Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X Jul - Sep 2006 / v.8 / n.3 / 137 - 148

Animal Welfare Concepts and Strategy for Poultry Production: A Review

■ Author(s)

Moura DJ[1]
Nääs IA[2]
Pereira DF[3]
Silva RBTR[4]
Camargo GA[5]

[1] Professor Doutor, FEAGRI – UNICAMP. CxP 6011. 13083-970, Campinas, SP.
[2] Professor, FEAGRI – UNICAMP. CxP 6011. 13083-970, Campinas, SP.
[3] Professor Doctor. UNESP, Tupã, SP.
[4] Graduate student, FEAGRI – UNICAMP, CxP 6011. 13083-970, Campinas, SP.
[5] Researcher Doctor, CT-UNICAMP.

■ Mail Address

Daniella J. Moura
FEAGRI – UNICAMP
CxP 6011
13083-970. Campinas, SP, Brasil.

E-mail: daniella.moura@agr.unicamp.br

■ Keywords

Bird welfare, housing, behavioral pattern, welfare assessment.

ABSTRACT

Well being of animals had been historically a public concern, since the beginning of human kind history. As world's population grows there is a need for food including meat. In the last decades there has been a great improvement in poultry production based on the careful control of several aspects, among which nutrition and management (environment, health and rearing systems). Nowadays, the search for good welfare conditions is a global tendency in animal production; however issues surrounding farm animal welfare or well-being, such as definitions, measurements, interpretation, and perception, continue to be controversial. It is known that the result of a broiler not adequately housed is a direct loss in production which leads towards a thought that health, welfare and productivity are intimately connected. In the other hand hints are found in the observation of behavioral responses as well as vocalization, which may provide more precise assessment to welfare. This has been possible due to the use of information technology applied to the field of ethology as well as the multidisciplinary view of the problem. This text provides a review on broiler's welfare issues since its definition to several way of trying to assess it adequately.

INTRODUCTION

The domestication of animals for food was an integral part of the development of agriculture as well as humankind, and along the years in which humans have interacted with animals since their domestication, changes have been made in both animals and their husbandry.

Animals well being is historically a public concern. In the Kahoun papyrus, dated from around four thousand years ago and found in the 1990s, there are observations regarding special care for domestic animals. Maschio (2006) describes that norms and obligations to be followed by humans to ensure animal health were also found in the Hamurabi code. Buda preached a harmonious and virtuous relationship with all living beings. In the Book of Animals, the philosopher Aristotle wrote the first rules based on animal observation, describing specific behaviors, such as walking of horses, as well as their reproduction. Pythagoras also asserted that it should be considered right to be good to animals. It was only after the Cartesian era that the ethical behavior of humans relative to animals was reversed.

The remarkable improvements in the efficiency the production of poultry and other livestock occurring in the last fifty years are reported by several authors (Cast, 1981; Mench, 1986; Albright, 1986). In the United States, for instance, the number of eggs annually laid by hens doubled during this period, while the amount of feed consumed for each egg produced has decreased in nearly 50%. Due to this improvement in egg production and feed efficiency, the cost of eggs to

Arrived: May / 2006
Approved: August / 2006

the consumer has risen by only 40% since 1925, which is considerably less than the cost increases of most other consumer goods (Albright, 2006). Similar trends also occurred in beef, pork, poultry meat, and dairy production.

Many factors contributed to these improvements, such as sophisticated techniques of selection; advances in the detection, treatment, and prevention of diseases; mechanization of farm labor; as well as the development of nutritionally balanced feed. The adequate use and management of light and temperature-controlled housing provided protection from weather extremes, and allowed the control of the photoperiod necessary to stimulate growth and reproduction.

Meanwhile, in the 90s, some authors considered that semi-intensive free-range broiler or layer production by promoted better animal welfare (Bastianelli, 2001; Heier *et al.*, 2002). Studies in literature (Singh *et al.*, 2001; Hellmeister *et al.*, 2003) report the genetic development of hardier chickens, with higher resistance to heat stress, as these have higher efficiency in dissipating sensible heat as compared to birds with larger feathering. Studying production data from free-range and conventionally rearing broilers (Table 1), Lima & Nääs (2005) found expected differences, especially when considering that flocks of both bird types presented different times to achieve the same slaughter weight.

Table 1 - Mean productive index in both rearing conditions A (conventional) and B free-range.

Production indexes	Rearing conditions	
	A (conventional)	B (free-range)
Feed intake*	4.73	6.02
Production index (PI)**	2.70	0.83
Daily weight gain (DWG, kg)	0.06	0.02

*FC = total feed intake (kg)/ total production of broiler (kg). **PI = (DWG. F)/FC. 100.

However, it is clear that broilers reared under semi-intensive conditions presented lower mortality (Table 2), and lower litter moisture as compared to conventionally reared birds.. In addition, free-range birds presented less problems and lower footpad burns, at an Odds Ratio[1] of 4.5, in comparison to broilers reared under conventional conditions. This was favored by the fact that, under semi-intensive rearing, birds are allowed to walk freely, as well as being exposed to natural photoperiod.

[1] Statistical ratio that allows comparison between occurrences.

Poultry rearing under extensive or semi-intensive conditions would be an interesting way to provide poultry welfare, if it were not for Avian Influenza (H5N1), which emergence poses a threat to poultry production internationally. Restricting animal housing facilities for broilers and other livestock became a biosafety issue. This is a return to the initial idea of housing animals together inside a facility to control the direct effects of weather, and to manage them more easily.

Table 2 - Mean productive indexes in rearing conditions A and B (conventional and free-range).

Production indexes	Rearing conditions	
	A (conventional)	B (free-range)
Mortality (%)	5.32[a]	1.34[b]
Weight gain at slaughter (kg)	2.58[a]	2.10[b]
Feed conversion	1.97[a]	2.98[b]
Age at slaughter (days)	45	80

Means followed by different letters in the row are different ($p<0.05$).

ANIMAL WELFARE CONCEPTS AND DEFINITIONS

There is a general agreement around the definition of animal welfare, meaning a balance between the animal itself and its surrounding environment. In practice, this can be understood as providing them sufficient health and comfort, as well as avoiding stress of any order. After all, if a broiler is not adequately housed, there is a direct loss in production. This leads to the thinking that health, welfare, and productivity are intimately connected.

A scientific assessment of animal welfare was earlier compiled by Fox (1994), who studied welfare determinants; cognitive ethology; self-awareness; and animal consciousness, feelings, and suffering. Duncan & Petherick (1991) differentiated needs from desires, sensing from detecting, and perception from learning and awareness, among other concepts. More recently, some authors support the idea that welfare is mainly (Dawkins, 1990) or solely (Duncan, 1993) dependent on what the animal feels more than its response. Animal welfare is currently a major requirement for intensive poultry production. Beak trimming, stocking density, free access to feed, heat stress, and air pollutants became important issues, which are regulated in several countries. At the same time, the lack of effective assessments of animal welfare represents a great difficulty for the establishment of welfare regulations, and for the evolution of animal welfare knowledge *per se*.

Dawkins (2003) summarized animal welfare concerns on in two questions: *"Are the animals healthy?"*, and *"Do they have access to what they need?"* Whereas the first question is relatively easy to answer, the second one has a certain level of complexity, as it involves concepts which are not very well understood under the engineering standpoint, because they cannot be straightforwardly measured. On the other hand, these issues are transversal to different fields of knowledge (Animal Science, Physics, Veterinary Medicine, etc.), which need to exchange ideas in order to find the way forward.

Beyond definitions of welfare, remains the issue of how it is assessed. European animal welfare administrators and academics accepted behavioral needs as a kind of doctrine. In the United States, issues related to animal behavior, physiology, the external appearance of animals, ways of expressing emotion, learning processes, and behavioral needs are still being discussed. Research and interpretation concerning farm animal perception and cognition are still needed in order to be better understood (Albright, 2006).

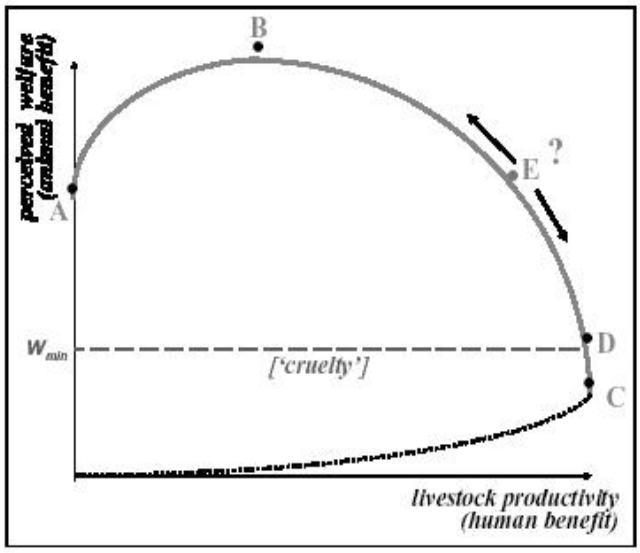
The approval of legislation regulating animal production in England and in the European Union has been a complex process (Ewbank, 1988), and similar legislation has been proposed by animal welfare groups in the United States and other export countries. A growing number of American agricultural commodity groups have developed guidelines and codes of practice on animal welfare. Guides voluntarily produced by the processing industry provide good examples of the ethical establishment of priorities in animal care and handling, as well as in the self-controlling nature of industry. In order to understand the regulations and the limits of their application, it is necessary to provide definitions to specific terms, as follows:

1. Cruelty is defined as being indifferent to pain or suffering;
2. Producer-caused animal suffering has been categorized in three areas as:
   - Neglect: failing to provide an animal with a vital requirement, such as food, water, or shelter;
   - Abuse: willfully harming an animal with an instrument of harm; and
   - Deprivation: limiting an animal's freedom or preventing an animal from associating with others of its kind (Ewbank, 1980).
3. The five freedom are expressed as:
   - Freedom to express natural behavior
   - Freedom of not experiencing hunger or thirst
   - Freedom of illnesses
   - Freedom of movement
   - Freedom of not experiencing fear or threat

Most humane societies are able identify animal suffering, and proceed legal prosecution. Cases of deprivation are difficult to understand or resolve, as they involve the denial of certain needs of the animal's environment. In some cases, these needs have not been definitely established (Albright, 2006). The Brambell Report (1965), one of the first publications on the well-being of animals, states that farm animals can suffer, and that they have behavioral needs. Further research and interpretation concerning farm animal perception and cognition are still needed worldwide.

Meanwhile, economists try to understand the impact of welfare issues on trade and producer's profit. Figure 1, adapted from McInerney (2004a), shows how to find the appropriate point where the use of welfare principles may be translated into an added value to poultry.

Natural welfare (A) in Figure 1 is the point where the animal feels free to act , using the same feeding patterns, social grouping, mating behavior, rearing young, establishment and maintenance of maintaining territory, aggression and imposing social dominance (Eath & Keeling, 2003) as in nature, which is clearly distinct from domestication and commercial production. Maximal welfare (B) is understood as the best condition



A= Natural welfare ; B= Maximal welfare; C= Welfare breakdown; D= Minimal' welfare; E= Appropriate' welfare

Figure 1 - Conflicts and choices between animal welfare and productivity. (Source: Edwards, 2004a)

attainable offered within the environment of domestication. Apart from some restrictions on natural behavior, the best possible food, shelter, space, physical comfort, health, safety, social interaction, etc. are provided. (McInerney, 2004a; Edwards, 2004b). Minimal welfare point (D), from the human standpoint, is where the major trade-offs are made between animal welfare and human interests, and the husbandry conditions are at the lowest acceptable limit. This point may indicate the boundary of cruelty. Appropriate welfare point (E) is determined through human preferences, and some trade-offs are made between animal welfare and meeting human interests. Animal response depends on the management adopted by the farmer. This means the anima have no choice, even in terms of time of slaughter. According to McIrney, animals have no possibility of making any choices..

From the standpoint of economic analysis, McInerney (2004b) defines farm animals as simply one of the resources employed in the economic activity of livestock production – an activity driven by the economic forces and incentives of human food supply. In particular, they are a resource classified within the *capital* category – either as *working capital* (laying hens), goods in progress (broilers), or *investment capital* (grandparent broiler stock). The key point is that they are subjected to the same considerations as any other production input. Their value and importance is explicitly derived from what they contribute to the economic output of the production process; and the care they receive is logically determined by what is necessary to sustain productivity at the appropriate level during the appropriate period, in order to obtain maximum returns from the input.

WELFARE, LEGISLATION AND RIGHTS

Regarding strictly the legislation on animal protection, the first known law was voted in the Massachusetts Bay colony, United States, in 1641. This law stated that nobody could exercise tyranny or cruelty to any animal, which was a helper in human tasks. Another pioneer legislation instituted to protect animals against cruelty was adopted in France, in 1850, and proven cruelty to animals could result in fines or detention. Law, according to the law researchers, is based on habits and traditions; however, laws are made to provide for every demand, and not for specific demands of a specific need (Martins, 2002). *Therefore, how could it be possible to establish the limits to animal's rights without knowing exactly which their well-being needs are? And also, as the rights are established, how to ensure them, and how to proceed in order to protect them?* There are no definite answers to these questions.

The first initiative in the Brazilian federal legislation to prohibit animal abuse and cruelty was issued in 1924, prohibiting public fights of bulls and/or birds, or any other attitude that could cause visible pain or suffering to animals. In 1934, the Brazilian federal legislation declared that all animals were protected by the State, but the few regulations on this matter were not known or obeyed by the general public, or even enforced by the government. In 1998, with the Brazilian Constitution revision, all matter related to fauna, flora, etc. (including domestic animals) was related to environmental issues. This generality led to the need of specific bill of law to aid the organization of regulations and procedures relative to animal rearing, transport, and other matters related to the agribusiness. However, Brazilian legislation is obsolete in the view of international market demands for new actions.

In 1978, UNESCO issued Universal Declaration of Animal Rights, which text starts asserting that all animals have rights. Husbandry conditions described in the text leave producers broadly comfortable with how animals are managed. These conditions correspond to an overall image of the desired or appropriate welfare standard accepted in our society. It represents the economic optimal position as defined in its broadest sense.

In the animal welfare movement, there is concern on consciousness of suffering (Harrison, 1964; Dawkins, 1980; Singer, 1990; Mason & Singer, 1990; Fox, 1994). Animal welfare activists assume that animals may be conscious of suffering as if the structure of their nervous system or their reactions to stimuli were similar of those in humans. The reactions of farm animals to stimuli of pain or fear are expressed as follows, according to Baker (1948):

- the struggle to escape,
- the contortion of parts of the body, especially the face,
- the production of sounds that are unusual in the ordinary course of life, and that are either loud or piercing.

The concept of minimal welfare is practically the most amenable to definition and specification, as its standards are embodied in much the formal legislation and related legal instruments designed to safeguard animal welfare. Below this minimal standard, the

animals are regarded as being subject to cruelty. This is the boundary beyond which the exploitation of animals would be regarded universally in society as being unacceptable. In this aspect, the following questions need to be answered: *What is the distinction between animal welfare and animal rights?* Animal welfare usually reflects people's concern for the humane treatment of animals, and it is regarded as more representative of the mainstream of society. Today, animal welfare appears to have obtained growing support from society at large. In contrast, proponents of animal rights hold that animals must not be exploited in any manner. Animal rights advocates believe that animals have basic rights, such as to be free from confinement, pain, suffering, use in experiments, and death for reasons of consumption by other animals (including humans).

Thus, animal rights extremists oppose to the use of animals for food, for clothing, for entertainment, for medical research, for product testing, as seeing-eye dogs, and as pets. Currently, animal rights doctrine is essentially philosophical, anti-vivisectionist, vegetarian, pro-activist, moralistic, and generally urban-based (Albright, 2006). In a radical way, animal rights proponents believe that humans have evolved to a point where they can live without any animal products, such as meat, milk, eggs, honey, leather, wool, fur, silk, or other animal byproducts. Nevertheless, it is clear to the average consumer that it is not necessary to the animal to experience either suffering or pain during the production cycle.

Welfare Assessment

Animal welfare depends on how the animal may perceives its living environment, taking into account not only the physical aspects of the environment, but the social aspects as well. Several welfare indicators may be used to assess welfare, such as health (mortality, mobility, and level of injuries); management (which type of rearing is offered to the flock); physiological responses to stress (respiratory rate, body temperature, variation in cortisol levels), and ultimately meat quality (pH1 and pHu), as stated by Chevillon (2000).

Behavioral responses are, however, are the most pertinent indicators of the well-being of an animal. Animals may also express their well-being through vocalization under certain specific management or environmental situations (Le Neindre *et al.*, 2004). According these authors, monitoring animals for welfare assessment may include a wide spectrum of experimental measurements, involving, for instance, rearing techniques associated to recording of specific responses, such as vocalization, postural expressions, etc. Due to its complexity, only by applying a multidisciplinary approach will the assessment of animal welfare be agreed and accepted by the academic community.

Anther critical point is related to specific practices, such as beak trimming, which is generally regarded as cruelty, but it is still not well known scientifically. Persyn *et al.* (2004) lead a research which objective was to comparatively quantify feeding behavior of laying hens submitted or not to beak trimming, which could reveal information for management or design decisions leading to enhanced animal welfare. By using electronic measurement system and computational algorithm developed by Xin *et al.* (1994), feeding behavior of poultry, including the number of meals, meal size, meal duration, ingestion rate, and meal intervals, was quantified. The collection of such behavioral information represented an attempt toward searching for an objective, quantitative, and non-invasive means to measure animal welfare, which continues to challenge both the academic community and the animal industry. The following conclusions were drawn from the study on the feeding characteristics of 18 laying hens, submitted (BT) or not (NT) to beak trimming:

- Both group of hens showed similar daily feed use and meal size. However, NT and BT hens displayed some subtle differences in their feeding dynamics. Specifically, the BT hens spent more time at the feeder (3.3 h/d *vs.* 2.0 h/d), coinciding with a slower ingestion rate of 0.43 g/min-kg 0.75 *vs.* 0.79 g/min-kg 0.75 for the NT hens, and shorter time intervals between meals (101 s *vs.* 151 s);
- Beak trimming seems to have an impact on the way the hen ingests feed, as evidenced by the feed pecking patterns and the particle distribution in the residual feed (larger particles for the BT birds);
- Residual feed for the BT hens tended to have a lower content of crude protein, phosphorus, magnesium, and potassium, but similar values of calcium, sodium, and metabolic energy content.

The results demonstrate the adaptability of the hen to beak trimming in terms of achieving its daily feed/energy intake by varying its ingestion dynamics or pattern. The authors mention that more data of this

nature are needed to better understand and to quantify the potential impacts of management practices on hens, and ultimately to ensure their welfare due to the beak trimming.

In the United Kingdom, guidelines for light exposure in poultry production are imposed or recommended by welfare organizations, such as the Royal Society for the Prevention of Cruelty to Animals and the Farm Animal Welfare Council, major supermarket retailers, and the Ministry for Agriculture, Fisheries, and Food. They usually specify a minimum luminance (20 lux) and a minimum length for the dark period. No consideration is given to the light color or temperature, its variation around the building, or flicker features.

Vision in the progenitor species of poultry was presumably adapted to the range of light environments that prevailed in their natural habitats. Both spectral composition and intensity in these habitats would have affected the availability and quality of visual information about the location and type of food; the identification and intent of conspecifics and the detection of predators; and cues for navigation and territorial recognition. When poultry were housed indoors, the relative importance of this information changed. First, recognition of another birds intent rather than their identification is potentially more useful within a large flock (on litter) if futile aggression is to be avoided. Secondly, the unnaturally large flocks that are closely confined in buildings lacking readily identifiable visual cues may mean that social groups within distinct territories can only be established with difficulty, even if they are desirable or necessary. Thirdly, the ready availability of feed and water overcomes the need to locate these sources. Thus, the design criteria for the light environment of poultry houses should be focused on the problems arising from large scale husbandry rather than the requirements of small flocks of free-range reared poultry.

Whether or not natural light should be used in environments is a central question; the proposition was rejected by the early pioneers of intensive poultry production. Prescott & Wathes (2001) proposed that light quality and intensity in a poultry house should:

- promote high levels of production and reproduction;
- allow the development of normal vision and eye morphology during rearing;
- satisfy preferences that are highly motivated; and
- enable a bird to carry out those visually mediated behaviors that are consistent with good welfare.

These requirements may differ from usual commercial practice, in which normally white light or low intensity is employed uniformly throughout the poultry house. Given the limited knowledge on poultry vision and on the utilization of visual information in large commercial flocks, a new scheme for broilers and group-housed hens could incorporate pools of bright light for feeding and drinking, and a dim zone for resting with a dawn and dusk, while specific radiation should probably be provided for breeders and turkeys. This would satisfy the principle that the light environment of a poultry house should be designed around visual abilities and visually-mediated behaviors, as well as production criteria, thereby satisfying both the farmer and his fowl. (Prescott & Wathes, 2001)

VOCALIZATION OF ANIMALS AS ASSESSMENT OF WELFARE

In general, experimented producers are able to perceive flock welfare by listening carefully to birds since the first week of rearing. Measurement of vocal expression of animals may be a reliable source of response to their emotional state or behavioral pattern (Crowell & Comuzzi, 1993; Weary & Fraser, 1995; Schrader & Todt, 1998; Mulligan *et al.*, 2002). The advantage of understanding the animal vocalization lies in the fact that it is a non-invasive technology, and very objective. Relating it to real-time welfare pattern information in may allow meaningful changes in the rearing environment.

New techniques of sound measurement and analysis can classify specific noises with precision. The major challenge is to understand the meaning of a noise emitted under certain circumstances, such as fear, pain, etc. Manteuffel *et al.* (2004), after several attempts to reduce errors, were able to successfully classify specific sounds. Chickens in general have a large repertoire of vocal calls. Approximately thirty distinct sounds were detected in both young and adult fowls by several authors (Collias & Joos, 1953; Guhl, 1968; Wood-Gush, 1971; Huber & Fölsch, 1978; Wennrich, 1981). Recent studies using modern sound interpretation tools include numerical analysis measured in specific situations, and if associated to known parameters, may allow welfare assessment. In a study with two layers genetic lines, Zimmerman & Koene (1998) exposed hens to frustration and feeding compensation. Results showed that feed restriction resulted in different specific vocalization differing in both lines (White Leghorns® and Brown Warren®), and

showed that the response of feeding restriction may be distinct in different genetics. Brown Warren® hens reacted with a crescent calling associated to an increase in locomotion, while White Leghorns® presented higher frequency and repetition as compared to those found by Collias (1987).

Several authors reported interesting findings on calling recordings of hens and fowl caused by restriction of feed and dust-bathing (Wood-Gush, 1972; Mills & Wood-Gush, 1983; Schenk *et al.*, 1983; Zimmerman & Koene, 1998). Stressful environments may increase occurrence of vocalization. According to Zimmerman & Koene (1998), when female broiler breeders are not able to nest their eggs by three consecutive days, their afflictive calls are distinct from others that do not show this need.

A study on social isolation of White Legorn® 12-day-old chicks showed that the physical spectrum of stress calls, characterized by the amount of energy input, decreased in duration and frequency of calls up to 0.4s when the birds were isolated inside the anechoic chamber[2] (Marx *et al.*, 2001). Another type of vocalization was registered when two birds were put together inside the same chamber, indicating that there occurred social stress when seeking contact with peers. In adult birds, sounds emitted when they feel hunger and fear are dependent on their social context and the specific presence of other birds (Karakashian *et al.*, 1988; Evans & Evans, 1999).

Behavioral Analysis as an Indicator of Welfare

Animal behavior was previously defined as merely the movements made by a living organism. However, a series of responses, such as signals in the form of sounds and noise, change in color and odor, and productivity, may be understood as animal expressions, which are certainly not characterized as movement (Costa, 2003).

The choice animals make when facing diverse environments, and the amount of stress shown when making those behavioral choices may eventually indicate whether or not they have actual access to their needs (Dawkins, 2003). One way to record specific behavioral response is using video cameras, which do not interfering in their normal behavior by using remotely controlled recording. Image-based bird behavior analysis has other research implications as well. Images can be used to develop time profiles of bird activity (movement, response to ventilation, huddling, etc.), as well as to compare activity levels in different sections of the house. Time profiles of broiler activity can contribute to improve feeder and drinker design, and to enhance distribution of air through ventilation in order to provide more uniform comfort.

Studying the aversion of fowls to ammonia concentration in the rearing environment, and using video camera images, Wathes *et al.* (2002) showed that the preference for social contact seemed to overcome any individual's desire for fresh air. Chronic exposure to ammonia may compromise animal health, and the findings of these authors demonstrate that intensively-housed poultry do not always make short-term choices that are necessarily in their long-term interests. Presumably, the ancestors of the domestic fowl were not exposed to high concentrations of ammonia, and therefore did not evolve adaptive mechanisms to limit their exposure to this noxious gas. Poultry farmers thus have a heavy responsibility to provide fresh air in livestock buildings, since their animals may not recognize that ammoniated atmospheres are harmful, and cannot always take corrective actions.

The same authors studied the interaction between light exposure and ammonia concentration, and their findings are shown in Table 3. They concluded that the atmospheric choices of housed animals can be revealed by the method of simple choice, escapism, which is also suitable for other components of an animal's environment, such as temperature and light. It is necessary to understand the physiological and behavioral mechanisms involved in these choices, as well as to measure the strength of motivation for fresh air. Integration of this new criterion into a scheme of enclosed environmental management will probably give rise new dilemmas, since manipulation of one aerial pollutant often affects another, equally important, component, due to its inter-relation complexity.

Table 3 - Mean occupancy (%) in each ammonia concentration.

Lighting Intensity	Ammonia Concentration (ppm)			
	0	10	20	40
Bright	37	41	15	6
Dim	65	25	9	2

Source: Prescott & Wathes (2001).

Electronic sensors have been used in both research and commercial settings for recording animal behavior among other uses, and giving support to data collection.

[2] Chamber with sound-proof characteristics.

A research developed for evaluating tools and strategy for assessing animal behavior was shown by Donát, (1991), who describes the power of new technologies, such as the use of video cameras and information technology for improving the efficiency in recording and analyzing animal behavioral responses with an accuracy never achieved before in behavioral studies. Korthals *et al.* (1992) studied the use of transponders for monitoring bio-energetic responses, and, by the use of electronic individual identification associated to microprocessor and video camera monitoring, the authors recorded accurate data related to feed consumption and behavioral responses in beef production.

Dusenbery (1985) demonstrated the feasibility of simultaneously observing 25 animals by using technology information associated to video camera images, describing the possibility of recording individual data and simultaneous animal movements. It was also possible and economically feasible to record data in real time. Hamrita *et al.* (1998) used a miniaturization of electronic devices to build up a bio-telemetric system for monitoring broiler body temperature. Although the recording of data was feasible, the results indicated the need of some degree of improvement in the electronic devices for continuous body temperature recording.

Due to new animal welfare requirements, it is necessary to develop non-invasive technology for behavior and welfare assessment, as well as the correlated methodology. In this sense, several authors have studied behavioral response of animal as a source of welfare information and assessment (Estevez *et al.,* 2003; Bizeray *et al.*, 2002; Pettit-Riley *et al.,* 2002; Estevez *et al.*, 2002). Behavioral patterns must be clearly related to certain degrees of welfare in order to be used as practical assessment tools by producers and technicians. Duncan & Mench (1993) proposed the use of behavioral response to identify suffering stages, particularly the presence of frustration, pain, and fever in various animal production systems.

The different types of responses of poultry to different suffering and stress degrees are still not well-known. Chickens under heat stress change their behavior to aid the maintenance of body temperature within normal limits. Behavioral adjustments may occur more rapidly and are less damaging than the physiological adjustments. In terms of social behavior, for instance, the frequency and the number of aggressive interactions, as well as the extension of social disturbances may be used to understand animal well-being. Several authors are investigating this field, and interesting results have already been found (Al-Awadi *et al.*, 1995; Martrenchar *et al.*, 2000; Marchant *et al.*, 2001; María *et al.* 2004;).

As physiological variables are not easy to be precisely measured under field conditions, behavioral responses studies have acquired increasing importance in the assessment of welfare of domestic animals.

Accessibility to feed and water, along with the lack of predators, may cause animals to move less when housed indoors, which reflects a change in its welfare pattern (Costa, 2003). In broiler production, Campos (2000) considers the identification of the factors that may influence chicken-welfare related issues, such as several types of stress (Snowdon, 1999), is important.

When Estevez *et al.* (2003) studied the aggressive behavior dynamics of layers of different weights and groups when there was evident competition for feed, and verified that group size had a negative influence on aggression reactions, due to survival considerations and avoidance of larger group conflicts., Olsson *et al.* (2002) showed that dust-bath behavior in chickens is part of their socialization process, which is usually synchronized by a leader starting and been imitated by the others (Olsson & Keeling, 2005). Dust bathing was considered by the authors an interesting welfare assessment for broilers reared indoors, depending otherwise on the bedding material.

More precise welfare assessments need to consider specific behavioral response of genetic lines, as different lines react differently when facing environmental challenges (Keer-Keer *et al.*, 1996; McGary *et al.*, 2003).

Some specific behavioral responses may also cause productive losses; for instance, excessive preening may damage feathering. Eicher & Wechsler (1997) found that bedding material may also influence foraging and dust bathing. According to their results, when foraging behavior increases, preening proportionally decreases. Pettit-Riley *et al.* (2002) found that the effects of growth rate and access to perch in the behavioral aggressive response of broiler were expressed as increase in aggressive behavior, according to the age and stocking density, as well as increase in the use of perches by broilers. These studies suggest many behavioral responses are related, making their analysis and modeling more complex.

The complexity of building environment inside poultry houses was studied by María *et al.* (2004), who showed that locomotion activities decrease due to stressing rearing conditions, leading to occurrence of

laminitis (Weeks *et al.*, 2000). It is of common sense that animal behavior is highly influenced by the housing environment. Graves (1982) defines the behavior as a *window* between the living organism and its surroundings, in which climatic and social variables may positively or negatively influence biological, morphological, and/or physiological mechanisms.

The understanding of behavioral responses may establish an efficient communication between animals and rearing conditions, promoting reduction in eventual production losses.

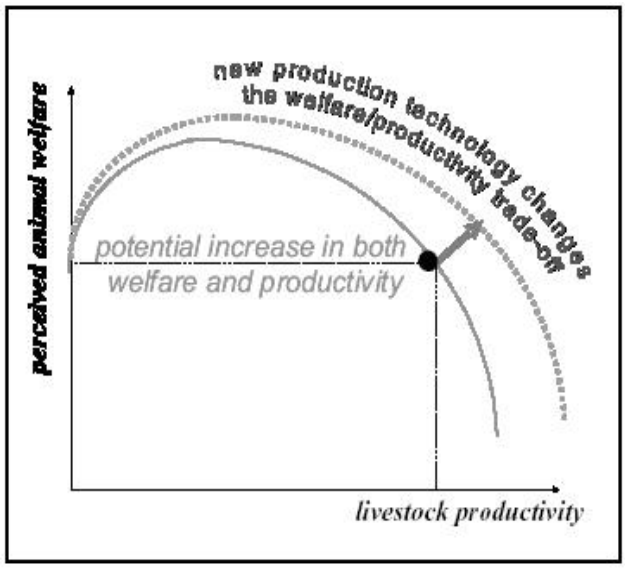


Figure 2 - Improving both welfare and productivity using welfare / productivity trade-off. (Source: Edwards, 2004a).

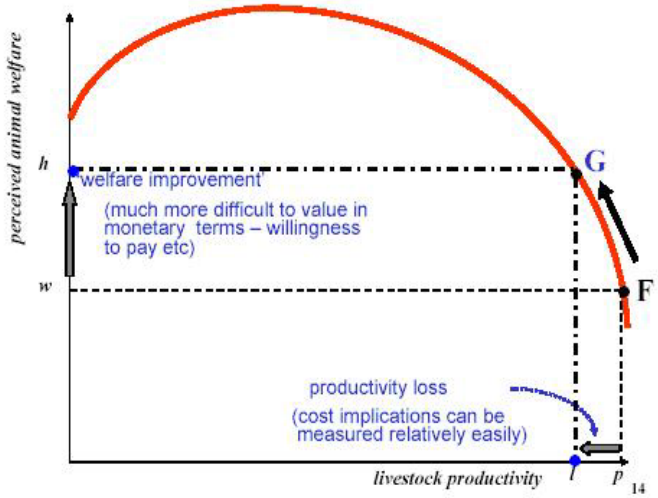


Figure 3 - Productive loss as a function of welfare increase and the ideal point that producer may be willing to reach while consumers may want to pay for it. Source: McInerney (2004b).

CONCLUSIONS

Animal rights and animal welfare have biological, cultural, economic, social, philosophical, emotional, political, legal, and political dimensions. Hundreds of organizations are active in some aspects of these issues, and the viewpoints range from animal rights advocates to livestock producers. The animal welfare issue has not been taken seriously by several poultry meat import countries, yet. Today, the animal rights movement needs to come closer to commercial and consumers needs, and a future balance must be achieved in order to fulfill the food demands of a growing world population.

REFERENCES

Albright JL. Animal welfare and animal rights .Phi Kappa Phi J. 1986; 66:34-37.

Albright JL. Animal welfare issues: a critical analysis. West Lafayette: Purdue University; 2005. 17p. [Acessed Feb. 2006]. Available from: URL: http:// www.purdue.edu.

Al-Awadi AA, Husseini MD, Diab MF, Al-Nasser AY. Productive performance of laying hens house in minimal shade floor pens and laying cages under ambient conditions in hot arid regions. Livestock Production Science 1995; 41:263-269.

Baker JR. The scientific basis of kindness to animals. Polter Bar (UK): Universities Federation of Animal Welfare; 1948. p. 3-11.

Bastianelli D. A produção de frangos diferenciados na França (Mercado, aspectos organizacionais e regulamentares). In: Anais da Conferência APINCO de Ciência e Tecnologia Avícola, SP; 2001; Campinas: FACTA; 2001. p.235-254.

Bizeray D, Estevez I, Leterriera C, Faurea JM. Effects of increasing environmental complexity on the physical activity of broiler chickens. Applied Animal Behaviour Science 2002; 79(1):27-41.

Brambell FWR. Report of the technical committee to inquire into the welfare of animals kept under intensive livestock husbandry systems. London: HMSO; 1965. (Cmnd. 2836).

Campos EJ. O comportamento das aves. Revista Brasileira de Ciência Avícola 2000; 2(2):93-113.

Council for Agricultural Science and Technology - CAST. Food from animals: quantity, quality and safety. Ames: Iowa; 1980. (Report, 82).

Council for Agricultural Science and Technology - CAST. Scientific aspects of the welfare of food animals. Ames: Iowa; 1981. (Report, 91).

Chevillon P. O bem-estar dos suínos durante o pré-abate e o atordoamento. I Conferência Virtual sobre Qualidade de Carne

Suína. [Acessed: Feb., 2005] Available from: www.embrapa.gov.br. 2000.

Collias NE, Joos M. The spectographic analysis of sound signals in the domestic fowl. Behaviour 1953; 5:75-188.

Collias NE. The vocal repertoire of the Red Jungle-fowl: a spectrographic classification and the code of communication. Condor 1987; 89:510–524.

Costa MJRP. Princípios de etologia aplicados ao bem-estar das aves. In: Anais da Conferência Apinco de Ciência e Tecnologia Avícola; 2003; Campinas: FACTA; 2003. p.169-177.

Crowell D, Comuzzie DK. Baboon vocalizations as measures of psychological well-being. Laboratory Primate Newsletter 1993; 32: 5–6.

Dawkins MS. Animal suffering: the science of animal welfare. London: Chapman and Hall; 1980.

Dawkins MS. From an animal's point of view: Motivation, fitness and animal welfare. Behavioral and Brain Sciences 1990; 13:1-9.

Dawkins MS, Cook PA, Whittingham MJ, Mansell KA, Harper AE. What makes free-range broiler chickens range? In: situ measurement of habitat preference. Animal Behaviour 2003; 65:01-10.a.

Dawkins MS. Behaviour as a tool in the assessment of animal welfare. Zoology 2003;106:383-387.b.

Donát P. Measuring Behavior: The Tools and the Strategies. Neuroscience & Biobehavioral Reviews 1991; 15:447-454.

Duncan IJH, Petherick JC. The implications of cognitive processes for animal welfare. Journal of Animal Science 1991; 69:5017-5022.

Duncan IJH, Mench JA. Behaviour as an indicator of welfare in various systems. Basic Biology and Welfare. Alternative Housing Systems 1993; 7:69-76.

Duncan IJH. The science of animal well-being. USDA/NAL. Animal Welfare Information Center Newsletter 1993;4 (1) p.132.

Dusenbery DB. Using a Microcomputer and Video Camera to Simultaneously Track 25 Animals. Computacional Biology Medicine Veterinary 1985; 15(4):169-175.

Eath RBD, Keeling LJ. Social discrimination and aggression by laying hens in large groups: from peck orders to social tolerance. Applied Animal Behaviour Science 2003; 84:197-212.

Edwards JD. The role of the veterinarian in animal welfare: a global perspective. In: Global conference on animal welfare: an OIE initiative; 2004; Paris. p.27-32(a).

Edwards JD. The role of the veterinarian in animal welfare - A global perspective. In: Global Conference on Animal Welfare: an OIE initiative; 2004; feb. 23–25; Paris. p.27-32(b).

Eicher BH, Wechsler B. Feather pecking in domestic chicks: its relation to dustbathing and foraging. Animal Behaviour 1997; 54:757-768.

Estevez I, Newberry RC, Keeling LJ. Dynamics of aggression in the domestic fowl. Applied Animal Behaviour Science 2002; 76:307-325.

Estevez I, Keeling LJ, Newberry RC. Decreasing aggression with increasing group size in young domestic fowl. Applied Animal Behaviour Science 2003; 84:213-218.

Evans CS, Evans L. Chicken food calls are functionally referential. Animal Behavior 1999; 58:307–319.

Ewbank R. Behavior and behavior-related problems in farm animals. In: Symposium on Role of Animal Behavior in Agriculture at 72nd Annual Meeting of American Society of Animal Science; 1980; Ithaca, NY.

Ewbank R. Animal welfare. In: Management and welfare of farm animals: the UFAW handbook. 3rd ed. London: Bailliere Tindall; 1988.

Fox MW. Farm Animals: husbandry, behavior and veterinary prractice: viewpoints of a critic. Baltimore: University Park Press; 1994.

Graves HB. Behavioral responses of poultry (chickens) to management systems. In: Proceedings of the Symposium of Management of Food Producing Animals; 1982; West Lafayiette: Purdue University. v.2, p.122-138.

Guhl AM. Social behavior of the domestic fowl. Transactions of the Kansas Academy Science 1968; 71:379–384.

Hamrita T K, Van Wicklen G, Czarick M, Lacy M. Monitoring poultry deep body temperature using biotelemetry. ASAE. Applied Engineering in Agriculture 1998; 14:327-331.

Harrison R. Animal machines: the new factory farming industry. London: Vincent Stuart; 1964.

Heier BT, Hogasen HR, Jarp J. Factors associated with mortality in Norwegian broiler flocks. Preventive Veterinary Medicine 2002; 53(1-2):147-158.

Hellmeister FP, Menten JFM, Silva MAN, Coelho AAD, Savino VJM. Efeito de genótipo e do sistema de criação sobre o desempenho de frangos tipo caipira. Revista Brasileira de Zootecnia 2003; 32(6 suppl.2):1883-1889.

Huber A, Folsch DW. Akustische Ethogramme von Hühnern: die Auswirkung unterschiedliche Haltungssysteme. Stullgar: Birkhaüser Verlag; 1978. 50 p.

Karakashian SJ, Gyger M, Marler P. Audience effects on alarm calling in chickens (*Gallus gallus*). Journal of Comparative Psychology 1988; 102:129–135.

Keer-Keer S, Hughes BO, Hocking PM, Jones RB. Behavioural comparison of layer and broiler fowl: measuring fear responses. Applied Animal Behaviour Science 1996; 49:321-333.

Korthals RL, Mcdonald TP, Eigenberg RA. Experiences with transponders for monitoring bioenergetic responses. Charlote: ASAE Meeting Presentation; 1992. (Paper number, 923010).

Le Neindre P, Guémené D, Arnould C, Leterrier C, Faure JM, Prunier A, Meunier-Salaün MC. Space, environmental design and behaviour: Effect of space and environment on animal welfare. In: Global conference on animal welfare: an OIE initiative; 2004; feb.23-25; Paris. p. 135-141.

Lima AMC, Nääs IA. Evaluating two systems of poultry production: conventional and free – range. Brazilian Journal of Poultry Science 2005, 7(4):215-220

Manteuffel G, Schön PC, Puppe B. Vocalization Analysis as a tool for welfare assessment in farm animals. Where are we and where do we go? Applied Animal Behaviour Science 2004; 88:163–182.

Marchant JA, Andersen HJ, Onyango CM. Evaluation of an imaging sensor for detecting vegetation using different waveband combinations. Computers and Eletronics in Agriculture 2001; 32:101-117.

María GA, Escós J, Alados CL. Complexity of behavioural sequences and their relation to stress conditions in chickens (*Gallus gallus domesticus*): a non-invasive technique to evaluate animal welfare. Applied Animal Behaviour Science 2004; 86:93-104.

Martins RF. Direito dos Animais. Revista Panorama da Justiça 2002; 5(35):83.

Martrenchar A, Hunnic D, Cotte JP, Boilletot E, Morisse JP. Influence of stocking density, artificial dusk and group size on the perching behaviour of broilers. British Poultry Science 2000; 41:125-130.

Marx G, Leppelt J, Ellendorff F. Vocalisation in chicks (*Gallus gallus domesticus*) during stepwise socialisolation. Applied Animal Behavior Science 2001; 75:61–74.

Maschio JJ. Os animais: Direitos deles e ética para com eles. [Acessed feb. 2006]. Available from: http://jus2.uol.com.br/doutrina/texto.asp?id=7142.

Mason J, Singer P. Animal Liberation. 2nd ed. New York: New York Review Book; 1990.

McGary S, Estevez I, Russek-Cohen E. Reproductive and agressive behaviour in male broiler breeders with varying fertility levels. Applied Animal Behaviour Science 2003; 82:29-44.

McInerney J. Animal welfare, economics and policy: report on a study undertaken for the farm & animal health economics. Londres: Division of DEFRA; 2004. 68p(a).

McInerney J. Animal welfare, economics and policy. DEFRA Report. February 2004; 80p(b).

Mench JA, Ari VT. Farm animal welfare. American Scientist 1986; 74:598-603.

Mills A,Wood-Gush DGM. Genetic analysis of frustration responses in the fowl. Applied Animal Ethology 1983; 9:88–89.

Mulligan BE, Baker SC, Murphy MR. Vocalizations as indicators of emotional stress and psychological well being in animals. Animal Welfare Informative 2002; 5:3–4.

Nääs IA. Pontos críticos no manejo que afetam o bem-estar animal: realidade brasileira. In: Anais da Conferência Apinco de Ciência e Tecnologia Avícola; 2005; Santos. Campinas: APINCO; 2005. p. 61-66.

Olsson IA, Duncan IJH, Keeling LJ, Widowski TM. How important is social facilitation for dustbathing in laying hens. Applied Animal Behaviour Science 2002; 79:285-297.

Olsson IA, Keeling LJ. Why in earth? Dustbathing behjaviour in jungle and domestic fowl reviewed from Tibergian and animal welfare perspective. Applied Animal Behaviour Science 2005; 93(3-4):259-282.

Persyn KE, Xin H, Nettleton D, Ikeguchi A, Gates RS. Feeding Behaviors of Laying Hens With or Without Beak Trimming. Transactions of the ASAE, 2004; 47(2):591-596.

Pettit-Riley R, Estevez I. Effects of density on perching behaviour of broiler chickens. Applied Animal Behaviour Science 2001; 71:27-140.

Pettit-Riley R, Estevez I, Russek-Cohen E. Effects of crowding and access to perches on aggressive behaviour in broiler. Applied Animal Behaviour Science 2002; 79:11-25.

Prescott NB, Wathes CM. Light, Poultry and Vision. In: Proceedings of the 6th International Symposium; 2001; may 21-23; Louisville, Kentucky. p.696-702.

Schenk PM, Meysser FM, Limpens HJG. Gakeln als Indikator fur Frustration bei Legehennen. KTBL-Schrift 1983; 299:65-80.

Schrader L, Todt D. Vocal quality is correlated with levels of stress hormones in domestic pigs. Ethology 1998; 104: 859–876.

Singh CV, Kumar D, Singh YP. Potential usefulness of plumage reducing Naked Neck (Na) gene in poultry production at normal and high ambient temperatures. World´s Poultry Science Journal 2001; 57(2):127-156.

Snowdon CT. O significado da pesquisa em comportamento animal. Estudo de Psicologia 1999; 4(2):365-373.

UNESCO. Declaração Universal dos Direitos dos Animais. 1978. [Acessed Feb., 2006]. Available from: http://www.aprodan.hpg.ig.com.br/univer.htm.

Wathes CM, Jones BJ, Kristensen HH, Jones EKM, Webster AJF. Aversion of Pigs and Domestic Fowl to Atmospheric Ammonia. Transactions of the ASAE 2002; 45(5):1605-1610.

Weary DM, Fraser D. Calling by domestic piglets: Reliable signals of need? Animal. Behavior 1995; 50:1047-1055.

Weeks CA, Danbury TD, Davies HC, Hunt P, Kestin SC. The behaviour of broiler chickens and modification by lameness. Applied Animal Behaviour Science 2000; 67:111-125.

Wennrich G. Zum Lautinventar bei Haushühnern (*Gallus f. domesticus*). Berl Münch Tierärztl Wschr 1981; 94:90-95.

Wood-Gush DGM. The behaviour of the domestic fowl. Heineman: London; 1971.

Wood-Gush DGM. Strain differences in response to sub-optimal stimuli in the fowl. Animal Behavior 1972; 20:72–76.

Xin H, Berry IL, Tabler GT, Barton TL. Temperature and humidity profiles of broiler houses with experimental conventional and tunnel ventilation. Transactions of the ASAE 1994;10(4):535-542.

Ye W, Xin H. Thermographical quantification of physiological and behavioral responses of group-housed young pigs. Transaction of the ASAE 2000; 43(6):1843-185.

Zimmerman PH, Koene P. The effect of frustrative nonreward on vocalisations and behaviour in the laying hen, *Gallus gallus domesticus*. Behavior Processes 1998; 44:73–79.