesättningar, identifiera gårdarnas strukturella särdrag och deras samband med införandet av planer för förbättrad djurhälsa samt att pröva ett strukturerat tillvägagångssätt för hälsorådgivning som är deltagardrivet och gårdscentrerat.

I studien ingick totalt 218 gårdar i Tyskland, Spanien, Frankrike och Sverige. Generella karaktäristika samlades in för gårdarna via ett protokoll. För att få jämförbara indikatorer på besättningsnivå användes samma beräkningssätt i alla länder. På varje gård hältbedömdes ett urval av korna. En rad faktorer för gårdarna (192 st.) och lantbrukarna användes för att identifiera strukturer. Tre grupper av gårdar identifierades och andelen införda åtgärder för att förbättra djurhälsan undersöktes. Under ett strukturerat och deltagardrivet möte med lantbrukare, veterinär och rådgivare identifierades åtgärder som en del av en hälsoplan med hjälp av en påverkansanalys (impact matrix). Detta utfördes på 122 gårdar i Frankrike, Tyskland och Sverige.

Prevalensen av produktionssjukdomar varierade mycket mellan gårdar och länder. Oddsen för hälta var till exempel sex gånger större i Frankrike och Tyskland, och något större i Spanien, jämfört med Sverige. Detta var särskilt fallet i stora besättningar, med kor av rasen Holstein, och som saknade tillgång till bete. Gårdarna i de olika grupperna införde olika strategier för djurhälsoplanering. Andelen införda åtgärder var hög. Inget direkt samband kunde ses mellan förändring i djurhälsa och det strukturerade deltagardrivna sättet att bedriva hälsoplanering på.

Den stora skillnaden i prevalens av produktionssjukdomar indikerar att det finns utrymme för förbättringar. Bristen på enhetlig registrering av hälsa i europeiska ekologiska mjölkbesättningar innebär att kvaliteten och tillgängligheten av data måste förbättras. Resultaten ger en grund för att kunna skräddarsy rådgivningsstrategier. Det innebär att olika grupper av ekologiska mjölkgårdar behöver olika typer av rådgivningssätt, anpassade till den specifika gårdssituationen för att nå förbättringar.

Nyckelord: prevalens, karaktärer, deltagardrivet tillvägagångssätt, produktionssjukdomar

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Dedication

To my inventive grandfather, who taught me to see possibilities in everything, to do something big out of something small, such as building a whole house with only one nail and lumber.

Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.

Albert Einstien

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Krieger M., Sjöström K., Blanco-Penedo I., Madouasse A., Duval J.E., Barreille., Fourichon C., Sundrum A., Emanuelson U. (2017). Prevalence of production related indicators in organic dairy herds in four European countries. *Livestock Science*, vol 198, pp. 104-108.

II Sjöström K., Fall N., Blanco-Penedo I., Duval J.E., Krieger M., Emanuelson U. (2018). Lameness prevalence and risk factors in organic dairy herds in four European countries. *Livestock Science*, vol 208, pp. 44-50

III Blanco-Penedo I., Sjöström K., Jones P., Krieger M., Duval J.E., van Soest F., Sundrum A., Emanuelson U. (2018). Structural characteristics of organic dairy farms in Europe and their association with implementation of animal health plans. *Submitted manuscript.*

IV Sjöström K., Sternberg-Lewerin S., Blanco-Penedo I., Duval J.E., Krieger M., Emanuelson U., Fall N. (2018). Effects of a participatory approach to herd health planning in organic dairy herds. *Accepted for publication in Animal.*

The contribution of Karin Sjöström to the papers included in this thesis was as follows:

I	Involved in the planning of the study, organised and performed the collection of data, contributed to the analysis of the data and to the writing of the manuscript together with the co-authors.
II	Involved in formulating the research idea and planning of the study, organised and performed collection of data, performed the analysis of the data, wrote the first draft of the manuscript and finalised it with the co-authors. Corresponded with the journal.
III	Involved in the planning of the study, organised and performed collection of data, contributed actively to the analysis of the data and drafting the manuscript, and to its finalisation together with the co-authors.
VI	Involved in formulating the research idea and planning of the study, organised and performed collection of data, performed the analysis of the data, drafted the manuscript and finalised it with input from the co-authors. Corresponded with the journal.

Abbreviations

AS	Active sums
D2.1	IMPRO report on regional kick-off workshops
D2.2	IMPRO report on variable list
D2.4	IMPRO report on health plans
D2.5	IMPRO report on results of on-farm assessments
D3.2	IMPRO report on final monitoring and preventive protocols
HHPM	Herd Health and Production management programme
IFOAM	International Federation of Organic Agriculture Movements
IMPRO	Impact matrix analysis and cost-benefit calculations to improve management practices regarding health status in organic dairy farming
PS	Passive sums
WP	Work package

1 Introduction

1.1 Organic farming "historically a hippie-craze, now the bright and sustainable or only future?"

Organic farming (as seen today) stems from many different ideas, philosophies and movements as a reaction towards the seemingly unsustainable development of agriculture, which was leading to depleted soils and thoughts about whether it was right to use so many chemicals. This was the basis for developing many different management systems in organic agriculture, and different standards were set up. To facilitate co-operation the International Federation of Organic Agriculture Movements (IFOAM) was founded in 1972 by five organic agriculture organizations from South Africa, the United States and Europe, (the Swedish Biodynamic Association was one of these) (IFOAM, 2005; Luttikholt, 2007). IFOAM developed principles of organic agriculture through a worldwide process, to provide ways to handle the challenges of global trade that could lead to conventionalisation, and in so doing have negative effects on animal welfare, the environment, and rural development. This led, in 2005, to the formulation of four principles; the principals of health, ecology, fairness and care. These are now seen as the grounds for the growth and future development of organic agriculture (IFOAM, 2005; Luttikholt, 2007).

There can be challenges with development in organic agriculture, associated with global trade, transportation of animals, or the lack of land. Organic agriculture varies a lot by region, which could in some aspects hinder development, e.g. international regulations that are not well adapted to various regional situations, or use of animal breeds not suited for that environment. The variation may, at the same time, be seen as an opportunity for successful integration of organic principles, e.g. naturalness, as in use of local breeds better

adapted to the specific environment, or lower energy use by shorter transportation of animals or food (Vaarst and Alrøe, 2012).

Worldwide, organic farming has increased and evolved during the last decades. In Europe there has been a quite rapid increase in the organic sector, from 5.7 million hectares in 2002 to a total area of 9.6 million hectares in 2011. Sweden has, after Austria, the second largest share of organic area (16%), while, for instance, the corresponding figure for Spain is 7%. Some of the countries with a lower acreage share of organic production seem to have a steeper developing curve than those with a larger share. Within organic production cattle is the second largest animal production sector, after sheep. In the organic dairy sector the trends are similar as in acreage, where Sweden has 13% organic dairy cows, Spain has 1% and France, who is the second largest EU dairy producer, has in total 2% organic dairy cows (Eurostat, 2017). When comparing the farms and farmers in EU, organic farms tend to be larger than conventional farms, permanent pasture covers the largest share of the organic area and the organic farmers tend to be younger and more often male (European Commission, 2013; Eurostat, 2017). Sweden is an exception with a more equal gender distribution. Organic production in the EU is regulated by the European regulation (EC) 834/2007(Council of the European Union, 2007), although some member states have additional rules(Kijlstra and Eijck, 2006; Luttikholt, 2007).

A complete picture of the organic sector is, however, lacking, due to insufficient data in some aspects of the organic production and food chain. Comprehensive and comparable official statistics are necessary for future review, work and development.

1.2 Animal health in organic production

There is a strong focus on animal welfare in organic farming, including philosophical and ethical ideas about good animal welfare. Animal health is part of the welfare, and previous studies have shown that animal health status could be used as a proxy for animal welfare status (e.g. Nyman et al., 2011).

In organic production, the individual animal space should be as large as possible, bedding materials are compulsory, and feed must be organically produced (to almost 100%). The use of antibiotics is restricted and the withdrawal periods after treatments are longer than for conventional farming. According to the EU organic regulations, the first line choice for disease treatment should be homeopathic or phytotherapeutic products. Only if these are not effective, are allopathic veterinary treatments allowed. In Sweden, use of homeopathic (or phytotherapeutic) treatments instead of allopathic veterinary it

is not considered as being based on science and evidence (Hammarberg, 2002), as there is no sufficient scientific evidence that such treatments are efficient, and it has been proposed that they may pose a considerable risk to animal welfare (de Verdier et al., 2003; Doehring and Sundrum, 2016; Hektoen et al., 2004).

Organic products are promoted as coming from animals raised under higher welfare conditions that not only reduce stress and allow natural behaviour, but also make them more resistant to diseases and contain fewer residues than products from conventionally raised animals. This is grounded in the IFOAM principles about naturalness (allowing natural behaviour and needs), and caretaking (taking responsibility for the animals so they are not suffering and interact with care), and reflects systemic views of animals and humans as part of a larger ecological system.

By use of good animal husbandry, organic production aims to improve disease resistance and prevent disease occurrence. Good management should include disease recording and use of breeds with high resistance to infections (Magnusson, 2001), and this is also stated in the European regulations(Council of the European Union, 2007). However, in organic dairy herds, health problems are often similar to those found in conventional herds (Fall and Emanuelson, 2009). Production diseases cause major problems in many European organic farms (Alvåsen et al., 2014; Lund and Algers, 2003; Sundrum, 2014; Whay et al., 1998), with the main problems being mastitis, reproduction disorders, and lameness(Booth et al., 2004; Krieger et al., 2017c; Sundrum, 2014).

There is no common monitoring of general disease prevalence in Europe and there is a lack of comparable records, including animal welfare issues, such as lameness. Thus, it is difficult to compare between studies, herds and countries (Krieger et al., 2017c; Sundrum, 2014). This demonstrates the need for more trans-continental harmonised systems to provide a basis for setting thresholds for health and disease, and for easier comparison between herds and countries. Occurrence of harmonised benchmarking systems could serve as drivers and incentives for the individual farmer to work with more preventive herd health management (and make use of advisory services), when his/her herd and farm can be compared to others.

1.3 Herd health management, planning and advisory services in the organic sector

The development of herd health and production management started in the USA and the Netherlands in the 1970s, and later was further developed in several other countries. The aims were to improve animal health, productivity, food safety and quality, and profitability for the farmers, through continuous monitoring (Brand

et al., 1997). These procedures have led to increasing productivity in conventional farms (Fourichon et al., 2001), but not to a notable decrease of animal disease levels (Oltenacu and Algers, 2005).

Animal health plans are mandatory in organic dairy herds, which is not the case for conventional herds (Council of the European Union, 2007; Lovatt, 2004). Advisory services in organic dairy herds sets other requirements (than in conventional herds), but the advisory services (including veterinarians) may not have sufficient knowledge about the standards, restrictions, and regulations that organic farmers work under. In several studies, veterinarians were generally not always aware of the goals and priorities of farmers regarding herd health management (Derks et al., 2013b; van Soest et al., 2015). This may be a contributing factor to why the use of veterinarians is less frequent (in general, not only as advisors) in organic dairy farms compared to conventional farms (Emanuelson et al., 2018).

There are factors constraining the success of Herd Health and Production Management programmes (HHPMs), such as the fact that farmers do not always implement recommended health improvement measures to a satisfactory degree. It may not be the lack of knowledge that limits the implementation of herd health management practices,(Huijps et al., 2010; LeBlanc et al., 2006), but rather the lack of knowledge transfer, and to be able to improve the implementation new approaches are needed. One recently studied strategy to improve animal health and welfare in organic dairy farms, was the ANIPLAN project, which through animal health and welfare planning achieved an improvement in some of the studied animal health and welfare areas (Ivemeyer et al., 2012; Tremetsberger et al., 2015). Although it did not fully succeed in all focused areas, it could serve as inspiration and driver for future participatory approaches to be further developed to improve animal health in organic dairy farms.

This was the incentive for the initiation of the IMPRO project.

2 IMPRO

This current thesis work was part of the European project IMPRO – Impact matrix analysis and cost-benefit calculations to improve management practices regarding health status in organic dairy farming, a project containing nine different work packages. The work packages (WP), were connected to each other as demonstrated in figure 1. The main participation for the PhD work was in, WP2, WP3 and WP5, but only parts of WP2 is included in this thesis.

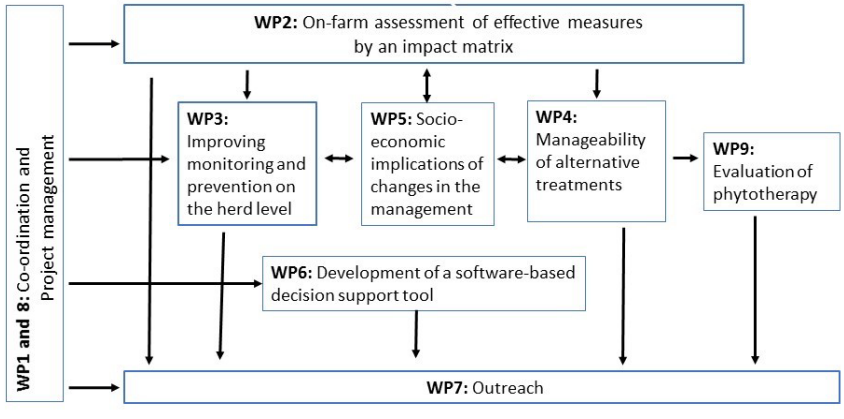

Figure 1. Illustration of the work packages in the IMPRO project and the connections between them.

The overall aim of IMPRO was to identify and overcome weak points in current health management strategies in organic farms, to improve management practices and animal health in organic dairy farming. To achieve this, a multidisciplinary and participatory approach was taken and farm specific solutions regarding preventive measures were developed, in line with the

expression “prevention is better than cure”. Six countries were involved: France, Germany, Great Britain, the Netherlands, Spain and Sweden. Great Britain and the Netherlands contributed in the socio-economic studies of the farms; this included studies of farmers, veterinarians and advisors that were involved in the farms, whereas the farm visits were carried out in the other countries. The plan was to include 200 study farms in France, Germany, Spain and Sweden, and to reflect the diversity of organic dairy farms in Europe. The target was to have equal distribution of farms across the countries, but because the Spanish organic sector is still small there were not 50 eligible farms in Spain, therefore the number of farms per country was redistributed. Also 20 control farms were visited in France for WP3, and these were included in the prevalence studies (papers I and II).

The main part of IMPRO was WP2, where several studies were performed. During this part, a benchmarking of the current health status in a standardised way was conducted, to make the comparison across a wide range of European production conditions more correct. A farm-centric approach, by a participatory process with an impact matrix, was used to identify actions to improve animal health. Thereafter a follow-up of animal health status was made. Animal health is part of the welfare, and though the welfare was acknowledged in IMPRO, the emphasis on animal health was used due to the need for data from recordings for the follow-up and evaluation of the intervention.

Data for the cost-benefit calculations and attitude studies performed in WP5 were also collected.

To adapt the impact matrix (tool), regional workshops were conducted in each country, involving multidisciplinary experts, e.g. farmers, veterinarians, advisors and researchers of different disciplines. During the workshops, areas and variables believed to influence animal health on the farm level were identified. Lists of possible variables from published studies were used as a background and as inspiration for discussion during the workshops. The aim was to end up with a manageable set of about 20 variables. These covered the different criteria that are to be included in an impact matrix, as defined in a sensitivity model, to capture “the farm specific interconnectedness of animal health related variables” (Vester, 2012). The numbers of variables from each country’s workshop were: 19 in France, 22 in Germany, 20 in Spain, and 20 in Sweden. The variables from each country were merged to a list of 20 variables. This was pilot-tested on two farms in Germany by the project members together. During this testing it became clear that the number of variables needed to be reduced further, and this was achieved by a process between the project members. The final variable list contained 13 variables covering the different

criteria that are to be included in an impact matrix as defined in the sensitivity model by Vester (2012) (Emanuelson, 2014, 2013a, 2013b).

The final list of 13 variables was in concordance with the country-specific lists to various degrees; some variables were merged into one variable, and some were excluded (see table 1) (Emanuelson, 2014, 2013a, 2013b, Krieger et al., 2017b, 2017a).

Table 1. *Variable lists, the final list, containing 13 variables and the country-specific variable lists.*

Nr	Final list (n=13)	France (n=19)	Germany (n=22)	Spain (n=20)	Sweden (n=20)
1	Milk performance	Milk production level	Performance level of the herd	Management of the production	Milk performance
2	Production diseases			Animal welfare	1.Udder health 2.Lameness 3.Parasite management
3	Financial resources	Rentability of the farm	Financial resources of the farm	Financial resources	Financial resources
4	Labour capacity	Amount of labour capacity	1.Priority of animal husbandry/ health 2.Process sequence structuring 3.Available labour time	Hand labour	Labour capacity
5	Feeding	1.Availability of feed 2.Quality of the diet and water supply for lactating cows	1.Adequacy in meeting the nutrient requirements 2.Availability of quality feed	1.A balanced ration 2.Quality of the food ration and silage	Quality of nutrient supply
6	Keeping conditions	Quality of the buildings and pastures for lactating cows	Appropriate relation to animal welfare	1.Farm building 2.Grazing management	1.Quality of housing conditions 2.Grazing
7	Reproduction management	Reproductive performances	Quality of health and reproduction management	1.Management of reproduction 2.Animal welfare	Fertility
8	Dry cow management	Appropriate management of the dry cows	Quality of health and reproduction management	Animal welfare	
9	Calf and heifer management	Appropriate management of calves and heifers	Quality of health and reproduction management	1.Management of colostrum 2.Animal welfare	Calf rearing conditions
10	Herd health monitoring	1.Quality of herd surveillance 2.Herd health status	1.Degree of controlling in the area of animal health 2.Morbidity rate 3.Culling rate due to health problems	1.Health prevention and degree of monitoring 2.Management of animal health	1.Degree of herd health monitoring/ controlling 2.Parasite management

				3.Management of milking	3.Health related culling rate
11	Hygiene	1.Hygiene standard for lactating cows 2.Risk of introducing infectious diseases	Level of implementation of hygiene measures	1.Biosecurity 2.Management of milking	Hygiene standard
12	Treatment	Therapeutic and medical intervention	Appropriateness of treatment	1.Management of animal health 2.Animal welfare 3.Management of milking	
13	Knowledge and skills on the farm	1.Stockmanship qualities of the farmer/ employees 2.Access to advice and education	Expertise of the farmer/ employees		Management skills
Excluded variables		Implementation of organic regulation	1.Level of legal and market claims 2.Suggestibility of the farm by external statement	1.Legislation 2.Sustainability(industry/bonus/consumer expectations)	EU regulations
		Herd size		Growth capacity of the farm	Herd size
		Breed and genetics		Genotype breed	
			1.Quality of advisory services 2.Availability of advisory services		
			Milk price		Milk price
					Animal observation time
			Degree of technologisation, (availability and use on the farm)	Management tools and degree of control	Use of management software
			Motivation to make changes	Farmer attitude – towards co-operation	

In WP3, a proactive monitoring and preventive protocol was developed by the researchers in France and Sweden, formed as a flowchart (decision trees) D3.2 (Bareille, 2016). The farmer, and the health advisor of their choice (veterinarian or advisor), could use the chart to a) find what problem or area they saw potential to improve, and b) to have suggestions of possible solutions. The protocols were developed during expert workshops, with discussions with experts in different health areas, as well as from previous studies. After a first visit, where health indicators suitable for monitoring were agreed on and an introduction to the protocols was made, four meetings in one year were aimed to to achieve continuous preventive work. Control farms, visited in France but derived from secondary data in Sweden, were used to derive data on health status and development for the same period as the farms participating in the project. Results from WP3 are published in Duval et al. (2017, 2016b)

The German partners evaluated the effectiveness of alternative treatments, where allopathic and homeopathic treatments were compared, for two major dairy cow diseases (WP4) (Doehring and Sundrum, 2016).

To identify potential incentives and socio-economic barriers towards improvements of animal health, several questionnaires were developed. These were based on examination of farmers' perceptions of animal health, motivations and intentions to improve disease management and to implement actions, and on assessment of the farmers', veterinarians' and advisors' reactions and attitudes towards the participatory approach (WP5) (Jones et al., 2016; van Soest et al., 2015).

A German company was involved in developing a software-based tool, including health monitoring, farm diagnostic procedures, and cost-benefit calculations (WP6). Outreach was made by communication to stakeholder and the general public, and spreading the outcomes and knowledge to eastern European countries. The developed approaches were tested in 'real-life' situations on pilot-farms in Great Britain and the Netherlands at the end of the project (WP7). The efficacy of homeopathy and phytotherapy in livestock was evaluated by an expert workshop, and by literature reviews of studies in organic farming (WP9) (Blanco-Penedo et al., 2018; Doehring and Sundrum, 2016).

3 Aims

The overall aim of this thesis was to strive for improved animal health in organic dairy herds, by an approach not used in organic dairy farming before.
The more specific aims in the thesis were:

- To assess the status of animal health in organic dairy herds (paper I and II).
- To assess the characteristics of organic dairy farms and the relation to implementation of animal health plans (paper III).
- To investigate a participatory and farm-centric approach to herd health planning in organic dairy herds (paper IV).

4 Materials and methods

4.1 Description of the parts of the IMPRO project included in this thesis

Data for this thesis were collected in various ways and at different time points, illustrated in table 2.

Table 2. *Data collection for the included studies in this thesis*

Databases		**Visits**		**Questionnaires** – postal and telephone	
Baseline (before visits)	Animal health status – before first visit (pertains to year 2012)	First visit	Interviewing by questionnaire – Characteristics of farms.	Before second visit	Socio-economic – economic costs due to lameness and udder disorders.
	12 months before second visit		Lameness scoring.		Farmers' attitudes and intentions regarding animal health.
Follow-up	Follow-up 1 refers to the 12 months starting one month after the second visit	Second visit	Participatory approach and Impact matrix analysis.	After second visit	Follow up on implementation of animal health action plans.
			Questionnaire - Animal health areas with potential for improvement.		
			Economic tool-costs for udder disorders and lameness.		
	Follow-up 2 refers to the 12 months starting six months after the second visit				

4.2 Animal health status (paper I and II)

This pertains to the first farm visits (performed between March and August 2013); it includes data from 200 farms in paper I and 201 farms in paper II (of the original 218 farms). Data were collected by face-to-face interviewing – using an on-farm questionnaire developed by the researchers. Through this, general information such as details about the respondent (the one responsible for the animal health), management regimes in reproduction, milking, housing, feeding, grazing, general animal health and herd health status was collected. Information on animal health status was also derived from animal health ledgers, where needed. Lameness scoring was assessed by following the Welfare Quality Assessment protocol for dairy cattle (Welfare Quality® Consortium, 2009). Data were also retrieved from official milk recording schemes, artificial insemination or natural services recordings and from animal registration and identification schemes in each country. A common procedure for data processing was applied to reach comparable results. One dataset was derived for the year 2013 for paper I and for year 2012 for paper II. Descriptive statistics and logistic regression models were used in paper I and II, respectively, to study the prevalence, and association between disease prevalence and various factors.

4.3 Characteristic of the farms in relation to implementation of animal health plans (paper III)

In this study, 192 farms were included. The data for this study were collected on several occasions between March 2013 and April 2015. Data were partly derived from the first visit interviews (on-farm questionnaire) about general farm structures. Written questionnaires were sent out to the farmers before the second visit, where information on economic costs due to lameness and udder disorders was also collected. Data on the farmers' attitudes towards the use of additional health actions to further control production diseases and their intentions about adopting additional health actions, were also collected. Approximately one year after the second visit another questionnaire was sent out to the farmers, to follow up on what actions had been implemented. In addition, data from national registers regarding the status of animal health, were also used. The characterisation of the farms in typologies was carried out in three steps: 1. Review and selection of variables; 2. Multiple Correspondence Analysis (MCA); and 3. Agglomerative Hierarchical Clustering (AHC). The MCA was

used to reduce the dimensionality of the data, i.e. reduce the number of categorical variables (principal components) that capture the most variability. The MCA was selected as the most suitable method to undertake this analysis, since most of the data were qualitative. In the final step, farms were grouped in clusters, using AHC based on the factor scores derived from MCA.

4.4 Participatory and farm-centric approach to herd health planning in organic dairy herds (paper IV)

The impact matrix, as described above, may be used to identify areas or factors where changes will have impact on the farm. This was used in a participatory approach, involving farmer, veterinarian and advisor to gain a comprehensive insight from different perspectives and to achieve agreement about actions that were most likely expected to improve animal health in farm specific situations. Through this approach, all participants had an active role and it gave a holistic perspective towards a farm as a complex system. The farmer would be in the driver's seat of what actions to be made on his/her farm, with input from the advisor and veterinarian in a 'round-table' discussion. The discussion was guided by the structured impact matrix, which then included discussions in all areas of the farm, and even areas not usually brought up in advisory situations e.g. family situation or workers' influence on the management of animals. The pros and cons for changes were weighed in. This made the process with the impact matrix a structured participatory approach.

A total of 122 farms were included in the evaluation of this study. However, Spain was not included in the evaluation of the effects of the approach, because data for the follow-up periods were not available. During the second visit, after the initial collection of farm characteristics data, the participatory approach, where actions to improve animal health were identified, was applied and information about which animal health areas the farmer found potential for improvement in was collected by a questionnaire. The impact matrix was filled in as part of the participatory approach. During this the farmer, veterinarian and advisor jointly agreed on which scoring grade to fill in for each variable included in the impact matrix (see figure 2). The scoring was based on their opinions on how strongly variable B would react if variable A were to change: 1. If variable A needed to change very much to give a small reaction (or change) in variable B; 2. If there was equal amount of change in variable A needed for an equal amount of reaction in variable B; and 3. If variable A needed to change to a small degree to give a large reaction in variable B (Figure 2).

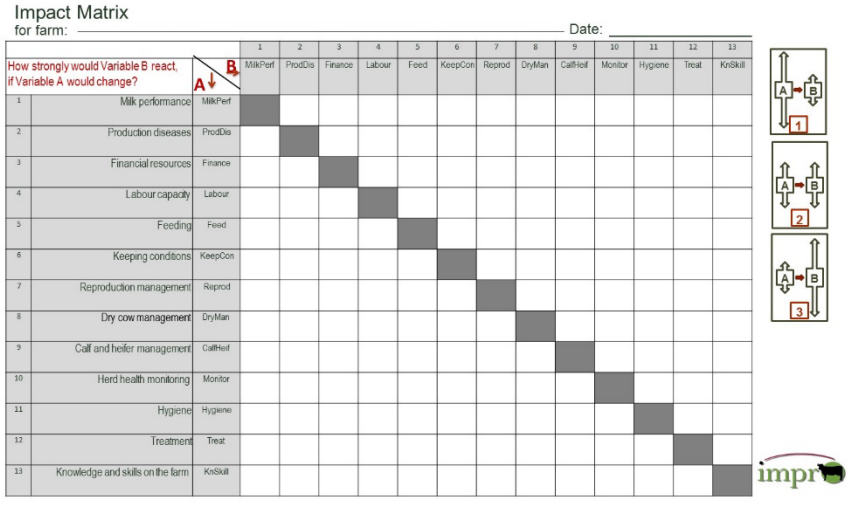

Figure 2. The impact matrix sheet that was filled in at the visit and the scoring grade (1-3) with explanatory figure to the right.

After filling the impact matrix, system roles for all variables were calculated by a data program (developed during IMPRO and modified from Vester's sensitivity model), based on active and passive sums of the rows and columns in the matrix. The results were presented in an output graph, where the variables with highest potential for improvement, and thereby the ones to focus on at this stage, were in the upper left corner (A and thereafter B and D) from the diagonal line. On the other hand, the areas that were placed in the right lower corner and on the right side of the output graph, were the ones that had very low potential for direct improvement and therefore no effort to focus on these was required at this stage (figure 3). (Emanuelson, 2014; Krieger et al., 2017a, 2017b)

Nr	Variable	PS	AS
1	Milk performance	18	6
2	Production diseases	16	21
3	Financial resources	19	4
4	Labour capacity	15	8
5	Feeding	10	11
6	Keeping conditions	5	11
7	Reproduction managemen	6	9
8	Dry cow management	5	6
9	Calf and heifer manageme	8	8
10	Herd health monitoring	7	9
11	Hygiene	6	8
12	Treatment	9	11
13	Knowledge and skills on th	6	18

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Figure 3. Example of a two-dimensional output graph created at one farm where the role of the 13 system-relevant variables was identified. The 13 variables are presented in the table to the right. On the x-axis is the AS, which is the active sums, and on the y-axis is the PS, which is the passive sums of the variables in the impact matrix.

Data were collected from the national registers the full year before the intervention visit (the second farm visit in the IMPRO project) and for two follow-up periods (as described in table 2). Data on what actions had been implemented were derived from the questionnaire sent out after the second visit. The change in the animal health variables was assessed at two time-points, and was evaluated with linear regression models.

5 Results

The available data for the baseline animal health status and at the follow-up differed between the countries and hence not all countries were included in the analyses in paper IV. Therefore descriptive statistics for all four countries are presented here. The characteristics of the farms are presented by clusters in paper III and also presented by country here.

5.1 Animal health status (papers I and II, and D2.5(2015))

The distribution of herd size was similar in France, Germany and Sweden, whereas Spain had much smaller herds. Milk production level was much higher in Sweden than in the other countries, which all had similar levels. The median prevalence of high somatic cell count (SCC) in milk, when using 200,000 cells/mL as the threshold, ranged from 0.26 (in Sweden) to 0.36 (in Spain), even though a notable share of the herds had rather a high prevalence. The same pattern was also seen when using both 100,000 and 300,000 cells/mL as thresholds. The median incidence of increased SCC (moving from below 200 thousand cells/mL to above, between the test days during the study), was similar between the countries, even though the pattern resembled the prevalence, where Spain had the highest incidence, followed by France.

Reproductive disorders (such as cystic ovaries, retained placenta and metritis) are important production diseases, but are not routinely recorded in all study countries. Thus, reproductive disorders were monitored indirectly by the median calving intervals, which was shortest in Germany with 379 days and longest in Spain with 398 days, and the proportion of prolonged calving intervals (> 400 days), with the lowest median proportion in Germany (0.36) and the

highest in France (0.45). The metabolic disorders were measured as prevalence of test-days with a fat/protein ratio > 1.4 as an indirect measure for ketosis, where the median ranged from 0.16 in Sweden to 0.23 in France and the variation found between herds within countries was quite large.

The longevity and cow stayability was measured by the proportion of primiparous cows per cow-year, where Spain had the lowest proportion with 0.22, and Sweden the highest with 0.40, and by the average parity number of cows removed from the herds, where Sweden had the youngest cows removed with an average parity of 2.7, and Spain the oldest cows removed with an average parity of 5.2. Another indicator of the health status of the herds was the mortality of cows and calves, although Spain did not have access to this data and was therefore excluded from the comparison. Mortality was measured as on-farm cow mortality (cases per 100 cow-years at risk), where the lowest was found in Germany (2.6) and the highest in Sweden (4.8), and calf mortality within the first 30 days of life (cases per 100 calf-days at risk), where the lowest was found in Germany (2.8) and the highest in France (12.3). Calf mortality was up to 45% in some of the French herds. The lameness prevalence differed between countries and herds, where the within-country prevalence was lowest in Sweden (7%) and highest in Germany (25%). The odds of lameness were higher in zero-grazing herds, herds with cows of Holstein breed, and in larger herds.

5.2 Characteristic of the farms and the relation to implementation of animal health plans (paper III, unpublished results and D2.5)

The characteristics of the herds were summarised in a clustering procedure, as described in material and methods. The majority of the farms in cluster 1 were from Germany and France, and were characterised by medium herd size, moderate use of grazing, highest proportion of home-grown concentrate, and generally farmed by younger males (26-54 years). Cluster 2 contained farms mainly from Spain, France and Germany, and were small-scale farms with traditional extensive management, mainly farmed by older males (35 to more than 64 years). Cluster 3 contained only farms from Sweden, described as highly efficient, with intensive management and the largest herd sizes, but with relatively low stocking density and a more equal age and gender distribution of farmers. The farm clusters differed significantly in almost all the production costs (per cow per year). In losses due to lameness, the clusters differed significantly in all cost variables, and in losses due to udder disorders, the farm clusters differed significantly in more than half of the variables.

The number of animal health actions differed between the clusters, where cluster 1 had the fewest (median 6) and cluster 3 the most (median 14.5). The proportion of implemented actions varied significantly between the clusters, with most implemented in cluster 1 (71.4%). In all clusters the most common reason for not implementing actions was lack of time and cost. There were significant differences in rejection of actions due to lack of skills and access to expertise, where cluster 2 had a much higher proportion compared to clusters 1 and 3.

5.2.1 The structural characteristics by country, unpublished results

Farm size was smallest in Spain, with a median total agricultural area of 43 hectares and largest in Sweden (median 198 ha), with the range of all farms being 9-1600 ha. The proportion of agricultural income derived from dairy farming ranged between 8-100 %, with high medians in all countries, lowest in Sweden (80%) and highest in Spain (100%). The manpower dedicated to the dairy cows (number of calvings per full-time equivalent) ranged between 4 and 131, with the lowest median in Spain (18.5) and the highest in Sweden at 46.

The total time on pasture ranged from 0-8030 hours per cow and year, where Germany had herds with zero-grazing and Spain had the highest amount of farms where the cows were kept outside all year round. Cows were mostly kept in loose housing, with 100% in Germany. Spain and France had cows that were always kept outside, 29% and 3% respectively. In Sweden 11% and in France 1% of cows were kept in tie-stalls. Automatic milking systems were used by 51% of the Swedish farms, 10% of the German farms, and none in France and Spain. Herringbone was the most common milking system in France, Germany and Spain. The predominant breeds were Holstein and Montbéliarde in France, Holstein and Fleckvieh/Simmental in Germany, Holstein in Spain, and Holstein and Swedish Red and White cattle in Sweden. In France 34% of the farms were striving for seasonal calving, in Spain 14%, Germany 10% and Sweden 2%.

All farmers in France and Sweden used antimicrobials, in Germany 98% and in Spain 89%, whereas homeopathy was used by 80% in Germany, 79% in France, 39% in Spain and 7% in Sweden. The use of phytotherapy was similar to the use of homeopathy in all countries.

5.3 Changes in animal health and structural characteristics after the participatory and farm-centric approach to herd health planning in organic dairy herds (paper IV, and unpublished results)

Overall the structural characteristics and animal health indicators were rather stable and did not change much during the study.

The median herd size increased from 2012 to year 2014 in all countries, with the least in Spain (3.5 cows) and the most in Sweden (17.8 cows). Milk production decreased in France (-1581 kg, 365 d milk production) and increased most in Sweden (454 kg). Of the animal health areas with potential for improvement, most farmers stated that udder health had a potential for improvement in their farm/herd (71 of 119) followed by reproduction (50 of 119), claw disorders (37 of 119), and metabolic disorders (27 of 119). The proportion of implemented animal health plan actions ranged from 0-100%, with most farms implementing more than 75%. The highest proportion of implementation was in Germany, with 49.6%, followed by Sweden (27.7%) and France (22.7%). However, quite many participants did not answer the questionnaire, 24.4% overall with the highest in Sweden (42.4%).

There were no obvious animal health effects relating to the participatory approach. Although the degree of implementation of actions was quite high, improvement of animal health could not be directly linked to the animal health planning approach. There was a significant association between somatic cell count and country, and a significant association between change in the proportion of prolonged calving interval and the farmer's wish to improve reproductive health as well as with a decrease in herd size.

6 Discussion

To be or not to be … an interconnected cybernetic thinker.

Frederick Vester was a biochemist and expert on environmental matters. He invented a practical guide (a tool), that fulfilled his aim to help people to be aware of how our world forms a system of links and to spread the interconnected thinking – cybernetic thinking with an interdisciplinary and holistic approach, that he saw as essential when dealing with our world as a complex system. “What we need to understand is that much is connected that we see as separate, that the invisible ties that bind things together are often more important as regards what happens in the world than the things themselves”. The art of interconnected thinking shows the cause of mistakes in the usual approaches to planning and management, and identifies the complexity of a system, and thereby gives sustainable results. To grasp the effects of our interventions in a complex system, we need to improve our understanding of the pattern of that system´s interconnected dynamics (Vester, 2012).

This approach of interconnected thinking was used in the core of this thesis, which has not been used before in organic dairy farming. It was adapted to suit dairy farms, from the ideas behind the sensitivity model by Frederick Vester. With a holistic way to tackle the complexity of dairy farms using interconnected thinking, the aim was to reach improvements in animal health by including the whole farm system in a structured participatory approach.

6.1 Herd health planning

This thesis addresses some of the most important aspects of herd health planning, implementing an interdisciplinary and holistic approach inspired by Vester.

6.1.1 Participatory approaches

Participatory approaches to herd health planning have already been implemented. One example is the Danish stable schools, which use animal health and welfare planning with an incentive to reduce antibiotic use, where farmers learn from each other (Vaarst et al., 2007). Another example is the ANIPLAN project, where the goal was to minimise medicine use in organic dairy farms (Ivemeyer et al., 2012). Together, these could give a base for further development of methods bridging the lack of knowledge transfer and implementation of agreed actions.

Active involvement of all relevant actors in herd health planning is crucial but challenging. The veterinarian may not be aware of the farmer's goals or not used to performing this kind of communication, because this is not part of the traditional veterinary curriculum (Bard et al., 2017; Derks et al., 2013b; Kristensen and Jakobsen, 2011). Dairy advisors were more likely to choose factors for biosecurity improvement more similar to those chosen by the farmers than the veterinary practitioners, although it was not significantly different and the dairy advisors were less likely than the farmers to choose improvement factors (Sayers et al., 2014). Even when farmers are motivated to make changes, and have the necessary knowledge to improve herd health, implementation of actions is often missing (Jones et al., 2016; LeBlanc et al., 2006). Therefore, in IMPRO, an impact matrix analysis was conducted to give a more objective and holistic view of which areas on the farm would have the highest potential of improvement if changes were made. A dairy farm is a very complex system and by using this structured approach, even unexpected aspects were brought up for discussion and weighed in. When entered into the impact matrix spreadsheet it became clear from the output graph where the changes should be made to have the greatest impact on animal health and farm management, thereby leading to most farmer satisfaction and improved self-esteem. To enable success with HHMPs, the advisor needs to realise what the farmer's true goals and motivations are, and also where the farmer's satisfaction in farm management lies. To reach this understanding, trust and open communication between farmer, veterinarian and advisor is needed (Lam et al., 2011). The structured participatory approach used in this project made the farmer more equal in the

decisions, or even 'put them in the driver's seat', instead of giving them 'top-down' advice or general advice not tailored to the specific farm and farmer's situation. Bard et al. (2017) saw that veterinarians tend to have a paternalistic and authoritative way of communicating, not really taking farmers' opinions into account, which then influences the farmers' motivation and behaviour. In addition, during the impact matrix analysis, the veterinarians and advisors got more insights into what hindered the farmer from implementing their advice - why the earlier advice had not been taken to heart and what the goals of the farmer were. It could also give advisors and veterinarians a more holistic view of the farm so that the farmer's goals and needs are taken into account, without putting the farmer in a state of cognitive dissonance, due to not being able to address what the advisor or veterinarian sees as the main problem. To handle this emerging cognitive dissonance, the farmer could either fulfil the advice given or reduce the dissonance by convincing him/herself that it is impossible to implement the action (Festinger, 1957; Jansen et al., 2010). Derks et al.(2013) showed that veterinarians were often not aware of farmers' goals and priorities. Thereby they did not reach a working co-operation with the farmer or insight into what was needed for improving herd health and setting goals or plans. This knowledge gap could be filled with more holistic participatory approaches, such as the one implemented with the impact matrix.

Continuation of the preventive work and participatory approach by continuous follow-up would be needed for a long-term success of the IMPRO project. This was also expressed by the participants (farmers, veterinarians and advisors), i.e. as a wish for the future, they would have liked to continue working like this. In WP3, a proactive monitoring and preventive protocol was used during the follow-up meetings. Still, no significant differences in animal health indicators were shown compared to control farms (Duval et al., 2017). A follow-up of the Swedish farms, where the farms participating in WP2 were compared with those participating in both WP2 and WP3, and with control farms that were not visited at all, showed a significant improvement in some of the included animal health indicators. The largest improvement was in WP3 herds followed by WP2 herds, compared to control herds (Sjöström and Emanuelson, 2016). These findings indicate that the more comprehensive and long-term the approach to herd health management, the better the improvement of animal health.

There can be a challenge to convince actors, such as advisors, veterinarians and farmers that this participatory approach is a good strategy for preventive work, if there is a well-established advisory service in place already. The time, both for learning the methods and for performing, can be a constraining factor. One of the major challenges can be to introduce this to other stakeholders, if a veterinarian wants to start working like this for example, it can be difficult to

acquire a working cooperation with advisors or other knowledges needed. There could be a fear that the other expertise will take over their area of knowledge and take their place. In a study on biosecurity, practices and communication, Sayers et al. (2014) found that communication between veterinary practitioners and dairy advisors was lacking to a high degree. The impact matrix can give a more objective view to the advice that is brought up in the specific farm situation, when an inter-connected, holistic approach highlights areas that are normally not discussed. For example, things the advisor always looks at and regards as important are not always those where a change would give most effect, in the specific farm and situation.

6.1.2 Structural aspects of (organic) dairy farms

The context of organic dairy farming is diverse in different countries, but even so it can be shown that it is possible to find similarities within farm types by clusters, even across country borders. The typologies of farms, and farmers that were found in this project, indicate that different types of organic farms need different types of advisory approaches. There were significant differences between the types, such as cluster three farms, which were the ones with lowest stocking rate and manpower per dairy cow, but highest amount of manpower for all agriculture activities, suggesting greater levels of efficiency in dairy production and labour use in all agriculture activities. Cluster one, with medium-sized herds, production and farms, had the highest amount of manpower dedicated to dairy cows, implying that they are more focused on the dairy production and in between cluster two and three regarding technological development. Farms in cluster two had the most extensive production systems. These differences require that different strategies for advisory service and management improvement are applied. Jansen et al. (2010) found that farmers who are seen as difficult to reach with advice are not uniform, but rather divided into groups based on trust in external knowledge and outside world orientation. In the referred study it was also seen that communication was essential for improvements in farm management, and that the farm structures and characteristics of different farms and farmers' impact on the implementation of actions must be recognised. The impact depends on the farmers' motivation and goals, as well as their everyday situation (Barkema et al., 1999; Garforth et al., 2006; Kristensen and Jakobsen, 2011).

A recent study on human-animal bonds by Ivemeyer et al. (2018) found associations to udder health, i.e. the more caring humans around the animals, the lower the animal stress levels and the better their udder health. They concluded

that this should be considered further in control programs, and could be used to refine clustering of farm types. Duval et al. (2016a) showed that French veterinarians usually only had contact with organic dairy farmers when an individual animal was sick or if there was an acute herd health problem. The veterinarians also regarded organic farming and its regulations as problematic, as it did not in all respects meet their views of good animal health and their perceptions of good veterinary practice. The lack of knowledge about organic dairy farming among veterinarians may lead to a less favourable outcome of advisory activities, since they may not meet the needs of the farmers. Although it is conceivable that the impact matrix method would ease such deficiencies due to the structured and participatory approach, the lack of knowledge may have contributed to the lack of success in improved animal health. In the organic principles the animals' naturalness is essential, meaning for example, as much as possible allowing the animals to meet their natural needs, an environment in the farm that assures the need for natural behaviour and freedom of choice for example to eat, drink and lie down. This is expressed in the organic principles of human caretaking (IFOAM, 2005; Lund, 2006; Vaarst and Alrøe, 2012). On the negative sides of naturalness, for the individual animal, compromising with physical health could be counted, and this may be a reason for many of the veterinarians' critical views of organic farming, as they see it as poor animal health (and welfare). Thereby the veterinarians rely on their knowledge and background in medicine and prioritize the animals' health above the naturalness (Duval et al., 2016a; Vaarst and Alrøe, 2012). In a study by Richert et al. (2013) it was demonstrated that there are other factors characterising the farms than organic or conventional management, such as more intensive production, that were associated with more frequent use of veterinarians and treatments. This could be compared to what was found in our studies, where the Swedish farms, belonging to the cluster with most intensive production, had the lowest prevalence in most of the measured diseases (Krieger et al., 2017c; Sjöström et al., 2017).

A common notion is that "the best plans are the ones that are implemented".

There is a great diversity of organic farms and farmers, both between and within countries that provides a key challenge to advisory services. This makes it apparent that advisors need to take greater account of both the farm structure and the characteristics of the farm and farmer, including farmers' goals and attitudes, and adapt their approach to these factors (Derks et al., 2013b; Lam et al., 2011; van Soest et al., 2015). Barkema et al. (1999), showed that the combination of farmer objectives and motivation, grouped in clusters of farms, had a significant influence on the implementation of measures to prevent animal

diseases. In our study, the number of actions were twice as many in cluster three (the largest, most high producing farms, with lowest stocking rate and most equal distribution of gender and age in farmers) compared to the ones in cluster one (medium-sized farms and herds), and two (small-scale farms with low input and output). The rate of implementation of actions was significantly higher in clusters one and three compared to cluster two farms. An explanation could be that in Sweden, where the cluster three farms were found, there is a tradition of good animal husbandry and it is common to use existing, well-established advisory services and veterinarians, throughout the country.

Another challenge is to overcome the limitations that hinder the farmers from implementing actions. In this project, it was shown that the major reason for not implementing the actions was time and costs and the second was limitations of housing and constructions, but without any significant differences between the clusters. This result is a little surprising, as when using the participatory approach with the impact matrix analysis, where all constraining factors should have been brought up for discussion; however, it could be that the impact matrix was not tailored to each specific farm and situation. This can be compared with the study by Derks et al. (2013a), where the least important areas to farmers, to include in advisory matters, were housing and feet health. It could be that without routine recordings and foot trimming it is not so obvious that there are problems with the feet. Cluster two farms in our study were the ones with a significantly higher rate of non-implementation of actions due to lack of skills and expertise, compared to cluster one and three. A lack of resources such as time and capital to be able to invest in additional skills could be one of the reasons for this, and another could be that there is a lack of professional organic advisory services in the regions where the organic farms are found in e.g. Spain (Blanco-Penedo et al., 2014).

6.1.3 Animal health status and benchmarking

One aim of these studies was to assess the prevalence of production diseases in European organic farms. This was achieved by common methods to calculate a comprehensive set of animal health indicators and could thereby be compared across countries. There are previous studies that have concentrated on this matter. Thamsborg et al. (2004) presented that there were large animal health issues in organic dairy herds, based on many single-country studies. In Ivemeyer et al. (2012), one of the later studies with assessments of animal health and welfare, seven countries were included with a total of 128 farms, but a rather small sample per country (mean 18 farms per country) using four indicators of

health that were based on common data. The present studies included fewer countries but larger number of farms and a comprehensive amount of animal health indicators. The structuring of the data collection and databases are very diverse in different countries, and the availability is inhibited by different ownership. This was possible to largely overcome this issue in our studies but definitely constrains the use for actors in the field that work with animal health. This demonstrates the need for more trans-continental harmonised systems, to give grounds for setting of, for example, thresholds for health and disorders, for easier comparison between herds and countries (Krieger et al., 2017c; Olsson et al., 2001; Sjöström et al., 2017; Sundrum, 2014). These could then serve as drivers and incentives for the individual farmer to work with more preventive herd health management (and make use of advisory services), when it becomes clearer where his/her herd and farm stands, in relation to others.

The need for harmonised data and benchmarking was discussed in stakeholder workshops, conducted within the IMPRO project, with representatives from the whole dairy production chain. The participants expressed the need to improve the farms scoring lowest with regard to animal health, as those pose a threat to the organic label. By a questionnaire, the stakeholders concluded that this could be achieved by different measures, such as giving encouragement to farms with good animal health and admonishing farms with poor animal health. The stakeholders were in favour of minimum standards for animal health and that farms below the standard should be obliged to improve their animal health, even though the stakeholders were unwilling to set the threshold levels for such standards.

The structured approach in IMPRO, where all included countries performed and collected data using harmonised methods allowed for valid trans-national comparisons, and suggests a way for the future. Due to insufficient data in some aspects of the organic production and food chain, comprehensive and comparable official statistics are necessary for future review, work and development. Comparable benchmarking is crucial, for improvement of animal health on individual farms, and for the dairy production sector as a whole, to be able to show consumers that organic farming is managed in a sustainable way and with good animal health, and to justify higher market prices (Hoischen-Taubner et al., 2016; Sundrum, 2014; von Meyer-Höfer et al., 2015). The degree of production intensity in dairy farms has been demonstrated to influence the prevalence of production diseases, as prevalence and severity tend to grow with increased production (Alvåsen et al., 2012; Oltenacu and Algers, 2005; Rutherford et al., 2009; Stengärde et al., 2012). The opposite was seen in this project, where Swedish herds that were the largest and had the highest production at the same time had the lowest prevalence of production diseases.

However, a large variation in prevalence was also seen within countries (Krieger et al., 2017c; Sjöström et al., 2017). Lameness assessment was included as a health indicator in our study because there are no routine recordings on locomotion disorders or proxies thereof, and it is one of the major production disorders. To implement routine foot trimming as a mandatory action, and paired with recordings of observations, could be a way to enhance the animal health and thereby give guidance for actions and be used for comparisons. Manske et al.(2002) showed that foot trimming effects lameness prevalence. Routine foot trimming is mandatory in Sweden (Swedish National Board of Agriculture, 2010) and this could be one reason for the low prevalence in Swedish herds found in our study. These results clearly show that there is a need for more comparable monitoring of disease levels based on consistent farm record-keeping in Europe (to raise the farms with a poorer animal health status).

Tremetsberger & Winckler (2015) and Tremetsberger et al. (2015), among others, state that the work to improve animal health (and welfare) needs to include benchmarking and assessment of the current status as a starting point. This, in turn, needs to be compared with other farms to make the actual status visible to all stakeholders involved in the particular farm. Otherwise, it can be easy to become blind to flaws, and see the status as very good because it is better than before in this specific farm. If it were possible to also compare between herds in other countries, it would give an even broader perspective on the benchmarking (Huxley et al., 2004; Krieger et al., 2017c; Sjöström et al., 2017). It would also, perhaps, give incentives for higher market prices, with long-term economic benefits.

6.2 Methodological aspects

The final list of impact matrix variables used in this project was a compromise of the different variable lists compiled in each of the participating countries. The reason for this was to compare the outcome of the research between countries, but resulting also in a list that was not tailored to each country's conditions. The excluded variables for each country may have a larger importance than could be estimated during this study period. Quality and availability of advisory services, for example, was identified in Germany as an important variable to include in the impact matrix but was excluded from the common list. This could be a sign that this is a more important factor for success in Germany, and if included in an impact matrix in Germany, it could have been more obvious that it really is this factor that is contributing to lack of improvements. By the same token, the common list of variables was not

tailored to any particular herd's conditions. It is conceivable that a positive impact of the advisory approach using the impact matrix would have been more likely if it had used a set of variables that were felt to be more relevant to the farmer, veterinarian and advisor in a particular farm.

Another aspect of the impact matrix, as used in this project, is that it took a long time to perform the analysis. To be practically applicable it needs to be more adapted to the situation, for example in how many and which variables should be included at each particular farm and situation. A set of variables chosen for each occasion to suit the farm situation would not only increase the chances of success, but also speed up the process because the actors would be more familiar with the variables.

The outcomes of this project could been different if the characterisation of the farms and farmers into clusters could have been used as an input for designing the variables in the impact matrix analysis to better suit each farm. However this information was compiled later in the process.

This project would have benefited from a longer time for implementation and follow-up. Many of the actions were more of a long-term investment and would have needed more time for follow-up to justify the work. Ivemeyer et al.(2009) found only trends of improvement in udder health after one year. In an extended study with a longer period of animal health planning and work with veterinarians, a significant improvement could be seen (Ivemeyer et al., 2008). The full effect of the actions that were agreed during the health planning of IMPRO could not be estimated within the short duration of the project, which is unfortunate.

Convenience sampling, as in the case of the included study farms, may differ from a random sample in the population of dairy farms as a whole of the countries. These farmers could have been more interested in animal health and in changes or participating in research. However, the variation in the studied farms corresponds to the mean variation in European organic farms (European Commission, 2013; Krieger et al., 2017c; van Soest et al., 2015). It could also be that some of the farmers with more animal health problems saw an opportunity to get a chance to make changes, even if their budget was limited.

To be in a multi-country project, such as IMPRO, there are always challenges, such as harmonising the data and the collection of data. It must not be forgotten that the cultural and language differences can be a hinder, e.g. translating questionnaires developed in English, into native language by people who don't have English as their native language. Still, it was a strength to have countries included in this project that reflect the differences of organic dairy farming in Europe and at the same time be able to compare structures and animal health status.

Multi-disciplinary teams, both in the form of the participators at the farms (vets, farmers, and advisors) and in the research team, from veterinary scientist to social scientists, have complemented each other during the progress of the research. The same results may not have been reached if only single disciplines were involved. Again, cultural and 'language' differences in such teams is a challenge but if overcome, as was largely the case in IMPRO, also fosters a stimulating and productive research environment.

7 Conclusions

Organic dairy farms in Europe face many challenges, as demonstrated in this thesis. These are the main conclusions:

- The prevalence of production disease indicators were similar to those found in studies of conventional dairy herds, and the large variation between herds implies that there is room for improvements.

- It is possible to find similarities among farms and group them into clusters, even with the great diversity that was found between farms and countries regarding the organic farming.

- The structured participatory approach with impact matrix could serve as tool for improved co-operation between farmer, veterinarian and advisor, and hopefully improve animal health.

- The results found in this project suggest that the advisory service organisation would benefit from further research to recognise what characteristics of different organic dairy farms (and farmers) hinder and favour the implementation of management actions associated with animal health.

8 Future perspectives

The structured participatory approach, involving several disciplines, such as farmer, veterinarian and advisor, as used in this project, could be a method for all forms of dairy farms to get input from different knowledges about their specific farm and farm situation. This would increase the opportunities to achieve improved animal health. However, the approach needs to be further refined to better fit each particular farm and situation to be useful.

Combining the approaches used in the studies of this thesis (benchmarking and the holistic, structured participatory approach with impact matrix analysis and the clustering of farms) and the one in WP3 (proactive monitoring and preventive protocols) would be a possible future working strategy for the advisory networks. However, this would need to be enhanced and further investigated by research, to be fully useful in the field.

The holistic approach to advisory services, in combination with comparable indicators, as tried out in the IMPRO project, was a further development of previous projects (e.g. Ivemeyer et al., 2012; Vaarst et al., 2011), to capture the complexity of dairy farm systems, as shown in Vester's sensitivity model for other large complex systems (Vester, 2012). This was only a first attempt to apply the procedure to dairy farms and more research and development would be needed to fully capture its potential.

In future research it would be interesting to adapt the set of impact matrix variables to each individual farm situation, and through that investigate if it is possible to further improve animal health.

The structured participatory approach with impact matrix analysis was very positively received by the participants in the project, but more research and evidence is needed to verify its usefulness in practice.

It would be an interesting issue for research to further investigate some of the more 'soft' values that were touched on in the visits, such as farmer-animal bonds or how farmers regard their animals, 'the eye for the animals'. Especially interesting is whether this affects the animal health status and the management

status on the farm, and how it relates to advisory services and communication with veterinarians.

Benchmarking could be an effective tool in animal health planning and there should be an incentive for governments, agricultural businesses and research networks to implement recording systems that are comparable across borders for more harmonised farming and animal management. More research is needed on how to achieve useful and comparable, trans-national systems.

Popular science summary

Organic farming as seen today, stems from many different ideas, philosophies and movements as a reaction towards the seemingly unsustainable development of agriculture, with depletion of soils and doubts about whether it was right to use so many chemicals. This led to IFOAM (International Federation of Organic Agriculture Movements) developing principles for organic farming and keeping animals with as much ‘naturalness’ and ‘fairness’ as possible, and in harmony with nature. There are many challenges to the success of these aims in our globalised world with trade of food and animals across the entire planet.

There is a strong focus on animal welfare in organic farming, including philosophical and ethical ideas about good animal welfare. Animal health is a part of welfare and previous studies have shown that animal health could be used as a proxy for animal welfare status. In organic production, the individual animal space should be as large as possible, bedding material is compulsory, and feed must be organically produced (to almost 100%). The use of antibiotics is restricted and the withdrawal periods after treatment are twice as long as for conventionally farmed animals. According to the EU organic regulations, the first line choice for disease treatment should be homeopathic or phytotherapeutic (herbal medicine) products. In Sweden, it is, however, not permitted to use only homeopathic or phytotherapeutic treatments instead of allopathic (ordinary) medical treatments, such as antibiotics.

Organic food products are promoted as coming from animals raised under higher welfare conditions that should reduce stress and allow natural behaviour. It should also make them more resistant to diseases and reduce the risk that the products contain residues (such as drug residues or pesticides) compared to products from conventionally raised animals. However, research shows that animals in organic production, have similar health problems to those found in conventional production. In dairy cows the main problems are mastitis, reproduction disorders and lameness, regardless of whether they are raised conventionally or organically.

There is no common monitoring of the disease situation in Europe and there is a lack of comparable records, including animal welfare issues such as lameness. This makes it very difficult to compare the situation between scientific studies, between farms/herds and between countries. Even for the farmers themselves it is difficult to estimate how good or bad the situation is on their own farm when there is nothing to compare it with.

The development of herd health and production management has taken place gradually and the purpose in the beginning was to improve animal health, food quality, productivity and profitability for the farmers, through continuous monitoring. This gave, to a large extent, higher productivity in conventional farms, but did not necessarily improve animal health.

There are factors that can have a negative effect on the advisory services for organic herds, e.g. lack of awareness among veterinarians and advisors of the regulations that govern organic farmers, or lack of implementation of the recommended actions. It is probably the lack of effective knowledge transfer, rather than a lack of knowledge per se, that is the constraint. To overcome this shortcoming, new approaches are needed. In this project, the ideas of Frederick Vester about changes in complex systems have been used, where it is possible to examine how all areas in the system affect each other if a change is made somewhere in the system. For example, if a road in a city is moved, this approach shows how it also affects other areas, such as access time to schools or availability of 'green lungs'. Vester's model has been used by large organisations, such as UNESCO or KappAhl, when they were to redirect their transportation over the world. Using this approach it is getting easier to find where you will get the best effect of making changes; all areas are brought up for discussion and even unexpected areas are captured. A dairy farm is a very complex system and it is easy to miss where you really should make a change, and this could be something completely different from what seems to be the most logical at first glance.

This was the background to the initiation of the IMPRO project (Impact matrix analysis to improve animal health and welfare in organic dairy farming).

In IMPRO, six European countries participated, and in four of these, France, Germany, Spain and Sweden, dairy farms were visited. Great Britain and The Netherlands contributed in the socio-economic studies of the farms.

The aims of this thesis were to: study the status of animal health in organic dairy herds, by use of common calculations in all countries, identify structural characteristics of the farms and examine if there were connections to how they implemented plans for improved animal health, as well as trying a structured participatory and farm-centric approach to herd health planning (from Frederick Vester's ideas and model).

We chose to perform lameness scorings on a sample of the cows on each farm, because there is no common monitoring.

We found that the status of animal health varied widely between farms and countries. For example, the frequency of lameness was five to six times higher in France and Germany, and slightly higher in Spain, than in Sweden. Farms that did not let their cow out on pasture had a higher share of lame cows and the problem was also more common for cows of the Holstein breed, as well as on larger farms. We found that it is possible to divide the farms into three groups based on their structural characteristics. Farms in the different groups implemented different strategies for herd health planning. They had implemented a large part of the actions that were part of a health plan. The actions were identified during a structured participatory approach where the farmer, veterinarian and advisor were present. This was done by use of a so-called impact matrix that was developed based on Frederick Vester's model. Often it was the actions or areas that were unexpected by the participants, such as the family or a knowledge-enhancing activity, that were the most important. In a follow-up of how the progress had been for the farms, no direct connection between changes in animal health and the efforts made in the project using the structured participatory approach was found. This could, for example, be explained by a too short time for implementation or that the economic situation for the farms had changed compared to the time when the plans were made.

The large differences in animal health on the different farms (even between the countries) show that there is room for improvement. The fact that there is no unified registration of health in European organic dairy farms reinforces the need for improved quality and accessibility of such data. The results also show that it is possible to use the registration and grouping as a background for tailored advisory service strategies, i.e. different groups of organic dairy farms need different types of advisory approaches to reach improvements (adapted to the specific farm situation).

Populärvetenskaplig sammanfattning

Ekologiskt jordbruk, som vi ser det i dag, härstammar från många olika idéer, filosofier och rörelser som en reaktion på det jordbruk som sågs som ohållbart med utarmade jordar och med tankar om huruvida det var rätt att använda så mycket kemikalier. Detta ledde vidare till att IFOAM (International Federation of Organic Agricultural Movements – den internationella federationen för ekologiska jordbruksrörelser) satte upp principer; för hur ekologiskt lantbruk ska drivas, hur djuren ska hållas på ett så naturligt och rättvist sätt som möjligt och ske i samklang med naturen. Det finns många utmaningar för att lyckas med detta i vår globaliserade värld där vi bedriver handel med mat och djur över hela jordklotet.

I ekologisk djurproduktion finns ett starkt fokus på djurens välfärd, vilket även inkluderar filosofiska och etiska idéer om vad god djurvälfärd är. Djurens hälsa är en del av djurvälfärden, och det har visats att hälsan går att använda som en uppskattning av hur statusen av välfärden för djuren är. I ekologisk produktion ska utrymmet för varje djur vara så stort som möjligt. Det måste finnas strömaterial för djuren att ligga på och fodret måste till största delen vara ekologiskt odlat. Antibiotikaanvändningen är begränsad och karenstiderna är dubbelt så långa efter behandlingar av ekologiskt hållna djur som för konventionellt hållna djur. Enligt EU:s ekologiska regler ska homeopatiska preparat eller fytoterapi (örtmedicin) användas i första hand. I Sverige är det dock inte tillåtet att använda bara homeopati eller fytoterapi istället för allopatisk (vanlig) medicinsk behandling som t.ex. antibiotika.

Ekologiska matprodukter marknadsförs ofta med att de kommer från djur som fötts upp under förhållanden med bättre välfärd, vilket ska reducera stressen för djuren och ge dem möjlighet till naturligt beteende. Det ska också göra dem mer motståndskraftiga mot sjukdomar och produkterna ska innehålla mindre restsubstanser (t.ex. läkemedelsrester eller bekämpningsmedel) än produkter från djur som hållits under konventionella förhållanden. I studier har man har ändå sett att sjukdomsläget hos djur i ekologisk produktion är liknande som hos

de i konventionell produktion. Hos mjölkkor är de vanligaste problemen juverinflammation, reproduktionsproblem och hälta, oberoende av om de är ekologiskt eller konventionellt uppfödda.

I Europa finns det inte någon gemensam övervakning av sjukdomsläget och det saknas jämförbara uppgifter. Detta gäller även djurvälfärdsaspekter och områden som hälta. Det här gör det mycket svårt att jämföra hur läget är, mellan olika vetenskapliga studier, mellan gårdar/besättningar och mellan länder. Även för lantbrukarna själva blir det svårt att få en uppfattning om hur bra eller dåligt läget är på deras egen gård då de inte har något att jämföra med.

Utvecklingen av hälsoplanering och djurhälsovård har skett gradvis och syftet var först att förbättra djurens hälsa, kvaliteten på maten, produktiviteten och lantbrukarens förtjänst/lönsamhet genom kontinuerlig övervakning. I stor utsträckning gav detta ökad produktivitet på konventionella gårdar, men det förbättrade inte nödvändigtvis djurens hälsa.

Det finns olika saker som kan påverka rådgivning i ekologiska besättningar negativt, som att veterinärer eller rådgivare inte är medvetna om de regler som lantbrukarna måste hålla sig till, eller att åtgärder som föreslås inte blir införda. Det är troligen mer en fråga om att kunskapen inte överförs på rätt sätt än att kunskapen i sig saknas. För att överbrygga denna brist behövs nya tillvägagångssätt. I detta projekt användes idéerna från Frederick Vester om förändring i komplexa system, där man går igenom hur alla olika områden i systemet påverkar varandra om man gör en förändring någonstans. Om man drar om en väg genom en stad, hur påverkas olika områden då? Vesters modell har bland annat använts av stora organisationer som Unesco eller Kappahl när de skulle göra om transporterna över världen. Genom det här sättet är det lättare att hitta var man får bäst effekt av att göra en förändring. Alla områden tas upp, vilket innebär att även oväntade områden fångas upp på detta sätt. En mjölkkogård är ett mycket komplext system, och det är lätt att förbise var det egentligen bör göras en förändring. Det kan vara något helt annat än vad som verkar vara det mest logiska vid första anblicken.

Det här var bakgrunden till att IMPRO (Impact matrix analysis and cost-benefit calculations to improve management practices regarding health status in organic dairy farming), ett projekt för förbättrad djurhälsa och välfärd i ekologiska mjölkbesättningar startades.

I IMPRO deltog sex europeiska länder. I fyra av dessa, Frankrike, Spanien, Sverige och Tyskland, besöktes mjölkkogårdar som ingick i projektet. Holland och Storbritannien bidrog till de socioekonomiska studierna av gårdarna.

Målen med denna avhandling var att: ta reda på hur hälsostatusen i ekologiska mjölkkobesättningar är, genom att använda jämförbara beräkningssätt, identifiera strukturella karaktärer hos gårdarna och se om det

fanns något samband med införandet av planer för djurhälsan samt att testa ett strukturerat tillvägagångssätt för hälsorådgivning som är deltagardrivet och gårdscentrerat (utifrån Frederik Vesters idéer och modell).

Eftersom det inte finns rutinmässiga registreringar av hälta valde vi att utföra hältbedömningar på ett urval av korna på varje gård.

Vi fann att läget för djurhälsan varierade mycket mellan gårdar och länder. Bland annat var frekvensen av hälta fem till sex gånger högre i Frankrike och Tyskland, och något större i Spanien, än i Sverige. Gårdar som inte hade sina kor på bete hade högre andel hälta, och problemet var också vanligare för kor av rasen Holstein, samt på större gårdar. Vi såg att det gick att dela in gårdarna i tre grupper utifrån de strukturella karaktärerna. Gårdar inom de olika grupperna visade sig införa olika strategier för planering av djurhälsa. De hade infört en stor del av åtgärderna, som var en del av en hälsoplan. Åtgärderna hade identifierats under ett strukturerat tillvägagångssätt med aktivt deltagande av lantbrukare, veterinär och rådgivare. Detta gjordes med hjälp av en så kallad matris för påverkan som vi tog fram utifrån Frederick Vesters modell. Det handlade många gånger om oväntade åtgärder eller områden för deltagarna, som att familjen eller kunskapshöjande aktiviteter var det mest betydelsefulla. Vid en uppföljning som gjordes för att se hur det hade gått för gårdarna kunde inget direkt samband ses mellan förändringar i djurhälsan och insatserna som gjordes i projektet med det strukturerade, deltagardrivna tillvägagångssättet. Detta kan bland annat bero på att det var för kort tid för att tillräckligt många av åtgärderna skulle hinna införas eller att det ekonomiska läget på gårdarna hunnit förändras.

Den stora skillnaden i hälsan hos djuren på de olika gårdarna (även mellan länderna) som vi fann visar att det finns utrymme för förbättringar. Det faktum att det inte finns någon enhetlig registrering av hälsa i europeiska ekologiska mjölkkobesättningar, förstärker behovet av att förbättra kvaliteten och tillgängligheten på sådana data. Resultaten visar även att man kan använda dessa som bakgrund för att skräddarsy rådgivningsstrategier, d.v.s. att olika typer (grupper) av ekologiska mjölkkogårdar behöver olika typer av rådgivningssätt för att nå förbättringar. Dessa måste då också vara anpassade till varje gårds situation.

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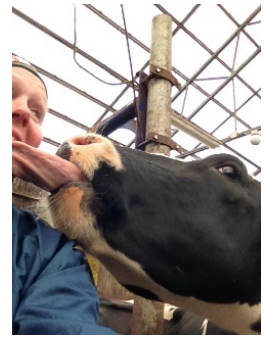

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