Chapter 5

"Healthy Food" from Healthy Cows

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Additional information is available at the end of the chapter

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1. Introduction

Milk and milk products are the outcome at the end of a long process and food chain. Various factors on different scales along production and processing can have beneficial or detrimental impacts on various features of dairy products' and process qualities. Indeed, the processes are very complex and far more complex, peculiar and heterogeneous than generally imagined and expected by consumers. On the other hand, the white color of milk and their products provides like a screen an ideal area to project very different attributes and link very different associations with the product while only few reference points are given to validate any of these assumptions.

"Health" implicates a strong attraction for human beings, and food that promises to support and improve health conditions is highly appreciated by consumers. In recent years, consumers' attention to health and food safety issues has increased overwhelmingly because of their increased concern about their own health and the crises and emergencies reported worldwide [1]. "Healthy food from healthy animals" is a slogan often used in the communication between different stakeholders to associate a relationship between the production process, the health status of farm animals and the possible impacts of products from these animals on human health via the consumed food. Although the link is very weak from a scientific point of view (low level of correlation), the associations are strong in the mind of humans and stakeholder groups and effective, especially for the purpose of product marketing.

In the forthcoming sections it is the intention to contribute some enlightenment in the complex process of dairy milk production with a special emphasis on organic production. Without striving for a comprehensive disquisition of the extensive issue, the focus is directed to the question of how expectations of consumers with respect to "healthy food" and the deliveries of organic dairy farmers might fit together. Moreover, which measures might be adequate to bridge the gap between the expectations of different stakeholders involved and what might ex-

ceed their potentials? Finally, overall conclusions are drawn with respect to the challenges for organic farmers and for a market driven label program such as organic dairy farming.

2. Expectations of consumers

Consumers are becoming increasingly sensitive about health and welfare problems in commercial livestock production systems, an industry currently under scrutiny for inconsistent practices. More and more consumers expect their food to be produced with greater respect for the needs of farm animals. They express concern about possible hormone, antibiotic, pesticide or chemical residues in animal products and assume that organic products are superior to those produced conventionally in being lower in residues and higher in nutrient content. This largely explains the attention given to this issue as a specific object for public policy and market intervention.

Many consumers also associate organic farming directly with enhanced animal welfare and conflate organic and animal-friendly products [2,3]. For many people, organic farming appears to be a superior alternative to conventional livestock production [4,5]. Consumers' interests and expectations are linked to their willingness to pay premium prices on products which they feel are healthier and safer for their families [6]. In contrast, consumers are less strongly motivated by the altruistic concerns of animal welfare, environmental protection, and the support for rural society – the so-called »public goods«.

Even though organic farming only covers a small percentage of the food market, the expressed sympathy in the general public appears far greater than the market share. Interest in organic food has grown remarkably as consumers react to popular media about health effects and then have gradually evolved attitudes toward the origins and to the production process of food. For example, a change from confinement to grazing systems is one of the tools to evoke positive associations with the product. In this way, animal health and welfare have been turned into quality attributes of food.

Not only the word “health” but also the word “organic” means many different things to consumers. Correspondingly, consumers of organic foods are neither homogenous in demographics nor in beliefs [5,7,8,]. They hold a huge variety of motivations, perceptions, and attitudes regarding organic foods and their consumption. For example, some organic milk consumers buy organic to avoid antibiotics and hormones whereas others focus on different concentrations in valuable ingredients or on the health status of the farm animals. All of these factors drive the decision-making process to buy those products [2].

In contrast to the metaphors and the associated pattern of thought used in sales promotion, consumers’ awareness of “healthy food” encounters very complex phenomena, including a large number of factors that have to be taken into account and which are heterogeneous in the outcome. Many consumers do not understand the complexities of organic farming practice and food quality attributes [4]. There is reason to assume that consumers delegate responsibility for ethical issues in food production to the retailer or the government as many

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consumers do not like to be reminded about issues connected with the animal when choosing products of animal origin [9]. On the other hand, consumer groups mistrust the limited information available at the point of purchase, whereas price is an extremely visible attribute of products related to quality by the notion of value [10]. Demand tends to depend more on the price differential with respect to conventionally grown products than on actual price. In contrast to sensitivity of demand to changes in price, income elasticity of demand for organic foods is generally small [8].

3. Organic agriculture – Based on minimum standards

The International Federation of Organic Agriculture Movements [11] states that organic husbandry focuses on improving animal health and preventing disease through a holistic approach, while at the same time minimizing the use of synthetic medicine. Introduction of the wholesomeness concept in livestock production by organic production is mainly due to a wish for reestablishing a positive image of food safety and animal welfare aspects [12]. Largely, the widespread sympathy for organic agriculture seems to stem from its value-based approach.

Guidelines have been a characteristic feature of organic farming since 1954 when clear criteria have been required by trademark legislation to identify organically produced goods [13]. Because the variety of production sites and the resulting product properties did not allow their identification to be linked to products qualitatively in terms that could be described exactly and understood analytically, the production method itself became the identifying criterion. This fundamental principle has been kept to the present day in the standards of international and national organic agriculture movements and in legislation.

The organic concept refers to the whole farm as the base of a comprehensive system where the production process is intended to ensure quality production rather than maximizing production. The leading idea is based on the voluntary self-restriction in the use of specific means of production with the objectives to produce food of high quality in an animal-appropriate and environment-friendly manner on the basis of a nearly complete nutrient cycle [14]. Organic farming commits itself to a number of substantial values, and thereby sets itself apart from conventional farming. The IFOAM states four principles: (1) Health, (2) Ecology, (3) Fairness, and (4) Care. These principles grew out of stakeholder consultations and were agreed upon on a worldwide basis by the members of IFOAM with each principle being accompanied by an explanation [11]. Nevertheless, organic agriculture is not organized uniformly, neither with respect to the various objectives, nor in the degree of their implementation. There have been and still are different perspectives on organic agriculture with different understandings of what it is and what it develops [15]. A comprehensive definition of organic production is provided by the *Codex Alimentarius* Commission [16].

In Europe, the EU-Regulation (EEC-No. 1804/1999) on organic livestock production, now replaced by EEC-No. 834/2007 was introduced to protect consumers from unjustified claims, to avoid unfair competition between those who label their products as organic, and to en-

sure equal conditions for all operators. The EU-Regulation provides a framework ensuring living conditions for organic livestock to be better than those in conventional systems, to harmonize the rules across member states, and to make all organic systems subject to minimum standards. Labeling food as being "organic" identifies products as deriving from a production method. In the case of organic products of animal origin minimum standards are defined by specifications for the conversion process, housing conditions, animal nutrition, care and breeding, disease prevention, and veterinary treatment.

According to the EU Regulation, animal health problems shall be controlled mainly by prevention, based on the selection of appropriate breeds or strains of animals, as well as application of animal husbandry practices appropriate to the requirements of each species, and encouraging strong resistance to disease and the prevention of infections. The use of high-quality feed, together with regular exercise and access to pasture, is expected to encourage the natural immunological defense of the animal. Furthermore, an appropriate density of livestock should be ensured, thus avoiding overstocking and any resulting animal health problems.

Concerning veterinary treatment, phytotherapeutic essences and homeopathic products shall be used in preference to chemically synthesized allopathic medicinal products or antibiotics. Where dairy cows receive more than three courses of treatment with chemically synthesized allopathic medicinal products or antibiotics within one year, the livestock concerned, or produce derived from them, may not be sold as being of organic origin. On the other hand, organic farmers are obliged to intervene and treat animals immediately at first signs of illness. In general, the majority of antimicrobial drugs in organic dairy production are used for udder treatments [17,18]. However, due to a lack of control measures, little is known so far as to which degree organic farmers follow the leading ideas of the EU Regulation consistently.

At the international level, the regulation on animal health issue is widely harmonized [19]. Only the US National Organic Program Regulation (NOP) deviates substantially: animal products cannot be sold as certified organic if antibiotics or other substances not listed in the US NOP positive list such as bovine growth hormone, which is used among conventional dairy farmers in the USA to increase milk production, have been used just once. While the US concept seems to be more consumer driven ("pure" food), the European approach considers not only the health aspects of the food but also animal welfare as an important issue.

4. Outcome of minimum standards

As all organic farms are obliged to follow the same minimum standards, one might expect a high level of uniformity in the framework of livestock production and living conditions in comparison to conventional production. However, living conditions for farm animals differ markedly between organic production systems within and between countries [20]. They range from outdoor to indoor production with varying options with respect to space allowance, stocking densities, performance levels, nutrient availabilities, hygiene and air conditions, etc., depending on the farm-specific and local conditions [21]. Although most organic

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farmers make use of conventional breeds and genotypes, a large variation in the performance level and in the nutrient resources used is found. While feeding rations should be based in the first place on home-grown feedstuffs, they provide a higher variability in ingredients and composition than is expected in the case of feed from the feed mills [22].

In contrast, intensive systems have closely controlled environments to maximize aspects of animal productivity. The equipment of indoor housing and the feeding ration is offered by specialized enterprises, becoming more and more standardized all over the world. Living conditions have typically been adopted across regions and countries, thereby increasing environmental homogeneity between farms and leading to the predominance of a small number of breeds and genotypes that are particularly productive under these specific conditions. Parallel to the increasing performance level, nutrient demands have increased the call for the use of highly concentrated concentrate to meet the nutrient requirements of the animals at their various life stages.

While conventional livestock production has a strong shift toward specialization, the basic concept of organic farming is focused on mixed farms, although the degree of mixture can vary widely [23]. It can be supposed that farmers on highly specialized livestock farms have a more specific management qualification and are more aware of the relevant health-related factors than farmers on mixed farms. Because time capacity and competence of the farmers can be limited, excessive demands in several fields at the same time provoke conflicts within the farm management. In consequence this can lead to deficits on one or more of the various agricultural fields. Thus, there are reasons for the assumption that on organic mixed farms, handling and management of the farm animals are in far greater competition with various other farm activities compared to highly specialized conventional livestock farms.

Thus, the leading ideas and guidelines of organic livestock farming exist only on a meta-level, whereas the implementation in farm practice results in a large variation of living conditions for the farm animals. The complex interactions between different availabilities of resources (labor time, investments, know-how, etc.), different objectives and different priorities thus provide divergent implications on the level of animal health status.

5. Farm animals challenged by multi-factorial diseases

Mastitis, fertility problems, lameness, and metabolic disorders represent the main production diseases within dairy farming throughout the world [24]. These are multi-factorial man-made diseases. They emerge from interactions and synergetic effects between different risk factors and processes which in themselves would not necessarily cause clinical signs of a disease. Their occurrence indicates an overstrained capacity of the farm animals to cope with the living conditions provided by the farm management. To cope with multi-factorial diseases it is of high importance to consider the farm specific conditions, the dynamics and interactions between the various elements of the system, the availability of resources and the ongoing outcome of the interactions. In this respect, animal health status of the herd can be defined as an emergent property of the individual farm system [21].

Thus, the issue of animal health is not primarily related to minimum standards. It largely depends on the capability of the farm management to think through the complexity of the processes on different process levels and to organize a well-balanced farm system and good living conditions for farm animals while facing severe limitations in the availability of relevant resources (labor time, investments, knowledge, etc.). However, living conditions found in practice are so many and diverse that it is often difficult to identify those factors that are most influential and relevant in any actual combination of factors. The challenge to grasp the complexity within a farm system is also hampered by an on-going fragmentation of veterinary and agricultural science into a large number of sub-disciplines with an increasing risk of misinterpretation and misunderstanding [25]. Considerations of single or very few aspects include the risk to oversimplify the matter and to jump to premature conclusions. Relationships between single factors found in experimental studies under *ceteris paribus* assumptions are not always confirmed in epidemiological studies and vice versa, and often do not represent the interactive structure in the farm specific system and situation. Differences between experimental and on-farm conditions shed some doubt on the general applicability of experimental findings for practice.

There is a growing understanding within the scientific community that it is necessary to develop more comprehensive concepts in agricultural science which simultaneously consider a larger number of causal relationships. The isolated view under *ceteris paribus* assumptions is required to be replaced by a systemic approach [26].

6. Milk quality and "healthy milk products"

The term »quality« is documented very diversely in general language use and in the scientific literature. Whilst some understand something very sound and »normal« by this term, others see it rather as something special and extraordinary. According to Mair-Waldburg [27] quality includes both exemptions from deficiencies (inadequacies) as well as the fulfillment of previously determined features (properties) which exceed the usual. For a consumer-orientated quality product it is significant that quality products include a high degree of fulfillment of the consumer's expectation as far as the desired properties are concerned.

Next to the characteristics of the product quality which encompass aspects of nutritional value and hygienic-toxicological, technological and sensory characteristics, consumer expectations also include those related to the production process - so-called »process quality«. According to survey results, many consumers expect that milk originates from healthy animals, produced under animal-friendly husbandry conditions [28].

For some time now, great importance has been ascribed to the content of unsaturated fatty acids, especially the Ω3-fatty acids in milk. Their content in milk is used from various sides in a promotionally effective way to be able to offer consumers a "healthier" milk. In human nutrition the various trans-isomeric fatty acids experience a diverse nutritional evaluation [29]. Whilst trans-fatty acids are assessed negatively, conjugated linoleic acids (CLA) are hoped for. Diverse survey results moreover attribute the Ω3-fatty acids health-promoting ef-

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fects [30,31]. However according to a meta-analysis, correlating results have not been clearly proven [32].

Research presented by Nielsen & Lund-Nielsen [33] showed organic milk to have higher levels of vitamin E, Ω3-fatty acids, and antioxidant levels than conventional milk. The study concluded that the increased nutritional benefits were due to the organic cows being allowed to graze freely on grass as opposed to being kept in holdings, pens or feed lots. A three-year study in the United Kingdom found organic milk contained 68 percent more Ω3-fatty acids on average than conventional milk [34].

Composition and texture of the milk (especially the protein and fatty acids' content) are very much influenced by the nutrient uptake and nutrient composition [35]. Feeding clover silage, particularly red clover, increases the levels of polyunsaturated fatty acids [36]. A three-fold increase in milk alpha-linolenic acid levels was observed between cows offered red clover silage compared with grass silage. With cows fed with alfalfa and red clover silage, a significant reduction was observed in palmitic acid content of milk. Seasonal effects on the content of fatty acids in milk are primarily due to a modified feed supply. Distinct effects originate from pasture grazing or the intake of greenery compared to feed rations during the winter period [37].

To investigate the effect of the dietary intake of the cow on milk composition, bulk-tank milk was collected on 5 occasions from conventional (n = 15) and organic (n = 10) farms in Denmark and on 4 occasions from low-input nonorganic farms in the United Kingdom, along with management and production parameters [38]. The main results are illustrated in figure 1. The concentration of α-linolenic acid (ALA) was the response variable (Y-variable; the measured output variable that describes the outcome of the experiment), and the amounts of the 8 feed variables were predictors for the organic and conventional milk production systems (X-variables; figure 1A). The regression coefficients (the numerical coefficients that express the link between variation in predictors and variation in response) were significant for the proportion of cereals, pasture, and grass silage in the feed, indicating that these feed components increase the concentration of ALA in milk from the organic and conventional milk production systems. The proportion of maize silage, other silages, by-products, and commercial concentrate mix in the feed gave in contrast a lower ALA concentration in the organic and conventional milk. Moreover, the concentration of linoleic acid (LA) was low in milk from the extensive milk production system, and to identify which feed components in the organic and conventional milk production systems, which had an effect on the concentration of LA in milk, a partial least squares regression analysis (PLS) analysis was performed with the concentration of LA in the milk as response variable and the 8 feed variables as predictors (figure 1B). In this case, the regression coefficients were only significant for the proportion of commercial concentrate mix in the diet, indicating that use of commercial concentrate mix increases the content of LA in organic and conventional milk. However, the proportion of grass silage and other silages in the feed resulted in a low concentration of LA in the milk from the 2 production systems.

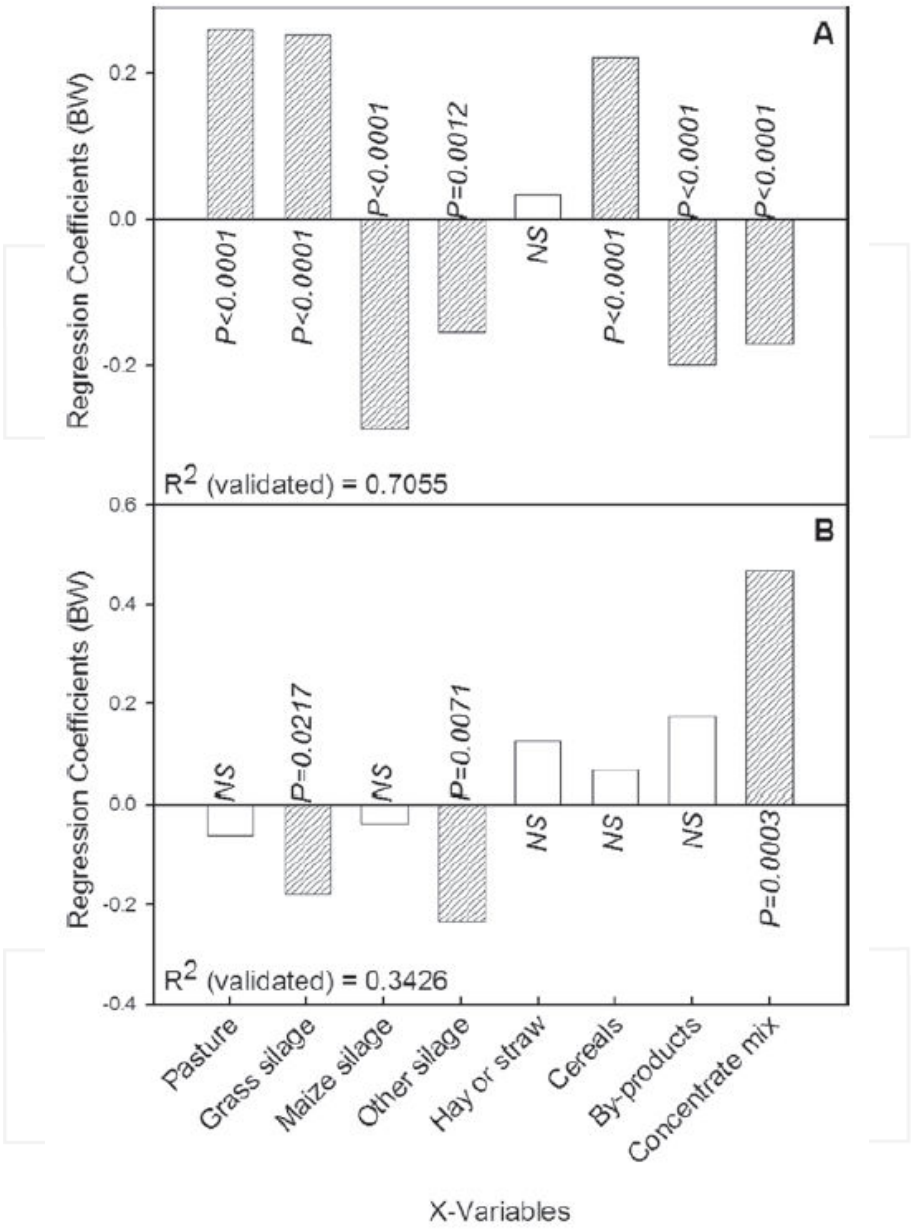

Figure 1. Regression coefficients obtained by partial least squares regression analysis for A) the concentration of α-linolenic acid (C18:3n-3) in organic and conventional milk and B) the concentration of linoleic acid (C18:2n-6) in organic and conventional milk as response variable with the feed variables as predictors (X-variables) minus the vitamin supplement. The bars with diagonal stripes are significant; NS = non-significant (Slots et al., 2009).

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According to the results found in trials in mountainous regions, milk from cows which only fed from greenery from alpine pastures showed a higher content Ω3-fatty acid than a comparable group of cows with silage feed [39]. The nutritional content of grass greenery is decisive for the fatty acid profile of the total milk fat regardless of the altitude of the pasture region [40]. The positive effect of silage feed and/or pasture feeding on the composition of fatty acid can be associated with a lower lacto-protein (41,42]. However, an increased Ω3-fatty acid content is not linked only to pasture grazing. Additives of vegetable fats, e.g. linseed oil, provoke similar effects as pasture grazing [43].

Although grazing in general provides a positive effect on the content of fatty acids in milk, buying organic milk does, unfortunately, not guarantee that one is buying milk from open pasture grass-grazing cows. Instead of pasture grazing, organic farmers in Europe are allowed to offer an outdoor area without any grass available. Moreover, access to pasture and feed quality of clover-grass is restricted and depending on the vegetation period, widely varying between regions and farms as does the daily time period cows are enabled or not able to spend on pasture.

Unfortunately, there are further constraints that act against the general trend of simplifying mental associations between grazing and "healthy milk". In the accessible literature there is reference that the contents of free fatty acids including the Ω3-fatty acids increase in connection with the inflammatory reaction in the udder [44]. A further survey brought to light that free fatty acids in the milk of clinically infected areas of the udder were in a six times higher concentration than in the non-infected udder area of the same cows [45]. Should these relationships be confirmed in further studies, an increased content of Ω3-fatty acids in the milk cannot be judged unreservedly positive, but only in connection with the status of udder health.

Mastitis does not only include a high content of Ω3-fatty acids in the milk but goes along with numerous impacts on milk quality: high somatic cell counts, high levels of bacteria in milk, high amounts of antibiotics used with the risk of antibiotic residue failures and the development of antimicrobial resistance, clinical signs with pain, suffering and tissue damage for the dairy cows.

Udder diseases are associated with minor up to high degree damage of the mammary tissue [46]. Often chronic progression of the disease and thereby irreversible modifications in the glandular tissue takes place. Furthermore, the animals suffer more or less distinct pain perception and general discomfort [47,48]. Functionality of other body organs can also be considerably affected [49]. High rates of illness in the herd with limited therapeutic success determine an increased culling rate [50,51]. After fertility disorders, udder diseases portray the second most frequent causes for culling of dairy cows from the herd [52].

Local and systemic reactions of the organism on penetrated foreign germs alter the content of immune defense cells and antibodies as well as the content of electrolytes and trace elements [53]. Subject to the degree of severity, the inflammation processes in the udder tissue always go hand in hand with losses in quality of the milk for human consumption. An increased cell and salinity [54], a reduction of the casein content, an increase of the pH-value, a

reduction of the cheese dairy efficiency and clearly increased lipolysis and proteolysis activity contribute to this [55]. The increased enzyme activity does not only impair the sensoric properties of milk, but also negatively affects the shelf-life of pasteurized and refrigerated storage of milk [56] as well as the cheese yield and storage [57,58].

The udder health status of dairy cows portrays a fundamental criterion of animal health. From the veterinarian perspective, an udder area (quarter) is then seen as healthy if the content of somatic cells in the milk does not exceed the figure of 100,000 cells/ml milk and with a bacteriologic test of the milk that there are no pathogens proven [59,60]. In contrast, the EU-Regulation (EC-No 853/2004) for bulk tank milk fixes the marginal value of 400,000 cells/ml in the geometric mean from three months for tradable milk. In the USA, the current legal limit for bulk tank SCC is even higher and fixed on 750,000 cells/ml for Grade A producers [61]. On the other hand, the EU-Regulation demands that raw milk must be from animals which are free of any signs of an infection which can be transmitted to humans via the milk. They must have good health and may not be suffering from a visible udder inflammation and udder wounds, which could affect the milk disadvantageously. While the inconsistencies within the EU Regulation are obvious, the utilization of milk from cows which suffer from subclinical mastitis is not explicitly prohibited by legislation. The threshold values with respect to milk quality ordinance bear no relation to udder health.

Nevertheless, in practice BTSCC levels beyond the legal marginal value are often associated with a tolerable udder health status. Although the concentration of germs and somatic cells in the milk deriving from dairy farms is generally high, this does not comprehend a problem for the issue of food safety as the milk is pasteurized. The exclusion of health risks for the consumers to a large extent might be the main reason why consumers and retailers are largely inert against the health and welfare problems in dairy herds.

Summing up, although defined by basic guidelines, organic livestock production is characterized by largely heterogeneous farming conditions that allow for huge differences in the availability of nutrient resources, housing conditions, genotypes and management skills, all of which variously impact milk quality and animal health. Correspondingly, there is substantial variation in the product and process quality of organic milk already within each herd. The milk of heterogeneous quality from different farms is delivered to the dairy, mixed to a homogeneous raw product with defined raw ingredients (especially fat content), while any top quality is down and worse quality is upgraded before the milk enters the market.

7. Status of animal health in organic dairy production

Several scientifically based studies on how and to what degree the EU-Regulation contributes to the objective of a high status of animal health in organic farming have been conducted in the last decade [62,63]. Still many open questions remain, especially with respect to the implementation of the gained scientific knowledge into practice. The assessment of animal health is a difficult task facing a high level of complexity due to the various interactions be-

tween health influencing factors. In the literature, huge differences and inter-country variation exist in study designs and quality of the studies. Complexity arises with current definitions of disease that includes subclinical conditions and a health management that considers animal health as herd performance [64]. Difficulties with methodology are also related to the health indicators in use. Indeed, good records are available only for the most easily diagnosed diseases. In this context, there is a need for a critical assessment of routinely collected health-related data used in research in order to make valid inferences regarding animal health performance [65].

Mastitis causes substantial economic losses and hampers animal welfare for both organic and conventional farmers. Differing results have been reported for udder health when organic and conventional dairy herds were compared. Based on treatment data from the Norwegian Cattle Health Service, no significant differences in the mean values of somatic cell counts (SCC) were found [66]. In a Swedish study, organic dairy cows tend to have higher somatic cell counts than non-organic cows [67]. In contrast, Garmo *et al*. [68] found that organic cows had lower milk SCC and a lower mastitis treatment rate than conventional cows. In Denmark, in a study involving 27 organic and 57 conventional herds, the percentage of cows treated for mastitis per month was 1.8–5.1 (25% and 75% percentiles) in organic herds and 3.3–6.7 in conventional herds [69]. Other studies show varying results including better udder health on organic farms [70], no difference [71] and higher levels of mastitis on organic farms [72].

Surveys from Switzerland, Norway, Sweden, Germany and the UK suggest that organic dairy herds do not have more fertility related problems than conventional herds [62]. In contrast, the calving interval and the intervals from calving to first and last artificial insemination (AI) were shorter for organic compared to conventional cows [73]; or showed only marginal differences between organic and conventional farms in reproductive performance [74]. An impaired reproductive performance in organic cows has been reported from Norway [75]. The differences from conventional production were due to a limited energy intake and longer winter season in the organic cows.

So far only a few investigations have been conducted to assess lameness in organic herds. Lameness plays a considerable role in organic dairy farming as demonstrated in a pilot study in 50 organic dairy herds in Germany [76]. Lower levels of lameness in organic farms than in non-organic units were found in a study by Rutherford *et al*. [77]. With the purpose of explaining the variance of different claw disorders, Holzhauer *et al*. [78] emphasized that herd-level factors are most important for the prevalence of hoof lesions.

The context of milk productivity may play a pivotal role in adaptation in the pathogenesis of metabolic disorders in relation to negative energy balance, such as excessive lipid accumulation in the liver, ketosis, abomasal displacement, cystic ovarian disease and laminitis [79]. In fact, surveys report lower production levels in the organic managed herds and support a yield-based explanation of any differences in metabolic or digestive disorder levels [62]. The incidence of clinical ketosis reported in most comparative studies was similar or even lower in organic than in conventional herds [80]. In the Swedish context, Fall *et al*. [71] and Blanco-Penedo *et al*. [81] found no significant differences in clinical ketosis between organic and

conventional herds, which included the change of legislation towards 100% organic diet. Regarding micro-mineral status, it has been suggested that selenium status may be poorer in organic compared to conventional farms [82].

Accounting for other health indicators, longevity is a reflection of the cow´s ability to avoid being culled. In Norway, cows in organic husbandry live longer [75] whereas results of a study in Sweden showed only marginal differences between organic and conventional farms in the length of productive life [74]. The rate of culling due to mastitis in Sweden was found to be similar in 26 organic herds and 1102 conventional herds [70]. In a recent study of Swedish organic herds, the overall most common reason for culling was poor udder health followed by low fertility and leg problems [83]. The ranking order in culling reasons differed in comparison to conventional herds. Studies that have compared health performance in conventional and organic farms have shown that disease problems in organic milk production tend to be similar (metabolic problems, lameness and mastitis in dairy cows) to what is found under conventional conditions while the extent of these problems varies considerably among farms [84], and between European countries [63].

Currently, a considerable number of organic farms cannot cope, in all respects, with the requests for high animal health status. As differences between farms appear to be greater than those between production methods, organic livestock farming defined by minimum standards does not provide a homogenous outcome with respect to animal health [85]. Obviously, the issue of animal health often is not the first priority in organic livestock farming.

Striving for a high status of animal health requires high management skills; one must be capable to gain an overall picture of the complex interactions within a farming system, to reflect on the most relevant factors, to implement feedback mechanisms, and guide the production process. Thus, it primarily depends on the management as to whether the potentials for a high level of animal health are fully realized. Differences in management practices, restrictions in the availability of resources (such as labor time, financial budget), and a lack of feedback and control mechanism within the farm system appear to be primary reasons for the substantial variation.

8. What prevents organic farmers from improving animal health status?

Reasons for the current unsatisfactory situation in organic dairy farming are manifold and differ considerably between farms as do the prevalence rates of multi-factorial production diseases. Identifying the main causes for the specific problems as well as the main constraints in farm management practices is essential when striving for improvements in animal health. Thus, a profound diagnostic procedure at different scales (animal, herd, and farm level) is the starting point of any initiatives.

Previous herd health planning has contributed to improving farm management and has prepared the ground for further advancements [63]. However, recommended measures have often been implemented in the daily farm practice only to a low degree. Thus, weak success

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has been achieved so far by traditional herd health planning and management, differing widely between farms. To reduce the prevalence of multi-factorial diseases it is required in the first place to identify and remove the main causes and risk factors of diseases therewith taking into account the whole farm context. On many farms the bottle neck for any improvements might be due to limitations in the ability to think through the complexity of the production processes on the different scales. Many farmers are trapped in their own perspective and are often left alone when assessing, diagnosing and treating farm animals without a valid reference point and without any control by a veterinarian authority or certification bodies whether they are successful or not in their efforts to improve the animal health status.

Because time capacities are limited, excessive demands in several fields at the same time provoke conflicts, leading to deficits in one or more of the agricultural fields. The need for additional labor efforts and increasing cost for health improvements often are constraints that prevent farmers from seeking advice and making use of recommended measures. In this context, it is often argued that farmers will benefit from a high status of animal health by higher performance and lower veterinary costs and thus should have an inherent incentive to reduce the occurrence of diseases. This conclusion seems comprehensible as production diseases have a serious impact on the productivity of a dairy farm by reducing the efficiency with which resources (e.g. feedstuffs) are converted into products [86].

However, from a different perspective, this widespread pattern of thought, frequently observed in different stakeholder groups including veterinary and agricultural science, belongs to a severe error in reasoning. It leaves the responsibility by the farmer for not being clever enough to make use of a high level of animal health as a relevant source of a higher income by reducing the production costs. This approach declares all farmers facing a high prevalence rate of production diseases, at least indirectly, as being stupid, an accusation which would - on the base on the prevalence rates mentioned above – apply to the majority of dairy farmers. In contrast, our own studies give reason to the conclusion that farmers might react quite reasonably as economic calculations on a high number of dairy farms in Germany showed that a high animal health status in general does not increase farmers' income [87].

The previous pattern of thought is an example for a restricted perspective, fading out relevant facts, in this case the costs for prevention and control of diseases. Generally, cost factors for dairy production diseases are restricted to those for cow replacements, veterinary services, diagnostics, drugs, discarded milk, labor efforts, decreased performance, decreased milk quality, increased risk of new cases of the same disease or of other diseases [88]. In daily farmers' lives, costs for treatment are often seen as a part of the losses due to the occurrence of disease but not as an additional input to reduce the losses through diseases.

According to Hogeveen [89], it is more practical to talk about failure costs and preventive costs instead of talking losses and expenditures. The higher the preventive costs, the lower the failure costs and vice versa. Because the relation between prevention and failure is not linear, there is an optimal level of control in relation to economic considerations. Because the production functions as well as the failure costs and preventive costs vary considerably from farm to farm, the optimal level of control is farm specific and cannot be generalized. In

a Dutch study on 120 conventional dairy farms, costs of prevention in the case of mastitis were made up to more than 75% by costs for labor and were predominantly higher than the total failure costs [90].

The cost and labor intensive efforts for preventive measures and the uncertainties with respect to their effectiveness explain to some degree why farmers are reluctant to increase the efforts for prevention in order to reduce the prevalence rates of diseases and the failure costs deriving therefrom. The success of preventive measures is dependent to a high degree on the expertise and the persuasive power of those who give advice. Without a validation process with respect to the given advice, there is a high risk that the advice fails to be effective and efficient. Correspondingly, cost-benefit calculations of recommended measures are essential to convince the farmer into action. Future research work is needed which focuses on the cost-effectiveness of preventive measures under various farm conditions.

However, profound knowledge alone is not sufficient to change the current unsatisfactory situation. Indeed, no progress can be expected with regard to animal health if farmers do not gain any benefit and profit from the market to compensate for the additional efforts and resources needed to improve farm management and health status. Currently, producers are very much at the mercy of retailers and supermarkets in terms of price paid per liter of milk. These are continuously trying to drop their milk price to producers. As a consequence, dairy farmers have been chronically underpaid in recent years and left alone by the market, which does not offer any monetary incentives to improve the animal health status on the farms.

The current market conditions widely ignore the large variability in quality traits and in the impacts on common goods, promoting unfair competition when enabling equal prices for very different performances in relation to product and process qualities. Farmers who gain economic benefits by selling organic products to premium prices but only providing a low level of animal health undermine the efforts of other farmers attempting to maintain a high level of animal health [91]. In general, the latter have to apply additional labor and cost intensive efforts, contributing to considerably increase their production costs while at the same time providing an essential competitive disadvantage.

9. Animal health as a marketable quality trait

The processes of production, processing and marketing of organic milk occur on different scales, within different systems and involve different stakeholder groups. Concluding, they can be characterized as being quite complex. Each stakeholder group has its own perspective on the scenery, overlooking some but seldom gain an encompassing overview about the main driving forces, potentials or constraints along the food chain. Kahneman [92] deserves the particular merit to have brought the issue of perception and decision making within economic affairs into the focus of a broader public. In the face of the enlightening findings by neurophysiology, cognition science and psychology, the *homo oeconomicus* as a basic model of economic science does more look like a legendary creature than a real person in life. Also other disciplines are challenged to rethink the axioms and assumptions of their disciplines.

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According to Kahneman [92], the operations of associative memory contribute to a general confirmation bias. Contrary to the rules of philosophers of science, who advise testing hypotheses by trying to refute them, people (and scientists, quite often) seek data that are likely to be compatible with the beliefs they currently hold. Jumping to conclusions on the bases of limited evidence is a main process of intuitive thinking, being radically insensitive to both the quality and the quantity of information that gives rise to impressions and intuitions. It is the consistency of the information that matters for a good story, not its completeness. Indeed, knowing little makes it easier to fit everything one knows into a coherent pattern. The associative machinery suppresses ambiguity and spontaneously constructs stories that are as coherent as possible. Unless the message is immediately negated, the associations that it evokes will spread as if the message were true. Thus, humans are in the first place pattern seekers, believers in a coherent world, in which regularities appear not by accident but as a result of mechanical causality or of someone's intention. People can maintain an unshakable faith in any position, however absurd, when they are sustained by a community of like-minded believers.

The previous excursion, although only a foretelling of what requires a comprehensive reflection concerning the impacts on agricultural and veterinary sciences, gives a hint why stakeholder groups are striving for coherency in their world view and patterns of thinking within their community and are prone to ignore and fad out all those aspects that might disturb this coherency. From a scientific point of view, there is need to focus especially on the inconsistencies in statements and conclusions within and between the stakeholder groups involved. Some of the various discrepancies between claim and reality with respect to the handling of the animal health issue in organic and conventional livestock production and some of the conflicting areas provoked therewith are described below [21]:

- Retailers and/or producers claim to offer products that derive from healthy animals, without providing transparency and evidence of animal health status of farm animals.
- Retailers want to increase the turnover by offering organic food with comparable low prices and at the expense of the possibilities of the farmer to investigate substantial improvements of animal health.
- Producers who strive for a high status of animal health by using appropriate management concepts and encountering higher production costs are confronted with unfair competition when competing with their products on the same markets as those who produce on a low cost and low quality base.
- A high percentage of consumers announces their special interest in the issue of animal health and their willingness to pay premium prices, but hesitates to do so when corresponding food is offered and instead prefers purchasing cheaper food.
- Many consumers prefer to delegate responsibility for ethical issues when choosing animal products to the retailer or the government and are by their ignorance jointly responsible for the severe deficits in animal health within livestock production.

Possible expectations of consumers that specific food might improve their own health status can be seen as part of a general oversimplification. As described above in relation to animal health, the issue of health is very complex and the aspect of nutrient intake is only one of many risk factors. Thus, it is very difficult to provide evidence for a direct impact of specific food on human health.

In Europe, the Regulation on nutrition and health claims made on foods (EC No 1924/2006) was adopted by the Council and Parliament to prevent misuse. It foresees implementing measures to ensure that any claim made on foods' labeling, presentation or marketing in the European Union is clear, accurate and based on evidence accepted by the whole scientific community. Consequently foods bearing claims that could mislead consumers will be eliminated from the market.

In contrast, it is possible to promote products deriving from healthy animals. However, such an advertising message should also be based on evidence. Due to the complexity of the interactions of various factors on different scales, evidence cannot refer to some input variables, e.g. minimum standards, but have to focus on the outcome of process. The appropriate reference point for the output orientation within a systemic approach is the animal health status of the individual farm. Health is the emergent outcome of the processes within a farm system. The farm system is the functional unit and system of the production process. It is characterized by boundaries and steered by the farm manager who is challenged to balance the potentials and limitations of the production conditions, the available resources and the conflicting areas provoked by limitations. The farm specific animal health status is the result of the steering process and as such the emergent property of the farm system. Within a label program such as organic, quality assurance and control programs for products labeled as deriving from healthy herds and animals can rely on fixed levels concerning the acceptable prevalence rate of diseases.

As the somatic cell count (SCC) from lactating cows are quantified monthly as a routine on nearly all farms, extensive data material is available which can be used for farm internal feedback analysis and improvements and simultaneously as a diagnostic tool with respect to the udder health of the dairy cows in the herd. Thresholds which define an acceptable status of udder health have been described by several authors [93]. For example, those farms which take part in a label program of top quality milk should provide milk with less than 150,000 somatic cell counts in the bulk tank (BTSCC), and the incidence of clinical mastitis (ICM) should not exceed the rate of 0,33 (cases per average cow in the farm per year).

Current data evaluations show that for instance approximately 11% of the Bavarian dairy cows exceed the threshold value of over 400,000 SCC/ml in the bulk tank milk [87]. These counts mark the top of a distinct ‚cell mountain'. In a study on 120 conventional dairy farms, the incidence of clinical mastitis showed a huge variation between 0.03 to 1.21 [90], therewith indicating the need to provide orientation and define a threshold that should not be exceeded. Due to the various impacts of udder diseases on relevant traits of milk quality, including risks due to residues and the development of antibacterial resistance, the recommended thresholds are suited to mark a distinction between different levels of both product and process quality.

Data of both BTSCC and ICM are resp. should be available on organic dairy farms, and hence do not require additional efforts for their assessment. Consequently, the possible oc-

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currence of enormous additional bureaucratic expenditures cited as possible counter-argumentation can be rejected. Nevertheless, the separated obtaining and processing of milk from farms with a high animal health status will definitely increase costs. The main question is what it worth is to produce and consume milk from healthy dairy cows.

The trade value of milk is determined primarily by quantity of milk and milk content while qualitative traits are currently of no relevance and an outstanding quality is not rewarded by higher prices. Without evidence based progress, organic livestock production faces the risk to lose the confidence of the consumers while being trapped between own demands, consumer expectations and limited resources [94]. Thus, there is need for an evidence based system of financial penalties and bonus payments to promote top quality milk. Despite the fact that many consumers express their wish for high quality products, the current payment and marketing systems counteract all efforts to follow consumer demands and fail to communicate adequately differentiated milk quality. Conclusion is that only a direct assessment of animal health and a payment system that honors quality grades beyond average can contribute to improve the currently unsatisfying situation. This, however, requires a shift in the paradigm from a guideline and input oriented to an output oriented approach, and the implementation of a systematic approach for an effective and efficient balancing of the multiple variables and complex interactions within each farming system.

10. Conclusions

Organic farming has committed itself to outperforming conventional farming in a number of areas including animal health. However, organic standards based on minimum requirements do not automatically lead to a high status of animal health that exceeds the level in conventional production and thus, does not in all respects meet consumers' expectations. Improvements are crucial to support and strengthen consumers' confidence and their willingness to pay premium prices. These are urgently needed to cover the higher production costs in organic farming and thus ensure a viable organic dairy production.

According to previous knowledge, assessments of the quality of organic milk provides inconsistent results and often falls short of expectations as it is often similar or even lower than the quality of conventionally produced milk. In view of the large heterogeneity between organic farms in relation to both living conditions of the farm animals and the status of animal health, it appears to have been a congenital failure of organic agriculture to have neglected the definition of minimum standards with respect to the qualitative outcome of the production process, especially the status of animal health.

While farmers as owners are initially responsible for the well-being of their farm animals, they are very limited in their options of decision-making as they, in general, possess little financial flexibility that can be used for improvements. In the past, a clear increase in the productivity of milk production has led to a remarkable decrease of milk prices in relation to the general income from which the consumers have benefited in the first place. While there might have been time periods when the majority of farmers and also farm animals have

gained advantage from technical innovations, these times have definitely gone. Dairy cows pay the continuous increase in productivity and milk yield with an increase in the prevalence rates of production diseases and with a decrease in longevity [52]. Farmers are facing a high volatility of milk prices. In recent years, they have gone through a long phase of milk prices which did not cover the total production costs. Correspondingly, the number of dairy farmers who had to quit has increased dramatically. The predominant competition is based on the reduction of prices while widely ignoring the internal and external costs that emerge from these processes. In Europe, the phase-out of the Milk Quota Regulation in 2015 will fuel the competition even more. In face of the shortfall to be financed, the increase in herd size and the decrease in available resources (labor time and investments), there is reason to assume that the situation in the future will become even worse. While the market fails to provide different levels of product and process quality, national governments fail to prevent unfair competition on the market. On the other hand, they are not forced by the majority of voters to initiate and chair changes in the predominating structures of the market.

From the farmers' perspective, to honor a higher health status by premium prices, and to reduce unfair competition are of great importance to improve the unsatisfying situation. The market, however, fails to provide incentives for any quality improvements, often blaming the consumers for not being prepared to pay adequate premium prices. On the other hand, the consumers are not appropriately informed about the current level of product and process quality and are misguided by sales promotion. It is generally accepted in the market economy that the stakeholders being part of the food chain are striving for their own benefit in the first place. In the complex interactions between stakeholders groups, the players generally pose in active as well as in passive roles, and are both victims and offenders. In general, the strength of one actor is based on the weakness of the other stakeholders. While farm animals and farmers are in a very weak position, retailers and supermarkets are in a strong position to beat down the price in order to increase the turnover rates and their profit. Nevertheless, they can only act in such a way because consumer groups are dominated by bargain hunters, and those who are largely ignoring the problems of the other stakeholders, including health and welfare problems of the farm animals. Consumers are able to make a choice between large ranges of products without being able to assess their quality. Expenditures for food in relation to the total budget of a household have dramatically decreased during the last few decades. Hence, consumers in general can afford more expensive food products if their priorities are inclined in this fashion. However, consumers have become used to very low food prices while imagining they are on the safe side concerning the quality issue.

So far estimations of consumers with respect to traits of food and process quality are primarily based on associations and on expectations deriving therefrom. They are definitely not evidence based. Large variations in features that are relevant for those who buy organic products meet with large variations in the factual results of quality traits. Currently, the complexity of processes within the food production chain is reduced primarily to the quantifiable size of the price stakeholders receive or have to pay for the intermediate or the final product. However, prices for intermediate or final dairy products are unreal for their part as they do not represent and include the entity of the internal and external costs of the production process, e.g. the worse ani-

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mal health situation for dairy cows, and the non-covering of the productions costs, let alone the environmental impacts due to the high amounts of nutrient losses and emissions of greenhouse gas caused by the processes of production and processing. While consumers could afford higher milk prices, only few and not enough are willing to face the problems, caused by the impacts of their buying behavior and by the unfair competition within the market. As long as not enough producers are willing to enlighten the consumers about the real production conditions and as long as not enough consumers are not really interested to get an inside view into the production processes, the discrepancies between demands and reality of organic and conventional dairy production is expected to continue.

One of the most frequently asked questions in western society: who is to blame for malfunction, does not provoke an easy and obvious answer as all human stakeholders are part of a production system that is based on exploitation of land area, and farm animals, some to a higher and some to a lesser degree. Currently, stakeholder groups involved are not prepared to rethink their dominating pattern of thoughts and are not willing to risk the possible need for changes when having a closer look at the living conditions of farm animals and the impacts on product and process quality. The persisting power is still too high to provide a chance for real improvements. While some stakeholders are trapped in inherent necessities with very small degrees of freedom in decision making, consumers are free to decide on what they spend their money and are benefitting simultaneously from very low food prices. Correspondingly, they could be blamed in the first place for their ignorance towards the impacts of their buying behavior on the production process and on animal health and welfare. Any complaints by consumers with respect to the low level of product and process quality, either in conventional or in organic dairy production, should be rejected.

In general, food does not exert a direct influence on human health but is well known for providing both positive and/or negative impacts on the capability of the organism to cope with the various and specific demands. Thus, the slogan "healthy food from healthy animals" represents an abbreviated mental association, not being scientifically sound. However, the slogan is applicable and valid in the way that only milk from healthy cows with healthy udders is delivering the starting product for milk products of top quality. Currently, milk and milk products which derive exclusively and evidence based from healthy cows are not available on the market. If consumers really want food from healthy cows they have to establish a corresponding demand and have to reject those products that do not fulfill this demand.

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