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**LAYWEL**

**Welfare implications of changes in production systems for laying hens**

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## **Definitions of welfare**

During the last 5 decades farming systems for laying hens have been subjected to continuous changes in various directions, from extensive free range to intensive deep litter and aviary systems to battery cages. The Directive 1999774/EC for the protection of laying hens, which basically intends to replace the conventional battery cages by enriched cages has stimulated the development of the latter. At the same time there was considerable development in the non-cage systems

There is little basic information on the welfare status of the hens in the newly developed systems so far. In order to appraise the implication of the changes of farming systems for laying hens it is essential to review the definitions of welfare. In the following the development of welfare definitions will be described. The stand of knowledge will provide the basis for interpreting the impact of the newly developed housing systems on the welfare of laying hens.

The perception welfare in general and animal welfare in particular has evolved concomitantly with the philosophical, ethical and economical progress of the human population. In the past the interrelationship between humans and animals was controlled by traditions. The traditions provided fixed rules on the treatment of animals and were controlled by the social communities. Traditions, however, do not give general rules for the treatment of animals, but regulate cases which are specific for different animal species and specific situations. There has been considerable variation of the traditions concerning the treatment of animals among and within ethnic groups, which still persists in some areas (e.g. fox hunting, bull and cock fighting). Even within individuals there is often no consistent trend in the declared opinion and real decisions concerning animal welfare. While the overwhelming part of the consumers in Northern European countries express their concern about caging of hens, eggs from this system still represent the major chair on the market (Trinh, 1997). The causes for this divergence are manifold and have been dealt with by EU (2005).

Discussions on animal welfare in general emerged in European countries with progressing industrialisation and urbanisation, where large parts of the population lost the contact with farm animals and the traditional knowledge on the treatment of animals. It is well documented that the organised animal welfare movement has its origin in the urban centres of Western European countries. The main focus of their activities was on animals working in the industry, e.g. in coal mines and road transport. In the middle of the last century most of the traditional livestock production systems have been subjected to dramatic changes. This was particularly pronounced in laying hens. Within a few years the prevailing small scale free range systems were replaced by large scale industrial battery cages. Consequently caged laying hens have become the focal point of the animal welfare debate (Harrison, 1964; Brambell, 1965).

While contacts and experience of the urban populations with farm animals disappeared, the number of pet animals increased. This development has contributed to changes in the status of animals in relation to human beings and stimulated the discussion on the animals' psychological needs, feelings and rights. There exist different philosophical and ethical opinions on the status of animals, which rank from a strict distinction to intermediate and equal position of man and animals. It is evident, that the extensive discussion during the last decades on the biological, philosophical, and ethical background of welfare has not resulted in a generally accepted concept. With the accretion of scientific knowledge on the behaviour, physiology and preferences of the animals the definitions of welfare have become more complex. Nevertheless there exists abroad consensus among welfare scientists concerning the main welfare problems in farm animals (Anonymus, 2001).

Considering the main existing definitions (table 1) it becomes clear that there is a high coincidence in the objective, but a wide scope of approaches and of the weight which is allocated to the particular aspects within the complex "welfare". Since there is a high extend of overlapping in the different definitions it is difficult to built distinct categories. Therefore it was decided to present them in a chronological order.

Interestingly, the terms which are being used for welfare are similar in many European languages (e. g. well-being; välfärd, Wohlbefinden; bien-etre, benessere, benestar). While the wording as such implies

positive experiences, among scientists working on this matter well-being is understood as a continuum from positive to negative impressions. This is clearly expressed in the definition of Spruijt et al. (2001) where welfare is defined as the positive net balance between positive and negative experiences and poor welfare represents the negative balance.

Most definitions comprise physical, physiological and psychological/mental aspects. There are, however, definitions which emphasis only one category (McGlone, 1993: physiological systems; Dawkins, 1990: subjective feelings).

Good health is considered a prerequisite for welfare. Despite, or because, the influence of diseases on the welfare conditions of animals is generally acknowledged, "health" is explicitly addressed in a few of the definitions only. Rushen (2003) expressed his concern about the underestimation of health aspects in the welfare discussion. Since health problems are closely related to the physical, physiological and psychological conditions of the animals, it may be understood as a part of the other categories. With regard to the specialised knowledge which has been elaborated and published on the interrelationship between health and welfare, this aspect will be retained as a separate category in the following.

There are different approaches to determine "normal" behaviour. Some authors propose the behaviour of animals in a quasi-natural environment should be the base line (Stolba, 1981). The deviation of the behaviour under commercial husbandry conditions, from the quasi-natural reference system, may be used as measure of welfare problems. It is assumed in this model that the welfare state of the birds is at maximum level in the reference system, and any changes in behaviour indicate deterioration of the state of welfare. A similar approach is given by the index of animal welfare (TGI) which allocates bonus points to housing systems which allow the expression of natural behaviours (Sundrum, 1997). The assumption that the environment which allows the expression of the full inventory of natural behaviours ensures maximum of welfare has to be questioned. It is also difficult to identify the limits where the change of behaviour exceeds the range of normal adaptation responses. Furthermore this system does not take into consideration that, under artificial husbandry conditions, the animals may develop alternative behavioural patterns, which may successfully maintain the state of welfare. In some cases the sequence of behavioural patterns rather than durations and intensities, are affected by adverse environmental conditions.

Welfare problems are obvious when the behaviour of the animals leads to serious behavioural disturbances (e.g. stereotypies) or damages of the birds themselves or of group mates (e.g. cannibalism).

A special problem is the lack of occurrence of behaviours either for the lack of space (wing-flapping), structure (roosting), or lack of eliciting stimuli (flight). The non-occurrence as such may only be considered with regard to welfare if the causes of the effect are known.

The interrelationships of the animals and their environment are elementary issues in the definitions of welfare (e.g. Lorz, 1973; Wiebkema, 1982; Tschanz, 1984, Broom, 1986). These definitions imply the requirement of the organisms for adequate environmental inputs so as to satisfy their needs. It is assumed that the animal lives in "harmony with its environment" (Lorz, 1973) when the environment provides such inputs. Hence this environment is considered welfare-friendly. Any deficiency of the environment with regard to the animal needs will elicit coping mechanisms. Whether coping is successful or not depends on the specific condition of the individual and the quality of the environment. Wiebkema (1982) assumes that the "inadequacy of the programmes performed to control relevant aspects of the environment ...." leads to stress and suffering. According to Broom's (1986) definition, the attempts to cope are taken as indicators of mismatch between the animals need and their environment. The presence of coping is not considered sufficient to indicate the state of welfare. Sandoe et al. (1992) introduces the cost of coping as essential component. This cost, however, may be difficult to measure. The welfare definition of Tschanz (1984) follows the idea that adequate environmental conditions are required so as to fulfil the animals' needs. This definition specifies the needs according to general principles of life, which are development, maintenance and reproduction and avoidance of damages. Deviations from normal development of the animal according to its genetic programme, problems in maintenance and reproduction and occurrence of damages are indicators of

poor welfare. The problem of applying this definition under practical conditions is the determination of the normal range of development, maintenance and reproduction. McGlone (1993) considers the situation welfare-relevant only when survival and reproduction are impaired. Hence mortality and reproduction rate are the criteria of welfare. Since welfare problems can occur before the animal dies or reproduction rate is impaired, this definition is not generally accepted.

In this context the question arises, how the risk of diseases, damages and mortality is related to welfare. In many cases the hens do not perceive risk-bearing conditions as adverse experiences. They may even show preferences for these conditions. If there are established relationships between the risk factors and the occurrence of welfare problems, the potential hazard of the birds' welfare has to be balanced against the strength of preference.

The American Vet. Association (1987) and Moberg (1993) focus their definitions of welfare on the classic stress responses. The response to stressors, which represents the physiological side of coping reaction, is considered not harmful to the animals as long as it leads to successful adaptation.

On the basis of anatomical and physiological homologies of animals and human beings Dawkins' (1990) definition underlines the subjective experiences and feelings of the animals as central issue of wellbeing and suffering. This line is extended by the "five freedoms" (FAWC, 1992). They concede animals the right not only for essential inputs but also for freedom from discomfort.

The above definitions rely mainly on adverse effects and indicators of impaired well-being and suffering. The quality of life definition (Mench, 1998) extends well-being beyond the state where welfare is adversely affected towards positive aspects. This may be shown in the extent the animals are engaged in normal behaviours, such as exploration and play, and in the ability to build social relationships.

Based on the analogy of animals and humans in their anatomical and physiological system it is generally acknowledged that higher animals have feelings and emotions. As far as well-being is related to health, production, reproduction and physiological traits there exists a basis of measurable characteristics which make the definitions accessible to established methods of natural sciences. Definitions related to subjective feelings, however, require special theoretical and experimental approaches. While Wemelsfelder et al. (2000) is of the opinion, that humans may recognise the animals' wellbeing or suffering intuitively by observation, there are attempts to approach the animals' feelings and emotions experimentally. With this regard tests for preferences, fear, avoidance and frustration and operant conditioning techniques have been used extensively to uncover the emotional state and motivation of animals under welfare-related conditions. The problems of the experimental designs and the interpretation of the results with regard to well-being have been discussed extensively by Duncan (1978). Assuming that animals - like humans - prefer pleasant experiences, preference tests can provide interesting information of the animals' subjective ranking of environmental conditions on the hypothetical scale of welfare (Dawkins, 1976). Since symptoms of poor welfare are easier to identify than symptoms of positive states of emotions the former part of the scale has been explored extensively. Frustration, fear and avoidance tests have proved to be particularly useful to explore the area of poor welfare (Jones et al., 1982; Koene, 1993). The state of positive experiences, however, is more difficult to identify. The consumer demand function has been used to investigate this area. The elasticity of demand (as expressed by the slope of the demand plotted against increasing "price" or work load) is considered an indicator of the motivation to obtain particular rewards (Houston, 1997).

The above mentioned tests have extended our knowledge on the relative importance and on priorities of environmental inputs, such as floor space (Faure and Lagadic, 1994), height (Nicol, 1987), nest and scratching area (Guesdon et al., 2004); litter material (see WP 7). The results have also shown that they must be interpreted with care. Choice tests, for example, highly depend on the design of the test and the criteria which are being observed. In operant conditioning tests it is important to choose techniques which are adequate with respect to the species and the particular motivation to be investigated.

Considering that welfare is the result of physical conditions and physiological and psychological mechanisms, which influence liveability, growth, reproduction, health and behaviour, considering further that environmental conditions influence the above mentioned criteria in different directions, the actual state of welfare of an animal is the result of the integration of the above mentioned processes.

Limiting physical space of indoor systems, for example, restricts freedom of movement, but reduces the risk of predators. Litter-less husbandry systems impair scratching and foraging behaviour, but may improve the health conditions. Choice tests and operant conditioning techniques will be helpful to establish a scale of priorities and to develop weights within the categories of indicators. But there is no experimental design so far that allows weighting the different aspects of welfare across the categories (e.g. health against freedom of movement). Recent studies on the reliability of the TGI-Index, which includes environmental and behavioural criteria have shown, that the appraisal system was successful in assessing the status of welfare within categories of production systems for laying hens, but it failed when different categories were to be compared (Mollenhorst et al, 2005).

## **Indicators of welfare**

In the following the main criteria which are addressed by the definitions of welfare are listed in 5 categories, productivity, health, physical conditions, physiological conditions, behavioural conditions and appraised for their relevance, reliability and feasibility.

### **Productivity**

High productivity is an indicator of undisturbed physiological function of the reproductive tract. The absence of stressors, which are known to reduce egg production, such as heat stress; stocking density, social strife (Reynard et al., 1996; Mashaly et al., 1982; Robinson et al., 1979) is a prerequisite for high productivity throughout the laying period. It has been reported episodically that birds showed high production rate despite serious wounds, diseases or stress challenges. But it is unlikely that laying hens will maintain high production rates after extended periods of stress.

However, sub-optimal production does not indicate lack of welfare. Low protein or/and high fibre/low energy diets, short lighting periods may reduce the productivity without obvious welfare problems. Therefore the interpretation of production traits in regard to welfare requires consideration of the other environmental and nutritional aspects.

It has been shown that stressors may influence the egg shell quality (Mills et al., 1987). Hence it may be an indicator of welfare.

### **Health**

Diseases generally reduce the state of welfare of an animal. Diseases are wide spread in poultry flocks; hence their relevance is important. While this is generally accepted for obviously diseased birds, some authors consider pre-pathological conditions to be welfare problems. The intensity and duration of suffering from diseases depend on type of disease (acute or chronic), medical care and culling practice. In order to get reliable data on the state of health, type and duration of the disease and number of diseased birds should be recorded. With regard to the work and specific knowledge and laboratory capacity needed for such data, we have to rely on very simple indirect criteria, such as mortality and medical treatments. Reduction of performance, body weight, feed intake and other symptoms of disease (e.g. alteration of egg shell) may also be considered as indicators, when their relationship to a disease is obvious. Mortality caused by injury, cannibalism and diseases is in most cases preceded by a state of poor welfare.

### **Physical conditions**

Bone strength and extreme claw length itself do not directly influence welfare, but are indicators of potential welfare problems, such as insufficient opportunities of scratching and locomotion, risks for trapping (Tauson, 1985) and bone breakage in case of accidents and rough handling (Gregory et al., 1990). Feather damages are often caused by feather pecking. Minor deteriorations of the feather structure is brought about by gentle feather pecking and may not be connected with pain and suffering. Plucking of feathers, however, is considered temporarily painful. There is a moderate negative correlation between feathering quality and fear in laying hens (Bessei, 1984). It has also to be mentioned that feather pecking bears the risk of cannibalism, which is an obvious welfare problem. Bumble feet and foot pad lesions are the result of injuries and infections and hence direct indicators of impaired welfare. There is no information on the relevance of keel bone deformation on welfare.

The frequency and intensity of the criteria can be recorded by established scoring methods (see WP 3).

### **Physiological conditions**

It is generally acknowledged that the intact organism disposes of particular physiological mechanisms to cope with adverse environmental conditions, e.g. the fight and flight syndrome and the general adaptation syndrome (Siegel, 1997). The corresponding hormonal and neural responses are being used as indicators of stress. Most of the criteria are also involved in basic metabolic functions. In order to differentiate between normal metabolic activity, such as low ambient temperature, increased exercise, and stress response it is essential to study the basal level as well as the dynamic response to challenges.

Physiological criteria usually return to normal levels within a given time after challenge. The persistence of high levels of corticosterone, for example, indicate lack of ability of adaptation and are considered as indicators of reduced welfare.

Collection of physiological data requires special equipment, laboratory methods and controlled environmental conditions. The criteria may not be applicable under practical husbandry conditions.

### **Behavioural conditions**

Deviation of behaviours as criterion for the welfare state of an animal requires the definition of “normal” behaviour. Since behaviour, like physiological reactions, is considered a means of adaptation, it varies according to the fluctuation of environmental conditions. The variation of behaviour as adaptive reaction to changes of the environment should be considered “normal”. Welfare problems are likely to occur, when the limits of adaptation are exceeded, e.g. the challenge is beyond the range of the reaction capability of the bird.

Behavioural observations are time consuming and require particular training of the personnel. The interrelationships between behavioural changes and the state of welfare will rely on observation under controlled conditions.

There is a high variability of behaviour in response to time of day, consecutive days, seasons and unpredictable stimuli, which overlaps the differences in the behaviour among production systems. Therefore it is difficult to define quantitatively the range of “normal” behaviour. In addition, the observation of animals under practical management systems may not provide reliable information which can be applied to all existing similar systems.

These problems have to be considered, when differences in the duration and frequency of common behaviours, such as preening, walking, eating, are being used to appraise welfare. The interpretation of differences in these behaviours needs to be supported by the knowledge of the underlying motivation. The interrelationships between behaviour and welfare is easier to interpret when the behaviour leads to obvious mutilations of the birds themselves, or, of their group mates. This is the case in feather pecking, cannibalistic pecking and aggression.

Obvious “abnormal” behaviours are often the result of inadequate environmental conditions. Sometimes these behaviours (e.g. stereotypies) persist even though the husbandry system has improved. In these cases the occurrence of abnormal behaviours may not reflect the welfare situation at the time of observation.

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**Table 1 Definitions of welfare**

- 1) Welfare is a wide term that embraces both the physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and function and also from their behaviour (BRAMBELL REPORT, 1965)
- 2) Living in harmony with the environment and with itself, both physically and psychologically (Lorz, 1973)
- 3) Welfare is a state of complete mental and physical health, where the animal is in harmony with its environment (Hughes, 1976)
- 4) The inadequacy of the programmes performed to control relevant aspects of the Umwelt, or the permanent failure of any behaviour, must cause severe feelings of distress. In this period the animal really suffers and its well-being is at stake. (WIEPKEMA, 1982)
- 5) Principles of live are: Development, maintenance, reproduction and avoidance of damages. Behaviour is a mean to procure the environmental inputs so as to fulfil the animal's needs for development, maintenance, reproduction and avoidance of damages. The environment is animal-adequate (tiergerecht) if it enables the animal to fulfil its needs (after Tschanz, 1984)
- 6) The welfare of an individual is its state as regards its attempts to cope with its environment (BROOM, 1986)
- 7) Distress is a state in which the animal is unable to adapt to an altered environment or to altered internal stimuli. If such stressors are short term, responses an animal will make to adapt to these changes do not usually, but may, result in long-term harmful effects. Prolonged or excessive distress may result in harmful responses, e.g. abnormal feeding and social interaction behaviour, inefficient reproduction, and can result in pathologic conditions, e.g. gastric and intestinal lesions, hypertension, immuno suppression. Distress also may be induced through changes in internal states such as disease, nausea, excessive anxiety, and fear. Such responses may become a permanent part of the animal's repertoire and seriously threaten the animal's well-being (AMERICAN VETERINARY MEDICAL ASSOCIATION, 1987)
- 8) Animal welfare is dependent solely on the cognitive needs of the animals concerned (DUNCAN & PETHERICK, 1989)
- 9) Let us not mince words: Animal welfare involves the subjective feelings of animals (DAWKINS, 1990)
- 10) The freedoms (FAWC, 1992)  
Freedom from hunger, thirst, discomfort, pain, injury, disease. fear and distress  
Freedom to express normal behaviour
- 11) An animal is in a state of poor welfare only when physiological systems are disturbed to the point that survival and reproduction are impaired (McGlone, 1993)
- 12) Risk to an animals welfare occurs when an animal experiences stress of such a magnitude that there is a significant diversion of the animals biological resources from normal function (Moberg, 1993)
- 13) Welfare is the animal's perspective on the net balance between positive (reward, satisfaction) and negative (acute stress) experiences of affective states (Spruijt et al., 2001)
- 14) The quality of life definition (Mench, 1998) extends well-being beyond the state where welfare is adversely affected towards positive aspects. This may be shown in the extent the animals are engaged in normal behaviours, such as exploration and play, and in the ability to build social relationships

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