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Primary factors influencing sheep welfare in intensive and extensive farming systems – a review article

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Abstract

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Studies related to factors influencing sheep welfare are not or are relatively recently performed, as well as studied on strategies aimed at minimisation of adverse effects of the environment and improper management practices on welfare of sheep. The present overview discusses the main critical points influencing sheep welfare in intensive and extensive farming systems as follows: extreme climatic conditions and seasonal fluctuations in sward quality and quantity, too little space and inadequate layout of premises along with poor control on microclimate, inadequate milking systems and underestimated role of human-animal relationships. Parameters essential for the practice with respect to evaluation of the degree of satisfaction of biological needs of animals, e.g. welfare level in line with the latest global achievements are analysed.

Keywords: welfare assessment; welfare issues; humane attitude; environment; technology

Introduction

Provision of good ecological and management conditions beneficial for sheep welfare is expected not only from consumers and the society in general, but is also related to achievement of adequate efficacy and profitability levels. Sheep welfare is one of pillars of efficient, productive and sustainable farming systems. Research on sheep welfare advances more slowly compared to that on other ruminants such as cattle, by reason of sheep physiological specific features and predominantly extensive farming. In fact, sheep are considered to be exceptionally adaptive animals but their ability to cope with adverse environmental conditions and inadequate management practices without compromising their welfare is often overestimated. One of the causes for extensive farming of sheep is their distribution in mountainous and semi-mountainous regions. During the last two decades, this practice has changed due to several reasons: spread of intensive farming systems, especially in high-yielding dairy sheep breeds; increased concern from consumers about the production cycle, quality and sustainability of animal foods and particularly, the national and EC requirements on welfare and farming practices, taking consideration of animal health (Dwyer, 2005; 2009).

Modern intensive and extensive farming systems create a number of changes and new relationships in the man-animal system dating back to the time of domestication. The implementation of new technologies and management practices in livestock husbandry has necessitated the acquaintance with vital activities and behaviour of animals, which results in complication of the created system. It assumes a new look, e.g. “man-machinery-animal”. In intensive farming conditions, sheep are continuously submitted to a number of stress factors influencing their welfare and natural behaviour. Nevertheless, they manage to adapt well by virtue to men that aims to provide a favourable environment predisposing to good health and high yield along with maximum reduction of stress. During the last year, dairy sheep farming has implemented technologies, among the main criteria of which is the satisfaction of biological needs of animals. The indoor sheep farming technology with production all year round is increasingly implemented in our country. Its main advantages are economical, biological and health-related. This principally novel sheep farming technology poses several questions associated to sheep welfare, their adaptation to rearing in large groups, their adaptation to environmental changes, within-group uniformity with respect to yield and needs from nutrients (Rushen, 2003; Goddard, 2006).

All countries with developed intensive and extensive livestock husbandry abide by norms (Codes for recommendations for the welfare of livestock – comprising paragraphs 1-65 for Cattle (a), comprising paragraphs 1-138 for Sheep (b). Ministry of Agriculture, Fisheries and Food, Department for Environmevt, Food and Rural Affairs, England, 2003) for maintenance of the normal behavioural activity of animals. The observation of deviations from the normal behaviour of animals impairs their health, reduces their productive performance and increases energy costs per unit produce.

The evaluation of intensive and extensive sheep farming systems from the point of view of welfare becomes essential. The present overview is focused on the main critical points influencing sheep welfare in intensive and extensive farming systems. Parameters essential for the practice with respect to evaluation of the degree of satisfaction of biological needs of animals, e.g. welfare level in line with the latest global achievements are analysed.

What is Animal Welfare?

Nowadays, the interest of society to animal welfare is similar to concern about animal foodstuffs quality. In fact, more and more consumers are ready to pay more for products, produced by farms obeying all requirements for high animal welfare level. One of causes for the increased interest to this issue is the huge changes that occurred in animal farms since the 1950s, in particular the spread of intensive and extensive farming systems, subject to sharp criticism and great attention from European legislation (Martelli, 2009).

The term "animal welfare" is increasingly used by farmers, consumers, veterinarians and politicians yet its meaning is often misused (Hewson, 2003). In the past, it was associated with body condition (good health and high productivity), rearing conditions (appropriate facilities and proper nutrition) and physiological condition (e.g. plasma cortisol, heart rate). Hewson (2003) affirms that using only few parameters to evaluate animal welfare could impede its interpretation. A specific welfare parameter could really either increase or decrease from a positive or negative aspect. Also, simultaneous interpretation of some parameters may yield contradictory information, for instance, an animal could be in optimum physiological state but its psychic state could be impaired.

It is not easy to give a precise definition of animal welfare. Making reference to the dictionary, welfare is explained as serene life and fortunes of a person. As animals are concerned, welfare should be interpreted from three points of view: those of science, ethics and legislation.

The science that studies the well-being of animals is animal welfare. It deals with the effect of human behaviour on animals from the point of view of the latter.

Ethics deals with animal welfare from the point of view of human impact on animals.

From the point of view of legislation, animal welfare is important only when the way humans interrelate with animals is concerned.

Broom (1986) defines animal welfare as a measurable physical state of animals as their attempts to cope with the environment, encountered difficulties during this process and inability to cope leading to compromised welfare are regarded. Fraser et al. (1997) and Rollin (1999) suggested that issues on animal welfare should include: 1) the subjective state of animals; 2) biological health; 3) their telos-related life. When developing concepts about farm animal welfare, all three points of view should be considered, as science puts an emphasis on physiological parameters, the ethics – in its introductory part and legislation – during the creation of nature-protecting jurisdiction (Varlyakov, 2011). Animal welfare is the animal physiological state in a certain period of time, ie. how well the individual feels in his environment. It is a result of the influence of abiotic, biotic, and anthropogenic factors, which guarantee the optimal realization of the animal genetic potentialities (Bozakova, 2004).

In the beginning, the animal welfare concept had some limitations in the scientific community, as researchers did not consider aspects difficult to investigation, as "feelings", "emotions" and "conscience" of animals but instead were focused on aspect influencing health or biological demands of animals. The main reason was the fact that health parameters used for animal welfare evaluation are strongly associated with the level of suffering in animals (Rushen, 2003). Others as Buller et al. (2008); von Keyserlingk & Weary (2017); Broom (2017) affirmed that animal welfare was an applied and not a scientific field, which is subject to various disciplinary approaches including physiology, genetics, nutrition, sociology, ethology etc. The main scientific approach to the solution of animal welfare issues is the investigation of their behavioural reactions, which are important for improving animal welfare. Studies on animal welfare are focused on improving their living, associated with good somatic and psychic health, improving productivity level and their ability to cope with changing environment. A third group of authors: Brambell (1965); Thorpe (1969); Fraser et al. (1997) believed that animal welfare is a term that emerged in the society to express ethical concerns about the quality of life of farm animals. As the term has emerged in the society, it is not a scientific term. Nevertheless, science permits its use for the identification, interpretation and application of society's concerns about problems related to quality, rearing and production of healthy and high-quality animal products. This has permitted to differentiate animal welfare as a scientific field. The moving force of the science is the ethical concern of people about farm animals' quality of life, which could be of essential assistance for solving animal welfare problems.

A more contemporary idea on animal welfare deals with the psychic state of the animals (Duncan, 2004, 2006; Fraser, 2008), this belief supports changing methods for minimisation of negative affection states e.g. pain, and enhancing positive states (for instance, pleasure). The main challenge to this approach is research work. Many investigations were devoted to the development and validation of methods for assessment of the natural state of animals (Weary et. al., 2017).

Another important prerequisite for evaluation of animal welfare is provision of conditions close to those of their natural environment, letting them lead a natural way of life and to express natural behaviour. Fraser et al. (1997); Greem & Mellor (2011); Mellor et al. (2015); Hemsworth et al. (2015) have published reports proving that animal welfare could be evaluation through integration of three approaches (biological functioning, natural behaviour and affective states) understood as dynamically interrelated elements in the body, acting as a whole.

Some of the most common questions posed with regard to animal welfare are:

Is rearing of layer hens in battery cages, sows in dry boxes, calves in cages, sheep in closed premises an acceptable practice? Should animals be castrated, dehorned and cropped (Harrison, 1964)? Answers may be provided by science, but still these are fundamentally ethical issues. From West Europe to Africa, various points of view exist as ethical problems of animal welfare are concerned. Even within the frameworks of one culture or groups with similar animal welfare concepts, various aspects are emphasized in a different way. For example, a farmer puts a greater weight on high productivity, the veterinary practitioner – on animal health, and ethologists – on the normal animal behaviour of animals etc. The scientific assessment of animal welfare requires that all these aspects should be taken into consideration (Duncan et al, 1997, 2002; Fraser et al., 2004; Vanhonacker et al., 2008).

Duncan (2002) performed a survey using a questionnaire to find out that most people from developed countries had a similar opinion on what animal welfare was. In the questionnaire, different people gave examples for animals with poor welfare, which were similar and included wounded, sick, hungry, thirsty, neglected and scared animals. People could hardly provide examples for animals with good welfare. They suggested that if none of abovementioned conditions worsening welfare were present, animal welfare could be defined as good.

In 1964 Harrison wrote the book „Animal Machines", criticizing the standards of intensive production systems for farm animals. As a response, the British government wrote a report entitled "Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems" (Brambell, 1965). As a result, the Farm Animal Welfare Committee (FAWC, 2010) develops the five freedoms concept:

1) Freedom from hunger and thirst – through providing animals with adequate diet and feeding regimen, with sufficient amount of and readily available drinking water.

2) Freedom from discomfort - by providing an appropriate environment, including shelter and rest area.

3) Freedom from pain, injury and disease – by prevention or rapid diagnosis and appropriate treatment.

4) Freedom to express normal behaviour - by providing sufficient area, proper facilities and company of the animal's own kind.

5) Freedom from fear and distress - ensuring conditions preventing animal suffering.

The Five freedoms' impact on animal welfare is enormous. They are at the background of the development of many laws related to animal welfare and protocols for welfare assessment. The five freedoms are assessed as individually necessary and jointly sufficient to form a logical and comprehensive framework for animal welfare analysis (McCulloch, 2012; Llonch et al., 2015; von Keyserlingk & Weary, 2017). The application of the Five freedoms concept is not useful to say whether an animal is healthy or not, but it allows evaluating rearing conditions and comparing animal welfare in different husbandry systems. For instance, Sevi et al. (2009) used the Five freedoms concept to identify critical points of two different systems (extensive vs semi-intensive) for dairy sheep farming. They found out that extensively reared sheep were submitted to various factors as: abrupt climatic changes, thermal discomfort, alterations in sward amount and quality on the pasture and presence of parasites threatening their welfare. On the other hand, in the semi-intensive farming system, a particular attention was paid on microclimatic conditions and the selection of proper construction and design of premises to avoid crowding, aggressive behaviour, increased environmental pollution and poor udder health.

Some of listed freedoms, for example the freedom from hunger and thirst are generally acknowledged while those related to behaviour and freedom from fear are not always understood and applied. This approach to animal welfare assessment is not directed to elimination of sources of stress for animals, but for prevention of suffering that may arise when the animal does not cope with stress. In fact, fear could be very intense, complex and continuous, or could be manifested when the animal is not able to undertake necessary actions for stress alleviation (Webster, 2001). As the five freedoms are based mainly on ethics rather than on a sound scientific background, Korte et al. (2007) deemed necessary to introduce a new concept for animal welfare based on allostasis e.g. the ability of animals to recover stability or a new balance after change. This ability is actually essential for the good health and welfare of animals. Fear is an important stimulus in evolutionary heritage because it makes the organism to avoid threats. Similarly, pain perception is important as a means of defense and protection from potential threats and dangerous substances.

In 2008, The European Livestock Welfare Quality® system (WQ®) has revised the Five freedoms concept (Brambell Committee, 1965) and has defined 4 main welfare domains: "good nutrition", "good environment", "good health" and "appropriate behaviour" (Botreau et al., 2007; Veissier et al., 2011). Later, these four main domains were subdivided into twelve independent criteria (Blokhuis et al., 2010; Rushen et al., 2011) each corresponding to key welfare issues.

These principles focused the attention on practical measures necessary to achieve desired results from welfare evaluation at farms, when the use of terms "good" and "appropriate" adapts the aims of minimisation of negative experience and promotion of the positive one. The model of the five domains for animal welfare assessment developed in 1994 (Mellor et al., 1994) and updated on a regular basis, most recently in 2015 (Mellor et al., 2015) determines nutrition, environment, health and behaviour as four physical and functional domains and thus, focuses the attention on the practical management of animals (Mellor, 2016).

Through a detailed overview of published reports in the field of animal welfare, Duncan et al, (1983); Broom (2017) demonstrated that it is not possible to give an exact scientific definition of animal welfare. They proposed that the broad working description of animal welfare should include animals in good mental and physical health, in harmony with the environment, able to adapt to artificial conditions created by humans without suffering.

It should be noted that the aforementioned working description of animal welfare included both the physical aspects of welfare as well as mental aspects of subjective feelings. It is well acknowledged that investigations related to animal welfare require cooperation between various scientific and social disciplines, which are not always easy to be understood, with consequent difficulties in the interpretation of existing measures of animal welfare. This multidisciplinary approach makes research studies on animal welfare unique, compelling yet conflicting as researchers should work together to develop appropriate animal welfare parameters.

Indicators Influencing Sheep Welfare

Since the beginning of the 21st century, systems for monitoring of welfare of farm animals are developed. Initially, monitoring protocols were based on ecological assessment of farm design that may influence welfare of animals. The EFSA (European Food Safety Authority) considers that at the farm level, the adequate evaluation of animal welfare requires implementing measures based on animals (EFSA, 2012). These indicators provide a more accurate assessment of animal welfare, giving direct information about their health, behaviour and interaction with humans and the environment. The assessment of welfare at farms could be used as a quantitative approach for determination of the impact of various rearing conditions, as well as could be used for development of juridical requirements, e.g. certification system and as adviser and tool for management of livestock farms (Main et al., 2003; Caroprese et al., 2009). The first protocols for assessment of animal welfare were developed by the "Welfare Quality®" project for pigs, poultry, dairy and beef lot cattle (Welfare Quality® Protocol, 2009a; Welfare Quality® Protocol, 2009b; Welfare Quality® Protocol, 2009c), and later, in 2011, AWIN (animal welfare indicators) developed a protocol for improvement of sheep welfare indicators. The creation of efficient indicators for evaluation of sheep welfare is a challenge, as they are not well studied and in general, there is little information about well-established sheep welfare parameters. The occurring difficulties during the development of efficient parameters of small ruminant welfare could be due to the fact that sheep are renowned with the high degree of adaptability and extensive farming. Just recently, along with improvement of automation in sheep farming, intensive sheep production systems have also spread and thus, the number of dairy flocks increased. Another important fact is that often, shepherd taking care for sheep flocks have not the required skills, knowledge and professional competence to be acquainted with standards for sheep welfare. This implies the development of a system for monitoring of sheep welfare at farms.
The "Welfare Quality®" project has developed a protocol uniting the needs of animals into four principles and twelve criteria, deemed necessary for inclusion of all animal welfare criteria (Blokhuis et al., 2010; Rushen et al., 2011, Richmond et al., 2017) (Fig. 1).

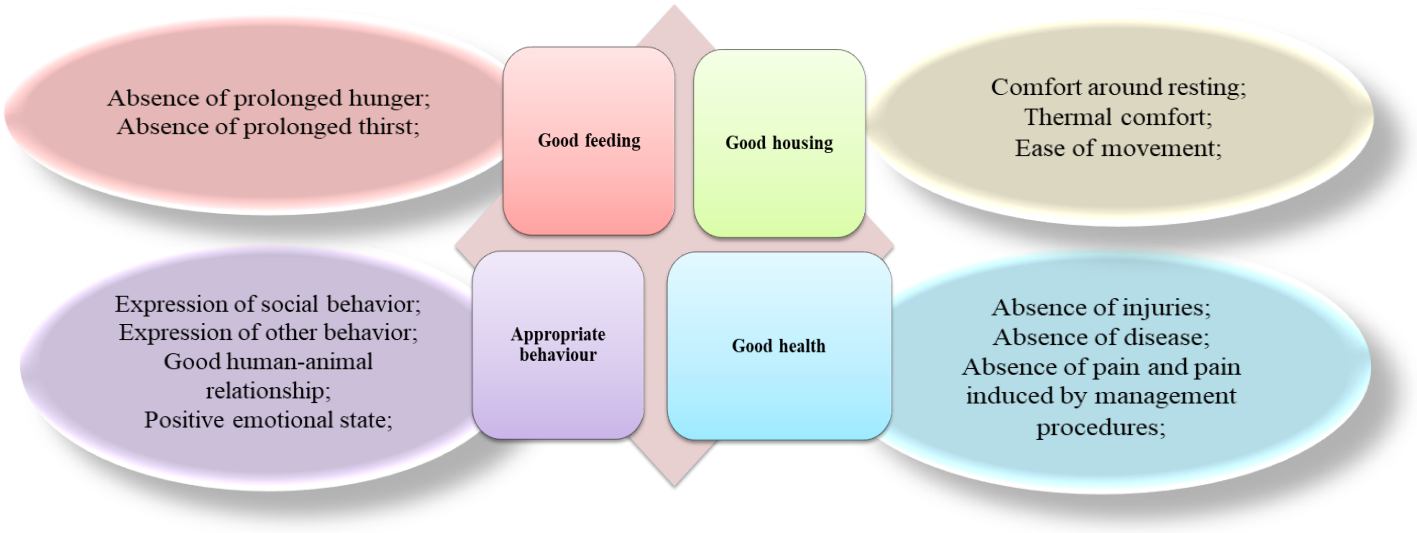

Fig. 1: Principles and criteria of good animal welfare according to "Welfare Quality®"

Every welfare principle is formulated in a way such as to respond to key issues associated to welfare. Four main principles have been differentiated: good nutrition, good environment, good health and appropriate behaviour that provide answers to the following questions.

- Have the animal's access to sufficient amount of food – compliant to requirements of the species and animals' physiological condition?
- Have the animal's access to sufficient amount of water and is water readily available?
- Are the animals reared in appropriate premises in line with biological requirement for comfort?
- Are the animals healthy?

Do animals manifest natural behavioural reactions?

Every one of these principles includes several independent criteria. The latter comprise specific parameters that may be used for evaluation of every welfare component (Rushen et al., 2011). By virtue of these principles and criteria, representing a minimum detailed list of parameters for evaluation of farm animal welfare, all future research studies on animal welfare are developed (Blokhuis et al., 2010).

The created protocols for animal welfare assessment allow for comparison of similar rearing systems and are designed for evaluation of welfare aimed to its improvement in Europe and worldwide. The assessment of welfare at farms begins with selection of appropriate parameters of welfare: easy for interpretation, validated, reliable and easy to be realised (Farm Animal Welfare Council, 2005; Napolitani et al., 2009; Sorensen and Fraser, 2010). According to Main et al. (2007); Kilbride et al. (2012); Llonch et al. (2015) the parameters for sheep welfare used a direct assessment of the mental and physical state of animals. They are considered as the most validated method for welfare evaluation, as they assess the animals themselves and not their resources and permit comparisons in all farming systems. Table 1 presents sheep welfare indicators determined on the basis of principles and criteria of the "Welfare Quality®" project.

Table 1. Welfare indicators divided by principles and criteria according to "Welfare Quality®"

Welfare principles	Welfare criteria	Welfare indicators
Good Feeding	Appropriate nutrition	Body Condition
		Score lamb mortality
	Absence of prolonged thirst	Water availability
Good Housing	Comfort around resting	Fleece cleanliness
	Termal comfort	Panting
		Access to shade/sheiter
	Ease of movement	Stocking density
		Hoof overgrowth
Good Health	Absence of injuries	Body and head lesions
		Leg injuries
	Absence of disease	Lameness
		Feacal soiling
		Mucosa colour
		Ocular discharge
		Mastitis and udder lesions (lactating ewes only)
		Respiratory quality
		Fleece quality
	Absence of pain and pain induced by management procedures	Tail length
Appropriate behaviour	Expression of social behaviour	Sociol withdrawal
	Expression of other behaviour	Stereotypy
		Excessive itching
	Good human-animal relationship	Familiar human approach test
	Posirive emotional state	Qualitative behaviour Assessment

Two broad categories of indicators could be used to evaluate animal welfare at the farm: indicators based on animals and indicators based on resources (Broom, 1996; Alban et al., 2001; Main et al., 2003, 2007). The need from emphasis on animal-based indicators became clear from the EC project on welfare quality (Blokhuis et al., 2010), yet only some of determined indicators are directly related to animals (Johnsen et al., 2001) and rarely directed to small ruminants. Resource-based indicators are more frequently encountered and approved in welfare assessment protocols, as the measures to be undertaken are fast and easy to be performed. Nevertheless, the good management and ecological resources do not always result in high welfare standards (Winckler, 2006). Animal-based indicators are the more appropriate approach to determine the real state of welfare. This is a considerable change in prospects of transition from a protocol measuring mainly ecological aspects (that may vary considerable in the different countries due to different rearing and management conditions) to a protocol assessing the way animals react to conditions created by a specific farming technology (EFSA, 2012).

What is more, individuals with different genetic origin (e.g. from different breeds) could react differently within the same farming system. Sheep are characterised with high degree of adaptability and extensive farming. During the last years, dairy sheep flocks increased, necessitating the introduction of intensive farming technology. The latter is characterised with significant rearing density in barns, and deep permanent litter. This has required the creation of monitoring systems for control of proper distribution of sheep density, waste management and provision of appropriate microclimatic conditions (temperature, relative humidity, air quality etc.) in facilities (Main et al., 2003; Caroprese et al., 2009; Sevi et al., 2009). On the other hand, in extensive farming systems, sheep are submitted to adverse factors as changing climate, feeding stress, inadequate water supply and parasitic diseases, which worsen their welfare. To evaluate accurately sheep welfare, good hygienic practices are necessary, as well as proper design of rearing premises, compliance to all biological needs of animals, selection of proper management practices for all types of systems.

Factors Determining Sheep Welfare in Extensive Farming Systems

Challenges associated with welfare differ with respect to farming system, reproduction cycle and geographic location (Goddard, 2006; EFSA, 2014; AWIN, 2017). The unique features or challenges to welfare in extensive sheep farming systems underline the importance of development of reliable and feasible measures for humane attitude to animals, which may detect the existing welfare as well as risks from future compromising of welfare. For example, the nature of extensive systems with rearing of sheep in large flocks outdoor all year round makes adequate observation, treatment and prevention of diseases more difficult. Extensively reared sheep are more frequently attacked by predators and climatic changes. The difference in the quality and availability of food all year round results in changes of physical condition underlying the significance of measures that could detect these differences. Although the welfare of animals reared in the extensive farming systems is ignored, the concept that welfare in these systems is good is not scientifically justified (Turnet & Dwyer, 2007). In extensive farming systems, sheep are encountered with a number of compromises with regard to welfare: feeding stress, inadequate water supply, climatic changes and parasitic infections. Extensive rearing of sheep in mountainous, semi-mountainous and Mediterranean regions included pastures during the light part of the day, shelter during the night and supplementation with concentrate and hay (straw). Thus, animals are free to move within their habitat which permits them to express their physiological needs and express normal behaviour.

The pasture may have a negative impact on sheep welfare due to seasonal variations in sward quality and amount. Therefore, animals that are supplied with the necessary nutrients through grazing on pastures, suffer a transient feeding stress. If this stress is manifested during the reproduction period, it may reduce the fertility of ewes (Rassu et al., 2004). In regions where sheep farming is more prevalent, late spring and summer are characterised not only with poor availability and poor taste of grass, but also with grass protein deficiency (Negrave, 1996; Sevi et al., 2009). That is why, during this period of the year, extensively reared sheep are submitted to nutritional imbalance altering rumen fermentation processes and protein synthesis, compromising their welfare and influencing negatively milk fat and protein contents. Pulina et al. (2006) found out that short-term restriction of feeding decreased substantially milk yield and increased milk fat percentage in dairy Sarda sheep. Undernutrition also influenced the profile of milk fatty acids as a result of body fat mobilisation. In underfed sheep, milk somatic cell counts were increased, demonstrating metabolic stress of animals and of udder. Another main factor that may influence sheep welfare and productivity, is the structure of pasture (plant height, plant density, ratio of leaves to stems, botanical composition of the sward). Field studies suggested that a plant height up to 60 mm and green mass yield from 1500 to 2000 kg per decare could improve the intake, welfare and productivity of sheep (Orr et al., 1990; Penning et al., 1994; Sevi et al., 2009). The deficiency of water sources in many pastures could also lower welfare level. The restricted access to water causes stress in sheep, decreases feed intake, increased rectal temperature and respiratory rate, decreased glycaemia and increased blood and milk urea concentrations (Ayoub & Safeh, 1998). Water stress causes more or less expressed change in the metabolic profile of animals and reduction of live weight is often observed (Casamassima et al., 2006b; Hamadeh et al., 2006). Aganga (2001) established that in some cases, the deficiency of water has led to reduction of milk yield by 50%, while in pregnant ewes – to increase in abortion rates and neonate mortality. The use of natural pastures favours endoparasitic infestation, which is rarely lethal but provokes significant reduction of efficiency from feeding sheep with resulting weight loss, reduction of milk yield, altered reproductive performance and reduced nutrients intake (Lia & Pantone, 2001). Infested sheep spend less time on the pastures, become less active from intact ones and their nutrients' intake is decreased (Hutchings et al., 2000). In the early stage of endoparasitic invasions, the behaviour of sheep is abnormal. As the disease progresses, infected sheep become more and more anxious and irritated by allergens (Dwyer & Bornett, 2004). A substantial challenge to sheep in extensive farming systems is lameness. The presence even of mild form of foot to causes increase in plasma epinephrine and norepinephrine concentrations, hence suppression of milk secretion (Goddard, 2006). It is considered that among all farmed animals, sheep are the most resistant to climatic extremes, especially high ambient temperatures. In sheep, the physiological decline of milk yield observed in the summer, during late lactation, often causes

entirely or partially negative impact of high ambient temperatures on milk production. Sevi et al. (2001a, 2002b) performed experiments to demonstrate significant increase in body rectal temperature, change in the metabolism and reduction of milk yield after exposure of sheep, even for short periods, to average daily temperatures of 35 °C or after prolonged exposure to ambient temperatures of 30 °C. Under such conditions, a substantial reduction of immune response along with severe mineral disequilibrium (mainly with respect to magnesium, potassium, calcium and phosphorus) and decreased milk casein and fat content (mainly long-chain and unsaturated fatty acids) are observed. In addition, hygienic quality of milk is characterised with increased number of neutrophils and staphylococci, coliform and pseudomonad counts, which deteriorate milk coagulation properties. The latter could be also due to reduced calcium and phosphorus in milk and more intense plasmin activity under such stressful conditions (Sevi et al., 2004). The availability of shadow during the hottest hours of the day and alteration of feeding time towards late afternoon helps reducing to a minimum the impact of high summer temperatures on lactating sheep.

Factors Determining Sheep Welfare in Intensive Farming Systems

Intensive farming systems are usually characterised with high rearing density and continuous accumulation of faecal masses in sheep premises.

That is why, adequate space, careful waste management and strict control on microclimatic factors (air temperature, relative humidity, toxic and harmful gases) are essential for welfare of indoor reared animals.

In these farming systems, proper design of structural parameters, maintenance of good hygiene and proper management practices are essential. Unfortunately, sheep are often farmed in premises which are not appropriate in terms of design, materials and dimensions (Sevi et al., 2009).

Indoor farming should provide optimum conditions allowing sheep expressing normal behaviour. A minimum area of 1.5-1.9 square meters per sheep is necessary (Ordinance No. 44). This area should include place for rest, movement and feeding width. Effects of rearing density on the quality of air, animal health and productivity were studied in lactating ewes. Sevi et al. (1999a) found out substantial decrease of total microbial counts and coliforms in air of premises, where sheep had an area of 2 m^2/head, compared to premises with individual areas of either 1.5 or 1 m^2/head. Additionally, sheep reared under conditions of low population density exhibited considerably higher milk yield, increased milk protein, fat and casein proportions, which generally contributed to improved milk coagulation properties. It was found out that milk produced by sheep provided with individual area of 2 m^2 had 3 to 4 times lower somatic cell counts and considerably lower counts of coliforms and mesophilic bacteria compared to milk of sheep reared on individual area of 1.5-1 m^2. Double air space and utilisation of efficient ventilation systems at farms resulted in decrease of microbial counts and improvement of air quality. This could be of practical interest especially if sheep are reared in plain regions with warmer climate. Having evaluated the impact of different air components in the environment of dairy ewes, Sevi et al. (2001c) established that air space with less than 7 m^3/head resulted in significant increase of relative humidity and microbial concentration in air (mainly staphylococcal counts), substantial increase of somatic cells and microbial counts (mainly psychrotrophs) in milk and higher incidence of subclinical mastitis. When sheep are reared in large groups with high population density, the vigilant waste management leading to fewer disadvantages from point of view of welfare and productive performance of sheep is especially important. The spread of various suitable chemical products on the litter, e.g. bentonite and paraformaldehyde, which inhibit bacterial replication and degrade urine and faecal nitrogen, is an appropriate strategy for reduction of air microbial counts and ammonia release from manure (Sevi et al. 2001e; 2003a).

Ventilation plays a major role for maintaining welfare and productivity of sheep, by influencing heat exchange between body surface and the environment, avoiding the excessive increase of relative humidity and maintenance of levels of harmful gases and particles in air (Sevi, 2005). Air velocity is determined by duration of ventilation cycles. The first parameter is rather important, as when air velocity exceeds 1 m/s, cooling efficacy is not improved. On the contrary, violent air currents generated by high ventilation speeds, could incur higher amount of dust in air entering animal premises (Sevi et al., 2003d). Sevi et al. (2002a, 2003c) found out that in summer, dairy ewes need an average ventilation rate of about 65 m^3/hour per animal. The main purpose of ventilation systems is removal of harmful gases (particularly ammonia) formed readily during faeces degradation and fermentation processes during the hot weather. Summer ventilation speeds under 40 m^3/hour per animal cause changes in the natural behaviour, immune and endocrine response and by about 10% lower milk yields in sheep. Poor ventilation increases also bacterial loads of milk and worsened cheese making properties leading to high loss of casein and lipids during curd formation and altered cheese maturation (Albenzio et al., 2005). The role of air exchange during the winter is often underestimated. This may be important for welfare and productivity of dairy sheep, by avoiding excessive increase of relative humidity and maintaining harmful gases and particles in air under control. Some experiments (Sevi et al. 2003d; Albenzio et al., 2004) demonstrated that exposure of dairy sheep to low (about 25 m^3/hour per animal) and very high ventilation rates (about 75 m^3/hour per animal) resulted in increased air concentrations of harmful gases, dust and microorganisms in comparison with moderate ventilation speed of about 45 m^3/hour per animal. In addition, exposure to inadequate ventilation regimens could reduce milk yield and deteriorate milk quality. Albenzio et al. (2004) detected high somatic cell and mesophil counts as well as higher plasmin activity and higher plasminogen/plasmin ratio in milk of sheep expl-

osed to low (25 m^3/hour) and very high (75 m^3/hour) ventilation regimens compared to milk of sheep exposed to moderate ventilation regimen (45 m^3/hour).

Another important factor influencing high-yielding sheep welfare in intensive farming systems, is nutritional imbalance. Undernutrition could occur by the end of spring and summer due to increased energy spent for thermoregulation and simultaneous decrease of energy intake, but also during the pregnancy. By altering the ration of dry ewes from very high to low nutritional levels and vice versa, Sevi et al. (2009) demonstrated that both feed restriction and overfeeding should be avoided in order to prevent metabolic disturbances and reduce costs for excessive fattening and maintenance of increased body weight. The authors also affirmed that body condition score was a reliable parameter for sheep metabolism and that it should never be either below 1.5 or over 3.5. In fact, the farmer should correct the rations taking into account the level of activity, physiological condition and category of animals reared in intensive farming systems to prevent the occurrence of nutritional stress. When comparing the behaviour, milk yield and physiology of sheep reared extensively or intensively, Casamassima et al. (2001) found out that extensive systems were beneficial for behavioural needs of lactating sheep although leading to a transient energy deficiency and reduced yield and quality of milk.

Conclusion

Research on sheep welfare clearly shows that prudent and careful flock management is essential to maintain and improve sheep welfare and biological efficiency of farming.

It is beyond any doubt that extensive farming satisfies more completely biological needs of sheep, but the exposure to climatic extremes, seasonal variations in the sward quality and quantity, and parasitic infections are important adverse factors. In intensive farming, attention should be focused in control of microclimate and proper solutions for premises in terms of materials and design to avoid crowding, aggressive behaviour, increased environmental pollution and udder pathology. Apart all these causes, it turns out that farmers have an important role in both extensive and intensive farming systems. We support the recent beliefs that sheep welfare, often neglected in traditional farming systems, is essential and could be the most important factor for influence on sheep productivity.

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References

Aganga, A.A., (2001). Water utilization by sheep and goats in Northern Nigeria. *World Animal Review* (FAO), *73*, 9-14.

Alban, L., Ersbøll, A.K., Bennedsgaard, T.W. & Johnsen, P.F. (2001).Validation of welfare assessment methods at herd level: An example. *Acta Agriculturae Scandinavica, Section A, 51*, 99–102.

Albenzio, M., Marino, R., Caroprese, M., Santillo, A., Annicchiarico, G. & Sevi, A., (2004). Quality of milk and of Canestrato pugliese cheese from ewes exposed to different ventilation regimens. *Journal of Dairy Research, 71*, 434-443.

Albenzio, M., Santillo, A., Caroprese, M., Marino, R., Centoducati, P. & Sevi, A., (2005). Effect of different ventilation regimens on ewes' milk and Canestrato Pugliese cheese quality in summer. *Journal of Dairy Research,* 72, 447 -455

AWIN (2017) Welfare Assessment Protocol for Sheep. http:// www.animal-welfare-indicators.net/site/flash/pdf/ AWINProtocolSheep.pdf (accessed on 24 October 2017)

Ayoub, M.A. & Saleh, A.A., (1998). A comparative physiological study between camels and goats during water deprivation. *Emirates Journal of Agricultural Sciences*, *10 (2),* 44-60.

Blokhuis, H. J., Veissier, I., Miele, M. & Jones, B. (2010). The Welfare Quality® project and beyond: Safeguarding farm animal wellbeing. *Acta Agriculturae Scandinavica Animal Science*, *60*, 129–140.

Botreau, R., Veissier, I., Butterworth, A., Bracke, M.B.M. & Keeling, L.J. (2007). Definition of criteria for overall assessment of animal welfare. *Animal Welfare*, *16*, 225–228.

Bozakova N., (2004). Comparative studies and assessment of the welfare (Animal Welfare) of broiler turkeys in different variants of floor rearing, Ph.D. thesis, Stara Zagora (Bg).

Brambell, F. W. R. (1965) Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems. Her Majesty's Stationery Office: London, UK.

Broom, D. M. (1986). Indicators of poor welfare. *British Veterinary Journal*, *142(6),* 524–526.

Broom, D. M. (1996). Animal welfare defined in terms of attempts to cope with the environment. *Acta Agriculturae Scandinavica, Section A, 27*, 22–28. 7.

Broom, D. M. (2017). Welfare of animals: behavior as a basis for decisions. In: Reference module in life science. Elsevier, ISBN: 978-0-12-809633-8.

Buller, H., Blokhuis, H., Jensen, P. & Keeling, L. (2008). Towards farm animal welfare and sustainability. *Animals*, *8*, 81, 2-13.

Caroprese, M., Casamassima, D., Rassu, S.P.G., Napolitano, F. & Sevi, A. (2009). Monitoring the on-farm welfare of sheep and goats. *Italian Journal of Animal Science*, *8 (1),* 343-354.

Casamassima, D., Pizzo, R., Palazzo, M., Quaranta, A., D'Alessandro, A.G. & Martemucci, G. (2006b). Effect of water restriction on production performance and on some blood parameters in intensively reared Comisana sheep. (Effetto della restrizione idrica sulle prestazioni produttive e su alcuni parametri ematici in ovini di razza Comisana allevati intensivamente.) In: Proc. 14th Int. Congr. FeMeSPRum, Santiago de Compostela, Spain, 477-478.

Casamassima, D., Sevi, A., Palazzo, M., Ramacciato, R., Colella, G.E. & Bellitti, A., (2001). Effects of two different housing systems on behavior, physiology and milk yield of Comisana ewes. *Small Ruminant Research, 41*, 151-161.

Defra (2003a). Code of Recommendations for the welfare of livestock: Cattle. Defra Publications, Admail 6000, London.

Defra (2003b). Code of Recommendations for the welfare of livestock: Sheep. Defra Publications, Admail 6000, London.

Duncan, I. J. H. (2002). Poultry welfare: science or subjectivity? *British Poultry Science*, *43 (5),* 643-652.

Duncan, I. J. (2004). A concept of welfare based on feelings. In: The well-being of farm animals: Challenges and solutions. G. J. Benson and B. E. Rollin, ed. Blackwell, Ames, IA, 85–101.

Duncan, I. J. H. (2005). Science-based assessment of animal welfare: Farm animals. *Revue Scientifique Et Technique De L Office International Des Epizooties*, *24 (2),* 483-492.

Duncan, I. J. H. (2006). The changing concept of animal sentience. *Applied Animal Behaviour Science*, *100*, 11-19.

Duncan, I. J. H. & Dawkins, M.S. (1983). The problem of assessing 'well-being' and 'suffering' in farm animals. In: Indicators relevant to farm animal welfare, D. Smidt, (ed.), Martinus Nijhoff, The Hague, 13-24.

Duncan, I. J. H. & Fraser, D. (1997). Understanding animal welfare. In: Animal welfare, M.C. Appleby and B.O. Hughes (eds), CAB International, Wallingford, 19-31.

Dwyer, C. M. (2009). Welfare of sheep: providing for welfare in an extensive environment. *Small Ruminant Research*, *86 (1-3),* 14 - 21.

Dwyer, C. M. & Bornett, H.L. (2004). Chronic stress in sheep: assessment tools and their use in different management conditions. *Animal Welfare*, *13*, 293-304.

Dwyer, C. M. & Lawrence, A. B. (2005). A review of the behavioural and physiological adaptations of hill and lowland breeds of sheep that favour lamb survival. *Applied Animal Behaviour Science, 92*, 235–260.

EFSA (2012). Statement on the use of animal-based measures to assess the welfare of animals. Panel on animal health and welfare (AHAW), EFSA Journal, 10 (6), 2767, 29pp.

European Food Safety Authority (EFSA). (2014). Scientific Opinion on the Welfare Risks Related to the Farming of Sheep For Wool, Meat and Milk Production. EFSA, 12.

Farm Animal Welfare Council, (2005). Report on the Welfare Implications of Farm Assurance Schemes. London, UK. http:// www.fawc.org.uk

FAWC (2010). Annual Review 2009-2010. Farm Animal Welfare Council. UK.

Fraser, D. (2008). Understanding animal welfare. *Asta Veterinaria Scandinavica, 50 (Suppl I).*

Fraser, A. & Broom D. (1990). Farm animal behavior and welfare, CAB, International, Wallingfard, Oxon, UK, New York, NY, USA, ISBN 0851991602.

Fraser, D. & Weary, D.M. (2004). Quality of life for farm animals: linking science, ethics, and animal welfare. In: The well -being of farm animals: challenges and solutions, G.J. Benson and B.R. Rollin (eds), Blackwell, Ames, 39-60.

Fraser, D., Weary, D. M., Pajor, E. A., & Milligan, B. N. (1997). A scientific conception of animal welfare that reflects ethical concerns. *Animal Welfare*, *6*, 187-205.

Goddard, P., Waterhouse T., Dwyer, C. & Stott, A., (2006). The perception of the welfare of sheep in extensive systems. *Small Ruminant Research*, *62*, 215-225.

Green, T.C. & Mellor, D.J. (2011). Extending ideas about animal welfare assessment to include "quality of life" and related concepts. *New Zealand Veterinary Journal*, *59*, 316–324.

Hamadeh, S. K., Rawda, N., Jaber, L. S., Habre, A., Abi Said, M. & Barbour, E. K., (2006). Physiological response to water restriction in dry and lactating Awassi ewes. *Livestock Production Science*, *101*, 101-109.

Harrison, R. (1964). Animal machine. Vincent Stuart Ltd, London.

Hemsworth, P. H., Mellor, D. J., Cronin, G. & Tilbrook, A. (2015). Scientific assessment of animal welfare. *New Zealand Veterinary Journal*, *63*, 24–30.

Hewson C. J. (2003). What is animal welfare? Common definitions and their practical consequences. *Canadian Veterinary Journal*, *44*, 496-499.

Hutchings, M. R., Gordon, I. J., Robertson, E., Kyriazakis, I. & Jackson, F., (2000). Effects of parasitic status and level of feeding motivation on the diet selected by sheep grazing grass/clover swards. *The Journal of Agricultural Science*, *135*, 65-75.

Johnsen, P. F., Johannesson, T. & Sandøe P. (2001). Assessment of farm animal welfare at herd level: Many goals, many methods. *Acta Agriculturae Scandinavica Animal Science*, *30 (Suppl),* 26-33.

Kilbride, A. L., Mason, S.A., Honeyman, P. C., Pritchard, D. G., Hepple, S. & Green, L. E., (2012). Associations between membership of farm assurance and organic certification schemes and compliance with animal welfare legislation. *The Veterinary Record*, *170*, 152–157.

Korte M. S., Olivier B. & Koolhaas J. M. (2007). A new animal welfare concept based on allostasis. *Physiology & Behavior*, *92*, 422-428.

Lia, R. & Pantone, N. (2001). Influence of strongylides-gastrointestinal infestations on the qualitative quantum production of milk in sheep farms conducted with traditional systems. (Influenza delle infestazioni da strongilidi-gastrointestinali sulla produzione quanti qualitativa del latte negli allevamenti degli ovini condotti con sistemi tradizionali.) In: Proc. Standing Seminar on Sheep milk quality, Foggia, Italy, 81-91.

Llonch, P., King, E. M., Clarke, K. A., Downes, J. M. & Green, L. E. (2015). A systematic review of animal based indicators of sheep welfare on farm, at market and during transport, and qualitative appraisal of their validity and feasibility for use in UK abattoirs. *The Veterinary Journal, 206*, 289–297.

Main, D. C. J., Kent, J. P., Wemesfelder, F., Ofner, E. & Tuyttens, F. A. M. (2003). Applications for methods of on-farm welfare assessment. *Animal Welfare*, *12*, 523-528.

Main, D. C. J., Whay, H. R., Leeb, C. & Webster, A. J. F. (2007) Formal animal-based welfare assessment in UK certification schemes. *Animal Welfare*, *16*, 233–236.

Martelli, G. (2009). Consumers' perception of farm animal welfare: an Italian and European perspective. *Italian Journal of Animal Science*, *8 (Suppl. 1),* 31-41.

McCulloch, S.P. (2013). A critique of FAWC's five freedoms as a framework for the analysis of animal welfare. *Journal of Agricultural and Environmental Ethics, 26,* 959–975

McGlone, J. J. (1993). What is animal welfare? *Journal of Agricultural and Environmental Ethics*, *6*, 26-36.

Mellor, D, J. (2016). Moving beyond the "Five Freedoms" by updating the "Five Provisions" and introducing aligned "Animal Welfare Aims". *Animals*, *6*, 59, 1-7.

Mellor, D.J.& Beausoleil, N.J. (2015). Extending the "Five Domains" model for animal welfare assessment to incorporate positive welfare states. *Animal Welfare*, *24*, 241–253.

Eastern European Countries, FAO REU, *50*, 317-323.

Mellor, D. J. & Reid, C. S. W. (1994) Concepts of animal well-being and predicting the impact of procedures on experimental animals. In: Improving the Well-Being of Animals in the Research Environment; Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART): Glen Osmond, SA, Australia, 3–18.

Milan, M. J., Frendi, F., Gonzalez-Gonzalez, R. & Caja, G. (2014). Cost structure and profitability of Assaf dairy sheep farms in Spain. *Journal of Dairy Science, 97,* 5239-5249.

Nabradi, A., Andras, J. & Sandor, K. (1998). Economic reserves of Hungarian sheep breeding. Sheep and goat production in Central and **Napolitano, F., De Rosa, G., Ferrante, V., Grasso, F. & Braghieri, A.,** (2009). Monitoring the welfare of sheep in organic and conventional farms using an ANI 35 L derived method. *Small Ruminant Research*, *83*, 49–57.

Negrave, R., (1996). Sheep grazing controls Calamagrostis Canadensis-dominated vegetation in the Boreal Forest Integrated Forest Vegetation Management. Page 2 in Options and Application, FRDA Report 251.

Orr, R. J., Parsons, A. J., Penning, P. D. & Treacher, T. T., (1990). Sward composition, animal performance and the potential production of grass/white clover swards continuously stocked with sheep. *Grass Forage Science*, *45*, 325

Penning, P. D., Parsons, A. J., Orr, R. J. & Hooper, G. E., (1994). Intake and behavior response by sheep to changes in sward characteristics under rotational grazing. Grass Forage Science, 49, 476-486.

Pulina, G., Mazzette, A., Battacone, G. & Nudda, A., (2006). Feed restriction alters milk production traits in Sarda dairy ewes. *Journal of Dairy Science, 89 (Suppl. 1),* 59.

Rassu, S. P. G., Enne, G., Ligios, S. & Molle, G. (2004). Nutrition and reproduction In: G. Pulina (ed.) Dairy sheep nutrition. CABI Publishing, Wallingford, UK, pp. 109-128.

Richmond, S. E., Wemelsfelder, F., de Heredia, I. B., Ruiz, R., Canali, E. & Dwyer, C. M. (2017). Evaluation of Animal-Based indicators to be used in a Welfare Assessment Protocol for sheep. *Frontiers in Veterinary Science*, *4*, 1-13.

Rollin, B. E. (1999). An introduction to veterinary ethics: Theory and cases. Lowa State University Press ISBN 0813816599.

Rushen, J. (2003). Changing concepts of farm animal welfare: bridging the gap between applied and basic research. *Applied Animal Behaviour Science*, *81*, 199-214.

Rushen, J., Butterworth, A., & Swanson, J. C. (2011). Animal behavior and well-being symposium. Farm animal welfare assurance: Science and application. *Journal of Animal Science*, *89*, 1219–1228.

Sevi, A., (2005). Influence of sunlight, temperature and environment on the fatty acid composition and coagulatine properties of sheep milk. In: D. Gabina, J.C. Le Jaouen, A. Pirisi, A. Ayerbe and Y. Soustre (eds.) The future of the sheep and goat dairy sectors. Special Issue No. 200501/2005, International Dairy Federation, pp. 305-311.

Sevi, A., Albenzio, M., Annicchiarico, G., Caroprese, M., Marino, R. & Taibi, L., (2002a). Effects of ventilation regimen on the welfare and performance of lactating ewes in summer. *Journal of Animal Science, 80*, 2349-2361.

Sevi, A., Albenzio, M., Marino, R., Santillo, A. & Muscio, A., (2004). Effects of lambing season and stage of lactation on ewe milk quality. *Small Ruminant Research, 51*, 251-259.

Sevi, A., Albenzio, M., Muscio, A., Casamassima, D. & Centoducati, P., (2003a). Effects of litter management on airborne particulate in sheep houses and on the yield and quality of ewe milk. *Livestock Production Science, 81*, 1-9.

Sevi, A., Annicchiarico, G., Albenzio, M., Taibi, L., Muscio, A. & Dell'Aquila, S., (2001a). Effects of solar radiation and feeding time on behavior, immune re sponse and production of lactating ewes under high ambient temperature. *Journal of Dairy Science, 84*, 629-640.

Sevi, A., Casamassima, D., Pulina, G. & Pazzona, A. (2009). Factors of welfare reduction in dairy sheep and goats. *Italian Journal of Animal Science*, *8 (1),* 81-101.

Sevi, A., Massa, S., Annicchiarico, G., Dell'Aquila, S. & Muscio, A., (1999a). Effect of stocking density on ewes milk yield and incidence of subclinical mastitis. *Journal of Dairy Research, 66*, 489-499.

Sevi, A., Rotunno, T., Di Caterina, R. & Muscio, A., (2002b). The fatty acid composition of ewe milk, as affected by solar radiation under high ambient temperature. *Journal of Dairy Research*, *69*, 181-194.

Sevi, A., Taibi, L., Albenzio, M., Annicchiarico, G., Marino, R. & Caroprese, M., (2003c). Influence of ventilation regimen on micro-environment and on ewe welfare and milk yield in summer. *Italian Journal of Animal Science, 3*, 197-212.

Sevi, A., Taibi, L., Albenzio, M., Annicchiarico, G. & Muscio, A., (2001c). Airspace effects on the yield and quality of ewe milk. *Journal of Dairy Science, 84*, 2632-2640.

Sevi, A., Taibi, L., Albenzio, M., Caroprese, M., Marino, R. & Muscio, A., (2003d). Ventilation effects on air quality and on the yield and quality of ewe milk in winter. *Journal of Dairy Science, 86*, 3881-3890

Sevi, A., Taibi, L., Muscio, A., Albenzio, M., Dantone, D. & Dell'Aquila, S., (2001e). Quality of ewe milk as affected by stocking density and litter treatment with bentonite. *Italian Journal of Animal Science, 13*, 77-86.

Sørensen, J.T. & Fraser, D. (2010). On-farm welfare assessment for regulatory purposes: issues and possible solutions. *Livestock Science, 131*, 1–7.

Thorpe W. H. (1969). Welfare of domestic animals. *Nature, 224*, 18-20.

Turner, S.P. & Dwyer, C.M., (2007). Welfare assessment in extensive animal production systems: challenges and opportunities. *Animal Welfare*, *16*, 189-192.

Vanhonacker, F., Verbeke, W., Poucke, E.V. & Tuyttens, F.A.M. (2008). Do citizens and farmers interpret the concept of farm animal welfare differently? *Livestock Science*, *116*, 128-136.

Varlyakov, I. (2011). Animal welfare – theoretical and practical aspects, Monograph. Bulgaria, ISSN – 978-954914296-9, p. 246 (Bg).

Veissier, I., Jensen, K.K., Botreau, R. & Sandøe, P. (2011). Highlighting ethical decisions underlying the scoring of animal welfare in the Welfare Quality scheme. *Animal Welfare*, *20*, 89–101.

von Keyserlingk, M. A. G. & Weary, D. M. (2017). A 100-year review: Animal welfare in the Journal of Dairy Science - The first 100 years. *Journal of Dairy Science, 100* (12), 10432-10444.

Weary, D. M. & von Keyserlingk, M. A. G. (2017). Public concerns about dairy-cow welfare: How should the industry respond? *Animal Production Science, 57, 2101-1209.*

Webster J. (2001). Farm animal welfare: the five freedoms and the free market. *The Veterinary Journal*, *161*, 229-237.

Welfare Quolity® Protocol, (2009a). Welfare quality assessment protocol for pig (sows and piglets, growing and finishing pigs). Welfare Quality Consortium, Lelystad, The Netherlands, 122 pp.

Welfare Quolity® Protocol, (2009b). Welfare quality assessment protocol for poultry (broilers, laying hens). Welfare Quality Consortium, Lelystad, The Netherlands, 114pp.

Welfare Quolity® Protocol, (2009c). Welfare quality assessment protocol for cattle. Welfare Quality Consortium, Lelystad, The Netherlands, 180pp.

Winckler, C. (2006). On-farm welfare assessment in cattle. From basic concepts to feasible assessment systems. In: Proceeding of the XXIV World Buiatrics Congress, Nice, France, Gloyd Group, Wilmington, DE, pp 493-500.

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