Lohmann Information

Cuxhaven, April 2012

Prof. Dietmar Flock, Editor

Editorial

Whether you are a graduate student trying to finish your thesis and publications from it, busy with a demanding job, or already retired: we all have the same 24 hours a day and it is up to us to find a balance between essential work and regeneration of our energy. More than 7 billion people in the world offer unlimited opportunities to assist them in getting a balanced diet at a price which leaves some purchasing power for other goods and services to improve the quality of their lives.

In my younger years, I missed a lot of opportunities to learn as much as possible and just wanted to finish school as early as possible. After deciding what to study, and more so in graduate school, I realized that continued learning is not only a privilege, but also fun and helps to keep up with an ever changing world around us.

When we think of the global food chain, we should not forget that people "need" more than enough to eat. You probably heard expressions like **"panem et circenses"** in Latin or **"der Mensch lebt nicht vom Brot allein"** in German. If you ask Wikipedia on the internet, you will find that ***"Bread and Circuses"****…was the basic Roman formula for the well-being of the population, and hence a political strategy unto itself…The phrase also implies the* ***erosion or ignorance*** *of civic duty amongst the concerns of the common man."*

We seem to have a similar problem in affluent countries with a lack of communication between modern food production, especially animal farming, and a general public which knows less and less about the "real world" of food production, but has strong opinions how to change it (back to what stage in history?). This was the focus of a recent symposium in Berlin, from which we include the first two papers in this issue. Some of our readers have asked already for the second part of Don Bell's analysis of field records with his results and comments on the variability of feed efficiency of modern laying hens. Also in response to questions from egg producers, Dr. Thiele explains how egg weight is determined by a combination of genetic potential and optimized farm management. The next two papers inform about turkey breeding and management opportunities to minimize foot pad dermatitis (FPD). Not for food, but for fun, is the last paper, which shows how horse breeding has evolved since their use as draft animals has been eliminated.

Most of our readers are primarily interested in poultry, many of them members of the World Poultry Science Association (WPSA). If you are, you will be aware of and perhaps planning to attend the World Poultry Congress in Salvador, Bahia, Brazil, in August. The European Federation of the WPSA currently has 10 Working Groups, and the Asian Pacific Federation has 4 Working Groups, which connect specialists from all over the world to exchange timely information. These meetings as well as Branch meetings offer excellent opportunities to keep up with developments around the world. By keeping up with meetings and publications across species barriers and topics, you may pick up fresh ideas and reduce the risk of falling behind after early specialization.

Lohmann Information is published by:
Lohmann Tierzucht GmbH, Cuxhaven, www.ltz.de
Managing Directors: Hinrich Leerhoff, Prof. Dr. Rudolf Preisinger

LOHMANN TIERZUCHT

This issue of Lohmann Information offers the following papers as “food for thought”:

1. Lohmann Animal Health GmbH, a subsidiary of the PHW Group, has agreed to leave the responsibility for publishing Lohmann Information exclusively to Lohmann Tierzucht GmbH, a subsidiary of the EW Group. During the first 40 years, the focus of this publication was on animal and poultry nutrition, with editors **Dr. Gramatzki, Dr. Küther and Dr. Maria Seemann. Dr. Christian Plath**, Director Corporate Development in the recently formed holding Lohmann SE, presents the current focus of the company: **"A company Profile of Lohmann Animal Health"**.
2. **Prof. Dr. Reinhard Fries**, Meat Hygiene Institute, Veterinary Faculty of the Free University Berlin, gives a short summary of papers recently presented at a two-day symposium in Berlin with focus on the question **“Wellbeing of Food Animals and Current Keeping Techniques: what is acceptable and what goes beyond acceptability?”**. Proceedings with all papers will be published later this year (in German).
3. **Pastor Karl-Heinz Friebe** received special attention at this symposium with his presentation **“A Christian View on Intensive Animal Farming: Position of the Lutheran Church”**. We include a translation of his paper in full length and would welcome future contributions from other authors representing other religious groups.
4. **Donald Bell**, poultry extension specialist at the University of California, presents results of his analysis of extensive field records: **“Experiences with Lohmann Selected Leghorn (LSL- Lite) Layers: Feed Consumption and Conversion”**. The emphasis is on non-genetic sources of variation which should be controlled by farm management to achieve optimal economic results.
5. **Dr. Hans-Heinrich Thiele,** responsible for keeping management guides for all strains of Lohmann Tierzucht updated, reviews latest recommendations for managing pullets and laying hens to utilize their high genetic potential, with special attention to egg weight: **“Management tools to influence egg weight in commercial layers”**.
6. **Dr. Abd El-Wahab** recently completed his doctoral thesis at the Foundation Veterinary Faculty of the University Hannover. The paper **“Investigations on diet composition, litter quality and experimantal infection on the severity of foot pad dermatitis in young turkeys housed with or without floor heating”** is co-authored by six colleagues at five institutes who co-operated in a series of four experiments.
7. **Mr. Magnus Swalander**, Director of Global Genetics, Aviagen Turkeys, recently reviewed the breeding program of his company at the 6th Symposium of Working Group 10 (Turkey) of the WPSA. The Proceedings of this meeting were edited and published by Prof. Hafez, who kindly allowed us to reproduce it in this issue under the title “Balanced Breeding of Turkeys for Health and Welfare Traits”. Welfare traits have been receiving increasing attention in modern selection programs, but need to be supported by optimized management to answer concerns of welfare.
8. **Dr. Hanfried Haring**, former CEO and General Secretary of the German Equestrian Federation and President European Equestrian Federation, provides insight into a different world, involving a species which is seldom used as a source of meat and lost its traditional role as draft animal in agriculture and transportation: **“The changing role of horses in our society”** is focused on business aspects of top sports, but the vast majority of horses is kept by amateurs who have to understand the needs of the animals to enjoy their hobby.

With kind regards,

Prof. Dietmar Flock,
Editor

A Company Profile of Lohmann Animal Health

Christian Plath, Cuxhaven

Lohmann Animal Health is a well-known provider of feed additives for all animal species and avian vaccines. In feed additives, our special skills are based on a high degree of technical knowledge in the formulation of compounds that meet customer needs in terms of further processing and nutrition. In the vaccine business, Lohmann Animal Health is the global market leader in salmonella vaccines, making us a notable key player in the global prevention of foodborne zoonosis. In fact, we offer a range of products that no other single company can offer. Lohmann's biggest strength however is its comprehensive view on food animal production.

Our company was established 15 years ago from merging a pharmaceutical and a nutritional company both part of one of Europe's largest poultry meat integrators. In total we can rely on over 80 years of experience in food animal production and we learned to look at animal health from different angles simultaneously, not with a limited, isolated point of view. Our customers face many different challenges that are the result of the driving forces in the market: Economics, Quality & Safety, Sustainability and Animal Welfare. Our broad competences meet these challenges, all based on the common principle of prevention. Our overall mission and our portfolio are represented in a graphic we call the "Lohmann wheel":

Of course, this commitment has an effect on the way we further develop and market our products, i. e. on the decisions where, how and by which means we do so. For many companies in the pharmaceutical or chemicals and additives sector “animal health” is actually an additional business. But animal health means more than providing a cure. It means to protect animals, humans and the environment along the food animal production chain. The large meat producers are interested in comprehensive solutions knowing that not only price or sensorial properties, but also food safety and sustainable livestock management are considered “quality” in the eyes of the end customer. A holistic approach is the key to the future in this business. Lohmann Animal Health has this knowledge. It enables us both to advise our major customers on holistic and individual measures to optimize animal production and to offer them tailor-made services. The aim is to extend these two elements and to create a chargeable consultancy service called “Integrated Solutions”.

This project began four years ago, with the first phase concentrating mainly on ideas and development. The second phase, the commercialization of the consulting portfolio that was developed, will begin soon. The aim is for this service to become an important Lohmann “product”. The aim is to help major egg and poultry meat producers combat zoonosis and improve animal welfare. Further focal points are planned. Pilot projects are already running or are scheduled to start in 2012 with major customers in Europe and the USA, and additional pilot projects are planned for later in Latin America and Asia. Innovation is of very high importance in this scheme and must not be restricted to products, but also involve innovative thinking about livestock management in total and the interplay of different elements, e.g. nutrition, hygiene, vaccination. It is all connected.

Soon 8 billion people will have to be fed on our planet. Food is a human right and it requires intensive agriculture and animal husbandry. On the other hand food animal production has to fulfill new and additional requirements in order to meet these expectations. New ideas and tools are necessary. Lohmann Animal Health is known to follow an academic approach to innovation, rather than having our focus on shiny marketing. We already maintain a good network into the academia and intend to invest more in these relations, e.g. with an endowed professorship at the renowned Tierärztliche Hochschule Hannover, our dissertation price, scholarships and Centers of Excellence. We think the cooperation of industry, academia and the users is the best road to genuine innovation.

Our business is closely linked to food animal production which is increasingly in the public focus. Coverage on irresponsible use of antibiotics, dioxin contamination in feed or animal torture dominates the public perception, also shedding a bad light onto the “enablers”. We need to show that intensive animal production can very well be in accordance with welfare and sustainability and that our industry is not only supporting this idea but also is the driving force behind it.

Author’s address:

Dr. Christian Plath
Director Corporate Development
Lohmann SE
Heinz-Lohmann-Str. 4
27472 Cuxhaven, Germany

christian.plath@lohmann-se.de

Wellbeing of Food Animals and Current Keeping Techniques: what is acceptable and what goes beyond acceptability?

Reinhard Fries, Berlin

1. Introduction

Intensive animal farming, widely practiced in many countries, is criticized in Europe in connection animal welfare, environmental issues and food quality. Veterinary science is involved in many respects and challenged to find solutions, asking the right questions and pooling multidisciplinary expertise. Disciplines such as sociology, ethics, theology, behavioural sciences and genetics have to contribute, without forgetting economic implications.

The 12th Annual Meeting on **Hygiene of Meat and Poultry Meat** of the Veterinary Faculty, Freie Universität Berlin, focused on animal wellbeing. In this short overview, 21 presentations are briefly characterised and then put together to shape a picture of the overall subject from the author's point of view who served as chairman during the two-day program.

The individual contributions were in German and will be published as proceedings later this year.

2. Specific Issues

2.1. Genetics and breeding

Case study 1: Over decades, poultry breeding (Gallus gallus) has concentrated on productivity, i.e. tissue for human consumption with minimal by-products. The result is a highly favourable feed conversion. This approach has been efficient under the viewpoint of economical food production for a growing world population. Humans in affluent countries frequently keep a critical distance (Flock).
These specialised breeds need also attention with respect to (their) health problems.

Case study 2: The PSE- syndrome was long regarded as a quality phenomenon observed primarily during post mortem inspection. However, clinical observation reveals sudden death, necroses and degeneration of the long muscle of the back. Background is a genetic failure for the Ryanodine receptionist, which can be compensated with smooth and easy treatment along the whole line. In contrast, the fundamental solution would be an elimination of this defective gene from the animal stocks (Lahrmann).

This syndrome may also cause pain to the animal during lifetime. It may serve as an eye opener for situations, which have been misjudged over decades: PSE is also a pain loaded ante mortem factor.

2.2. Technology of the food chains

In Germany, roughly 300 million birds are processed yearly. Catching and transport of poultry is a precondition for slaughter, however, under the given situation, only with high technical investment.

Case study 3: In the 1990s, mechanisation of catching and transport (modules) was intensified including transport of the birds in the abattoir. These days, lesions such as bruises or fractures or even death rates are considered to be caused by catching and transport (Langkabel *et al.*).

2.3. Amputation

Case study 4: Sexual odour of boar carcasses is caused by androstenone and scatole. In a survey with veterinary students (about same age), scatole was more frequently detected than androstenone, independent from the gender of the person (Schneider and Gäng).

Case study 5: In Europe, roughly 100 million male piglets are castrated per year, traditionally without narcosis. This is criticized by animal welfare, calling for alternative solutions. Narcoses have limitations (inhalation may transfer agents, injection is possible), elimination of boar odour by breeding is expected

to reduce fertility, sexing of sperms to produce only females is still in its beginning (Lahrmann).
The Veterinary profession is supposed to care for animal wellbeing; In fact, pig castration as a problem has been raised by large distributors and not by the Veterinary profession.

Case study 6: Alternatives: Problems may be circumvented by suppression of gonad activity through immunisation. Atrophy of the testicles is clearly visible. However, a checking post is needed, which is a matter of another discussion (Bader Mielke).
In addition, any administration of a veterinary medicinal product may raise concerns with the consumers again.

2.4. Practical approaches

Food animal keeping is under critical observation, mainly in industrial countries. Lack of transparency from the agroindustry may well contribute to some sort of mistrust from the public. Here, several types of labelling may indicate a change of philosophy. Beyond the requirements from legislation, information is given about the special chain being sort of answer to the public.

Case study 7: Animal welfare label “chicken” (Gallus gallus) uses breeds with slower growth rate, longer life span, more space per animal and access to outdoors. It is not ecological farming in the sense of EU Regulation, but not the “industrial” breed commonly used either. Offered at an intermediate price, it is said to be accepted happily by consumers (Bachmeier).

Case study 8: A major swine company in Germany developed several labels, dealing with animal welfare, post mortem lesion interpretation and an animal health related “piglet passport” monitor the source and the circumstances at that farm (Mischok).

2.5. The role of legislation and supervision

Basic legal requirements for animal wellbeing are in effect. If adhered to, these requirements should assure that animals are kept properly according to animal rights requirements. Such “basic” rules are needed, but they may not reflect all relevant individual needs of an animal. It is difficult to guarantee appropriate conditions on all farms, however, the important role of authorities cannot be overestimated.

Case study 9: Cattle kept permanently outdoors cannot be handled easily. So, preparation for slaughter and the technical performance of processing raises problems. Outdoor shooting with bullets, shackling and hoisting with a tractor is a solution (Stenzel-Kaiser & Bucher).

Case study 10: Despite of relevant legal (static) requirements, the risk related approach (in this case, risk is non compliance with animal wellbeing) is possibly even more important. In such cases, change in keeping techniques, even closing down of the site, is an option (Hopp).

2.6 Animals in transport

Case study 11: Transporters are designed to fit the needs of animals in transport. However, also technical requirements (technical traffic rules and safety) are required, not always fitting together. Double decks for cattle are difficult because of the ceilings needed for the animals: The higher the truck, the higher the risk of traffic accidents. Another problem is the street control: These days, communication spreads easily, posts may be circumvented with an increase of transport time (Eggers).
As an alternative, control may happen at the place of start, with high efforts from the administration side.

Case study 12: Transport conditions may be best served by training and dialogue and using the fro and back principle of communication. Post mortem terminals may serve here as tools for data collection. Feed back to the farm may help to solve the problem at the site. Examples for poultry are given (Mischok).

2.7 Animals at the abattoir

Case study 13: Observing the stunning sites and the facilities for slaughter gives clear indications for stunning procedures. Old and inappropriate pre stun drive-ways, electro-stunning devices without checking possibility, wrong or inadequate positioning of stunning devices at the animal, or the general state of the devices may still be found. In any case, it is not enough to document problem points, something should be done immediately (Scheibl).

Case study 14: These days, plenty of lesions post mortem is due to the conditions at the farm of origin, which is true for poultry (several types of contact dermatitis), pigs (tail biting), or cattle (loser cows). Post mortem post is an appropriate opportunity to record such lesions. For this, a clear identification and definition of lesions are needed (Fries).

Case study 15: Lesions can be observed and recorded using terminals, which is required for cattle and pigs as well. Results can be attributed to the farm of origin. A catalogue of defined lesions for regions rather than individual abattoirs is proposed to monitor problems is proposed (Steinmann *et al.*).

3. Discussion (the role of society)

Present lines with their technology from farm to the product are effective and from the economic point of view cost efficient. They are critically viewed from the animal wellbeing point of view.

So, we need a critical discussion as well. Yet, there is lack of assessment. We observe a given situation, which we are not able to assess for the good of the animal. In any case, such help is clearly needed and should be discussed among all interested and involved parties.

Both, human beings and animals should be included in such an analysis: Humans are influenced by their society's history and location.

Questions for man:

How did we arrange our relation with the animals?
What right should be given to the animal?
What sort of questions may be asked?
Are we clear with our emotions? What is driving us personally?

Questions for the animal:

What is their contribution?
What is our compensation for this?
How can we ask them?
How may they answer?
How can we understand these answers?
Who is supposed to help with such questions?

3.1. Animals and pain

In the past we have focused much on parameters of animal efficiency and paid little attention to parameters measuring pain in animals. Knowing very little about the feelings of animals about pain, how can we assess what is tolerable and what is unacceptable (going beyond the point of compliance)?

Case study 16: Without any discussion: Animals feel pain. However, we cannot ask the animal, so we need clear indicators for the pain as such. Measurable indicators are available (Martens).

3.2. Our European history

Historically, our society's attitude towards animals is ambiguous. Competition for food and feed, also sometimes in defence, has led to extinction of large wild animals in Central Europe as well as in other regions. Centuries later, our urbanised society has little (if any) contact to farming and food production and looks at food animals from another angle. This leads to criticism of animal farming, often without knowing the reality of modern farms.

Case study 17: From the beginning of civilised societies, law and religious codices embrace animal rights and animal protection as important means to survive. Each year, 3.5 million head of cattle and 55 million pigs are slaughtered in Germany, and 2.7 million animals are used for animal trials. Such numbers are likely to include cases, where animals are not treated as they should be. Also the acting persons and the pressure on them should be taken into consideration (Schulze Schleithoff).
We cannot exclude that acting persons are under pressure they cannot bear. Feeling hopeless themselves, they may also treat animals inappropriately.

3.3 A Global issue: Who has the right to decide, who is supposed to contribute?

Confronted with ethics, we may ask: whose ethics from which point of view is relevant for us? How many ethics do we have? Whose ethics should we follow? We have to respect animal rights (bioethics). But it is not always clear when we must compromise to reach a decision. Different points must be taken into consideration:

- Production: without it, no animal keeping and no food production
- Economics: without it, no production
- Bioethics: without it, no acceptance from society and consumer's point of view

In any case, we cannot ignore the growing demand of billions of humans for food of animal origin, when others may consider food from farmed animals as unethical. Mass animal farming or industrial farming is not unethical as such.

Case study 18: Animal right positions from the industrial countries' point of view may be viewed as offensive for developing countries. The utilitarian concept gives some insight into the role of animal wellbeing in animal farming. In phase 1 (low standard), animal wellbeing triggers increase of productivity, in "phase 2" (with high investment in facilities), we may observe decreasing productivity. The dilemma: the standards are defined by industrialised countries, which cannot be afforded by developing countries (Zessin).
"Global standards" may use models such as indicated by Zessin, taking into account animal rights as well as human feelings. Based on this, industrialised countries have to re-consider their position, too.

Case study 19: Observations from a camel market in South Egypt with transport indicate clearly, that the assessment of situations cannot be regarded only from the human point of view. In these pictures, animals have to put up with conditions, which appear cruel and unbearable to us (Große). Again, such pictures illustrate, that the reactions of animals are not the only criterion to assess a given situation. This case also shows the split ethics on the globe; our human attitude is deeply influenced by our individual situation, and the answers in industrialised countries may differ fundamentally from those in countries with low living standards, where people are struggling for survival.

Case study 20: Approaching the issue from the position of religion, a Christian pastor interprets what The Holy Bible means if man is told to cultivate the earth, which refers to the historic competition between man and animal for food. If we decide to eat meat, justice must be done to the animal. Ethics of agriculture include the concept of sustainability, too. Consumers should be aware of their role. However, the number of animals on a site is not necessarily an issue (Friebe).
An ethical approach towards food animal keeping must not mean a smallholder approach. The animal does not recognise the magnitude of a site. What counts, is the circumstances for the animal and its individual wellbeing.

Case study 21: The German Constitution includes animal welfare and the treatment of animals as living beings as well. Changing attitudes in the society should be taken into account by politicians when setting standards for future development. Widely used amputations in food animals and the administration of antimicrobial substances to food animals are important issues. Concerning animal rights and animal wellbeing, parameters should be established on international levels to reduce regional/national disparity (Goldmann).

4. Summary

This review gives a summary of 21 papers presented and discussed during a two-day symposium at the Veterinary Faculty of the Free University Berlin. The focus was on animal wellbeing beyond the point of legal requirements.

Animal keeping is presently a main concern in public discussions in Germany. However, we should keep in mind that the attitude of humans toward animals is influenced by region and society as well as personal experience.

It was agreed that pain in animals must be prevented. However, the significance of individual wellbeing has not yet been fully scrutinised and deserves further attention.

Zusammenfassung

Umgang mit Nutztieren: Wo liegen Grenzen der Nutztierhaltung?

Thema auf der diesjährigen Frühjahrstagung des Panels VPH am Fachbereich Veterinärmedizin der FU Berlin war der Umgang mit Nutztieren. Diese Synopse fasst die 21 vorgestellten Vorträge aus der Sicht des Autors zusammen.

Die Tagung hatte zum Ziel, den Begriffen „Tierschutz“/ „Tierwohlbefinden“ Inhalte zuzuordnen, die über die in Rechtsregulativen festgelegten „cm-Anforderungen“ hinausgehen.

Die Haltung der Nutztiere ist gegenwärt ein zentrales Thema der öffentlichen Diskussion in Deutschland.

Zu beachten ist, daß auch die Haltung der Menschen gegenüber dem Tier geprägt ist vom gesellschaftlich politischen und regionalen Umfeld und von persönlicher Erfahrung.

Schmerz beim Tier ist zu vermeiden. Allerdings sind die Komponenten individuellen Tierwohlbefindens nicht immer klar und bedürfen weiterer intensiverer Bearbeitung.

Address of author:

Prof. Dr. Reinhard Fries
Panel Veterinary Public Health
Institute of Meat Hygiene and Technology
Faculty of Veterinary Medicine
Freie Universität Berlin
Brümmerstr. 10
D 14195 Berlin Germany
fries.reinhard@vetmed.fu-berlin.de

A Christian View on Intensive Animal Farming: Position of the Lutheran Church, Hanover, Germany

Pastor Karl-Heinz Friebe

1. The origin of the position paper

The evangelical church community in Wietze/Steinförde near Celle, Germany, asked the Lutheran Church of Hanover for its position regarding intensive animal farming and slaughter plants in connection with plans to build the largest broiler processing plant in Lower Saxony. These plans have led to a controversial discussion in the community re. the need for and ecological as well as social implications of the project. Similar conflicts are seen in other communities where large production units are being planned. The regional Lutheran churches are generally considered as reserved and prefer to call position papers as “memos”. This memo was written in May 2011 and can be found on the internet under the German title "Position der Landessynode der Evangelisch-lutherischen Landeskirche Hannovers zur Landwirtschaftlichen Nutztierhaltung, Aktenstück 86 der Landessynode vom Mai 2011".

The focus of this memo is an interpretation of the text from the Bible ***“The LORD God took the man and put him in the garden of Eden to work it and keep it”*** (Gen 2,15), a commandment which all Christians in good faith should follow, but which is often misinterpreted when it comes to specific action. The supply of food for society and maintenance of the economic basis of agriculture is an essential part of the command. Equally important is the careful use of nature, which has its own value and needs to be protected for future generations. To find a proper balance between use and protection of resources is perhaps the most difficult part of the command for us. When it comes to conflicts between utilization and preservation, we need criteria to assess different interests in a specific situation.

2. Problems and Challenges

The per-capita consumption of meat in Germany has more than doubled since the 1950s. With about 60 kg per capita, we are not even on top of the list of industrial countries. Global meat consumption is growing especially in threshold countries. The **global consequences** of this development are undisputed, and animal farming is considered as an important contributor to environmental problems, including:

- Methane und CO_2 emissions and resulting climate change
- Contamination of ground water
- Eutrophication of rivers and lakes
- Reduction of biodiversity
- Acidification of soil
- Loss of forest areas

The high meat consumption in affluent countries can have negative effects in Third World countries growing animal feed for export, while village people give up faming and migrate to cities, hoping to escape hunger and poverty.

However, not all forms of animal farming necessarily have negative ecological consequences. The environmental effects can be very different and depend on the animal species, management system and regional density of animal farming. The changes of production processes in farming and the actual current conditions are hardly recognized by consumers. Since the industrialization, we can observe a progressing loss of knowledge how food is produced and further processed. For most people, rearing and killing farm animals is no longer a part of the real world. In the industrial societies, these jobs are left to specialists on farms and in processing plants. Food has become a product the value of which is mainly determined by price. Consumers generally buy the cheapest products available, with little attention to their source. At the same time, advertising and marketing strategies promote and intensify a romantic image of farming.

3. Theological Basis

The Bible is neither a dogmatic text-book nor an ethical manual. It is rather a book full of vivid descriptions of real life situations and controversial experiences. Unlike associations or political parties, the **Church does not represent any interest group**, but is a congregation of people with a defined common belief, which guides them to act morally and responsibly according to ethical standards. **Biblical stories contributed to our awareness** of the competition between animals and man for food and space since thousands of years. Animals are man's friends as well as enemies. Man rules over animals and depends on them at the same time. Animals and man are close to each other, yet they remain strangers.

We interpret the often used and controversially discussed quote ***"Be fruitful and multiply and fill the earth and subdue it and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on earth"*** (Gen 1,28) as a call to rule the world responsibly before God.

No ruthless exploitation, but conservation of all creation, especially considerate treatment of all forms of life. God created the world and sustains it. As part of the whole creation, man and animals get their value from God. Man and animals have a special relationship in this context. Similar to man, animals have been described as "living souls" or "breathing life". Humans and animals have their own dignity before God and have to be respected. This includes protection of life against being killed. Originally, this relationship between man and animals is free of force and mutual use and consumption.

But man wanted to be like God and lost his innocence. With his exit from paradise he and all creation with him got into a world with two faces. On the one hand life is being preserved and passed on to future generations by mutual consideration; on the other hand this process involves and requires utilization and consumption.

Thus, the relationship between man and animals has changed since the Bible's account of creation. Man and animals have become dependent on each other during the course of history, and ever since we entered into this relationship, we actually need the animals more than they need us. But the Bible does not idealize the relationships between man and animals and vice versa: ***"The fear of you and the dread of you shall be upon every beast of the earth and upon every bird of the heavens, upon everything that creeps on the ground and all the fish of the sea. Into your hand they are delivered"*** (Gen 9,2).

God holds man responsible for His creation, but with his exit from the "Garden of Eden", man became guilty. He is „like God", but not God himself. Nevertheless, the promise of God is still: ***"While the earth remains, seedtime and harvest, cold and heat, summer and winter, day and night, shall not cease"*** (Gen 8,22). This means God calls on man to continue the act of creation responsibly. But we have no unlimited right of disposal and need **ethical self-restriction**. We find this idea already in the Sabbath Commandment of the Old Testament. In view of the grown technical possibilities with man's ability to interfere with nature, this self-restriction has become more important than ever before in history. We are obliged to keep our world ecologically in order and treat all gifts of creation carefully.

But man's efforts will always remain fractionated and less than perfect. A deep cleft, a wound, cuts through the world and our lives, which can only be healed by God's grace. This world is not the "Garden of Eden" and not in a healthy state, we can only find traces of a paradise.

The Bible leaves us in suspension between the picture of a better world and the reality of the present world. The description of this conflict is quite sobering. The personal dignity of each individual human and animal and their right to be protected from killing is granted, but the Bible also recognizes the violence inherent in all living creatures. Therefore the right to be respected and protected from getting killed can only be practiced with due differentiation.

There is no reference in the Bible which would prohibit killing animals and eating meat. However, if it is decided to use animals as source of food, this must be in line with man's responsibility for creation. All life is interdependent, nothing belongs to anyone, and all individuals consume and are being consumed. Animals are God's creatures and part of this world just as we are. We have to treat them well, with humility and gratitude for what they give us.

Based on the above theological reflexions, the Synode of the Lutheran Church of Hanover formulated the following conclusions, demands and criteria:

1. Meat consumption

Although meat is not an essential element of the human diet, its consumption is recognized as an important part of human civilization since thousands of years. Occasionally it is proposed to give up meat consumption, but the response remains limited. Animal farming and processing of food from animals offers employment for many people and contributes to food security in large parts of the world. If - as is commonly practiced in most cultures - animals are utilized, then they have to be treated according to the imperative of justness, which means:

2. Attention to animal wellbeing and animal rights

Husbandry, transport and killing must not cause agony, pain or suffering for the animal. All management practice has to be directed toward this goal. This includes taking behavior preferences of the animals into account and identifying key factors for the wellbeing of the animals and managing them accordingly. Making full use of technical innovations as well as motivating and qualifying all active members of the staff are extremely important.

3. Health care for people and animals

This includes effective disease control for the animals based on good management practices with modern technical environment, minimal use of drugs, farm hygiene and feed quality control. Human health aspects include not only farm labor, but also minimum pollution of the neighboring environment.

4. Focus on sustainability

Human civilization with animal husbandry is not possible without any effect on the environment. However, as long as these effects are not contrary to sustainability principles, we don't have to worry about them. Sustainability in the area of animal production may be defined as follows:
Keeping animals should

- not consume more resources than can be regenerated by natural means
- will not jeopardize biodiversity
- will not burden soil, air or water with emissions intolerable for alternative usage
- will not harm the current user.

In case any of these sustainability goals is being violated, the current practice should be critically reviewed with the aim to develop alternative solutions. This analysis should include not only direct effects of animal production on the local environment, but also effects of feed production on global climate change.

5. Economic and legal constraints

Economic and legal conditions, under which a local farmer has to work, cannot be ignored, because they limit his possibilities to earn a living. However, when it comes to animal farming, maximum economic efficiency must not be the only criterion. Sustainable animal production, with due attention to animal wellbeing, should not be disadvantageous for the farmer. This kind of food production is a service to the whole society and should to be supported by joint commitment. Political decision makers, consumers and farmers are all called upon to contribute their part to this common goal.

6. Politics

Political decision makers have to develop a legal framework for animal farming, supporting sustainable production, animal welfare, and the protection of consumer and producer interests. Agricultural producers should be better protected by EU laws and consumer education against excessive power of a few companies controlling the food trade.

7. Farmers and Farmers Associations

Farmers associations should think beyond current interests of their members and develop concepts for an economically successful, sustainable agriculture with fair international trade regulations. Agricultural ethics must live up to social, economic and environmental requirements. For communication with the public, modern farmers who operate sustainably should be shown instead of romantic pictures with traditional setting.

8. Consumers

Consumers should be aware of the fact that their purchasing preferences can change farm animal management practices. But consumer‘s choice can only become effective if the value of different goods can be compared and not only the price. Knowing the source of the food and how it was processed may already reduce wastage. Consumers should also recognize that sustainable food production has its price and that they can support it with their purchase. Consumer ethics should be developed based on factual information and education.

Concluding remarks

As Christians following the Bible “to work and keep the soil”, we are asked to manage our world responsibly and to prohibit unlimited exploitation. This holds in particular for managing farm animals, for which we are held responsible. This leads us to the following criteria to assess animal husbandry practices and use of animals:

- Observation of animal wellbeing in a given environment
- Sustainable management, i.e. protection of resources for future generations
- Proper attention to the rights and needs of underprivileged people

These criteria are independent of the size of the production unit.

In the ongoing dispute over questions of intensive animal farming, all stakeholders share the responsibility to maintain social peace, especially in the villages. Participation, information and mutual understanding and acceptance are necessary. A procedure should be agreed how to develop local living conditions and employment opportunities. Local democratic institutions and traditions should play important roles in decision making.

In view of foreseeable developments in our society, animal farming needs to pay more attention to animal welfare, human health and sustainability, focused and without delay.

Zusammenfassung

Statt einer Zusammenfassung wird auf die deutsche Fassung im Internet unter www.kirche-landwirtschaft.de verwiesen.

Author's address:

Pastor Karl-Heinz Friebe
Kirchlicher Dienst auf dem Lande (KDL)
Archivstr. 3
30169 Hannover
Germany
friebe@kirchliche-dienste.de
www.kirche-landwirtschaft.de

U.S. Experiences with Lohmann Selected Leghorn (LSL- Lite) Layers ** Part 2: Feed Consumption and Conversion **

Donald Bell, University of California, Riverside, California, USA

Introduction

"The feed consumption level is a critical measurement in determining the nutrient density of the ration fed to an individual flock. Consumption is affected by:

1. **Age of the flock**
2. **Energy level of the feed**
3. **Egg production rate and egg size**
4. **Environmental temperature**
5. **Breed and strain of chicken**
6. **General health of the flock**

"Because there are so many factors which may affect feed consumption, the most accurate feeding system must be based upon actual on-the-farm records. Standardized feeding programs are more than likely to be more wasteful of nutrients and ultimately more expensive" (Bell, 1967).

Forty-five years ago, when the above article first appeared in Poultry International magazine, the measurement of a flock's feed consumption rates was in its infancy. The size and management of individual flocks was such that very few egg producers kept track of their flock's feed consumption levels. Methods to obtain the data were crude (in comparison with today's methods) and were in most cases merely estimates. In a University of California publication (Bell, 1975), a list of nine methods to determine feed consumption was provided to the industry, discussing methods still in use today. By 2012, practically all commercial egg producers insist upon obtaining and using accurate feed consumption records.

Other early articles on factors affecting feed and energy consumption include: "Factors that affect feed conversion" (Bell, 1960), "Measuring feed consumption and adjusting your feeding program" (Bell, 1965), "Feed consumption of White Leghorn hens" (Bell, 1974) and "Summer/Winter feed consumption" (Bell, 1979).

Current Data Analysis

In the previous article to this, which appeared in the October, 2011 issue of this publication, we discussed the egg production and egg size results of an extensive five-year study of 74 U.S. LSL-Lite flocks. The current discussion will concentrate on the feed consumption and feed conversion results for these same flocks. The third article in this series will emphasize mortality and economic measurements.

Feed Consumption

The list of factors (shown above) that affect feed consumption represents the major factors which are recognized as having a significant impact on the question. Their relative importance is recognized by various scientists in the prediction models they have constructed over the years (Summers and Robinson, 1995). Dozens of equations have been developed by scientists over the last 50 years. The data used for calculating such models are usually limited to small research flocks and represent data collected in the last 30-50 years with multiple strains and breeds no longer comparable to today's commercial stocks.

The scientists referred to have modified earlier prediction equations (models) and included a factor for "feather condition", while age per se is not accounted for. As shown in Table 1, the actual results calculated from our current field data are remarkably close to the prediction from the Summers & Robinson (1995) model.

Table 1: Energy Requirement Model for White Leghorn Laying Hens
(Summers & Robinson, (1995)

Model: kcalME = W * [(F) * (170-(2.2T)] + (2*E) + (5*G)

with the following measurements applied in California:
2860 kcal/ME daily energy intake in kilocalories of metabolizable energy
W = 1.56 kg body weight (3.5 pounds)
T = 23.9 °C temperature in degrees Celsius (75°F)
F = 1.0 feather score (ranging from .94 to 1.40)
E = 51.2g daily egg mass in grams
G = daily body weight gain in grams

	Predicted results	Actual U.S. results
Energy intake, kcal/day	294.2	285.0
Feed intake, g/day	102.7	100.4

Using the data obtained in the University of California study of farm records during the housing period from 2001 to 2005, we observed a 9 kilocalorie lower energy requirement and a 2.3 grams lower feed consumption level than predicted from this particular model – both very small differences. Note: we did not assume any differences due to feathering, because such measurements were unavailable and are somewhat subjective. The research on feathering, though, does indicate that this is a significant contributor to the energy requirements of a flock.

Table 2 lists the relative importance assigned to minor changes in various factors used in the Summers/Robinson equation. Models by other scientists usually include similar factors but with different levels of importance.

Table 2: Major Factors Affecting Energy Intake of Adult White Leghorn Layers

Factor	Base Measurement	Change	Net change in Energy Intake
Av. House temperature	23.9°C (75°F)	26.7°C (80°F)	- 9.8 kilocalories
Body weight - kilo (lbs)	1.591 (3.5)	1.636 (3.6)	+ 5.3
Daily BWt change	1 gram	2 grams	+ 5.0
Egg Mass	51 grams	52 grams	+ 2.0
Feather covering (%)	75-85%	60-75%	+15.0

Source: Summers, J.D., and F.E. Robinson, (1995).

The changes in energy consumption based upon small changes in contributing factors are commonly in a range of 5-10% change when we assume a daily feed intake of 100 grams. For example, a body weight change of only 45 grams is associated with 5.3 kilocalories per hen-day; a change in house temperature of 2.8°C (5.0°F) is associated with 9.8 kilocalories; a 10-15% decrease in feather covering is associated with a 15.0 kilocalorie increase in energy consumption.

Feed Conversion

Egg producers in different countries define feed conversion or feed efficiency in a variety of ways. In all cases, the expression refers to a relationship between egg production and feed consumption. The ways of defining this, though, result in different indices:

1. Pounds or kilos of feed per pound or kilo of eggs – this is probably the most commonly used term and reflects weight versus weight. This term is usually about 2:1.
2. The reverse of item #1 would express feed conversion as how many pounds or kilos of eggs are produced with 1 pound or 1 kilo of feed – usually about 0.5.
3. The method commonly used in the U.S. is pounds per dozen. This is less meaningful as it disregards the weight of the eggs. This ratio is usually in the 3.0 range.

In reality, this relationship should probably be expressed relative to energy usage. The answer would come out very similar to #1 above, but would represent a better efficiency measurement. The egg producer in the short-run, though, would be happy with the lowest cost measurement and this will be discussed in more detail in article 3 in this series.

Lohmann LSL-Lite Results – U.S.

The LSL-Lite first appeared in the U.S. with 2001 housing dates (18-20 weeks of age). Today, it represents the second most popular strain on commercial table egg layer farms. During the period 2001 to 2005 we accumulated weekly life-time data on 74 flocks totaling 5.9 million layers – averaging about 80 thousand hens per flock.

The most recent project included 165 flocks of all Leghorn strains. Results were reported (without strain identification) in a series of newsletters published by the University of California (Bell, 2008-2011). Earlier studies emphasized temperature and body weight effects on performance (Sterling, Bell, Pesti and Aggrey, 2003; Bell, 1979, 1982, 1998, 2005).

Table 3 lists the average feed consumption and conversion results by week for all flocks between 19 and 60 weeks of age. Sixty weeks was chosen as the closing age for this study to avoid the mixing of molted and non-molted flock data. Projections to 70, 80, 90 and 100 weeks can be easily derived from these data and standard regression analyses (see previous article for egg production results).

Variability of Results

The emphasis in the previous article was on management and its effect on the performance differences observed. Wide ranges of results are commonly seen in field studies. This was also seen in this study – even when the strains used were the same. Flock managers select many different programs in an attempt to maximize their returns and many factors are simply over-looked by management.

The operator's selection of factors, such as those listed in Table 2, are commonly two or more times as serious compared to the minor effects shown in the table. In other words, they may have a ten degree (F) difference between different tiers of cages or regions within the house, thereby affecting feed consumption by 20% or more.

Temperature differences within single houses as great as 10°F or 5.6°C result in major differences in a flock's energy consumption and this makes scientific feeding to the nutrient requirements of the flock that much more difficult. One region of the house may be consuming 280 kcal per day while another region in a colder part of the house is consuming 336 kcal – and all the nutrients and costs that go with it.

In a study of the University of California, two large modern egg production houses with 100,000 hens each were temperature-mapped in 1998 (Kuney, 1998). Table 4 lists some of the key differences observed between three significantly large temperature zones – hot, cold, and moderate. No performance figures were available due to the automated feed and egg collection systems being used.

Table 3: Weekly Feed Consumption/Conversion (LSL-Lite White Leghorns hens) (average results - 74 U.S. flocks - 2001 to 2005 housing dates)

Week	Feed: (g/hen-day)	Feed: (100 hen-days)	Feed: (lbs/ doz.)	Feed: egg ratio	Week	Feed: (g/hen-day)	Feed: (100 hen-days)	Feed: (lbs/ doz.)	Feed: egg ratio
19	73.2	16.1			41	103.7	22.9	2.98	1.86
20	75.7	16.7	6.23	3.49	42	104.0	22.9	2.98	1.85
21	80.3	17.7	4.07	2.70	43	103.8	22.9	2.99	1.85
22	85.5	18.9	3.26	2.45	44	103.7	22.9	2.99	1.86
23	91.2	20.1	2.92	2.13	45	103.9	22.9	3.01	1.86
24	95.2	21,0	2.80	1.96	46	103.9	22.9	3.02	1.87
25	97.2	21.4	2.79	1.91	47	103.8	22.9	3.02	1.87
26	98.2	21.7	2.79	1.88	48	104.1	23.0	3.04	1.88
27	99.7	22.0	2.83	1.89	49	105.1	23.2	3.09	1.90
28	101.2	22.3	2.86	1.88	50	104.3	23.0	3.06	1.88
29	101.2	22.3	2.85	1.86	51	105.4	23.2	3.11	1.92
30	101.5	22.4	2.87	1.85	52	104.7	23.1	3.11	1.91
31	101.6	22.4	2.87	1.84	53	105.3	23.2	3.13	1.92
32	102.3	22.6	2.88	1.84	54	105.1	23.2	3.14	1.92
33	103.0	22.7	2.91	1.85	55	104.6	23.1	3.15	1.93
34	102.5	22.6	2.89	1.84	56	105.2	23.2	3.18	1.94
35	103.7	22.9	2.94	1.86	57	105.1	23.2	3.19	1.94
36	102.6	22.6	2.91	1.83	58	105.0	23.1	3.20	1.94
37	102.3	22.5	2.90	1.82	59	105.2	23.2	3.24	1.96
38	104.3	23.0	2.98	1.86	60	104.8	23.1	3.23	1.95
39	102.1	22.5	2.91	1.82					
40	102.7	22.6	2.94	1.84	Av.	100.4	22.1	3.10	1.99

Table 4: House Mapping - Temperature Regions

Measurement	House A	House B
Outside temperature	35°- 40°C (95°-104°F)	38°- 40°C (100°-104°F)
Temperature set point	27°C (81°F)	26°C (78°F)
Mode temperature	30°C (86°F)	29°C (84°F)
High temperature	34°C (93°F)	32°C (90°F)
Low temperature	26°C (79°F)	24°C (75°F)
hens in comfort zone	54%	42%
hens in hot zone	26%	27%
hens in cold zone	20%	30%

Of particular significance is that only 54 and 42 percent of the flocks were in the central temperature zone, and these are the only ones receiving the appropriate diet for their assumed performance rates. The cold zone hens would be over-fed their nutrients, while the hot zone birds would have been deficient. In this situation, the only choice the egg producer has would be to over-formulate the flock's ration in order to provide the hot-zone hens adequate nutrient intake – and this is costly.

Similar mapping would appear to be justified for multi-tiered houses – especially for vertical heights of 5 or more meters (15+ feet). The author has observed vertical height temperature differences of more than 9.4°C (15°F) in such houses.

Temperature variation may occur within a single house (as described above), between flocks as a result of Inconsistent management policies, by seasonal effects, poor housing design associated with the environment, and lastly as a result of a feeding policy which provides different temperatures for different ages of flocks. Our studies have clearly demonstrated the user-choice of increasing temperatures as flocks age. On some farms, this may be as much as 5-10 °F from the age at housing until 60 weeks. All of the above may become problems if nutrient densities in the rations are not adjusted to compensate for variations in feed intake.

The observed feed consumption differences in the U.S. study are a result of all the factors discussed. Low feed consumption, per se, is not necessarily a problem, nor is it a benefit. Recorded data about temperature seldom tell the full story. A flock with higher and lower peaks may yield the same average measurement as one that experiences a constant pattern throughout its life. Higher temperatures say nothing about the quality of air required to reach them – especially in the winter months.

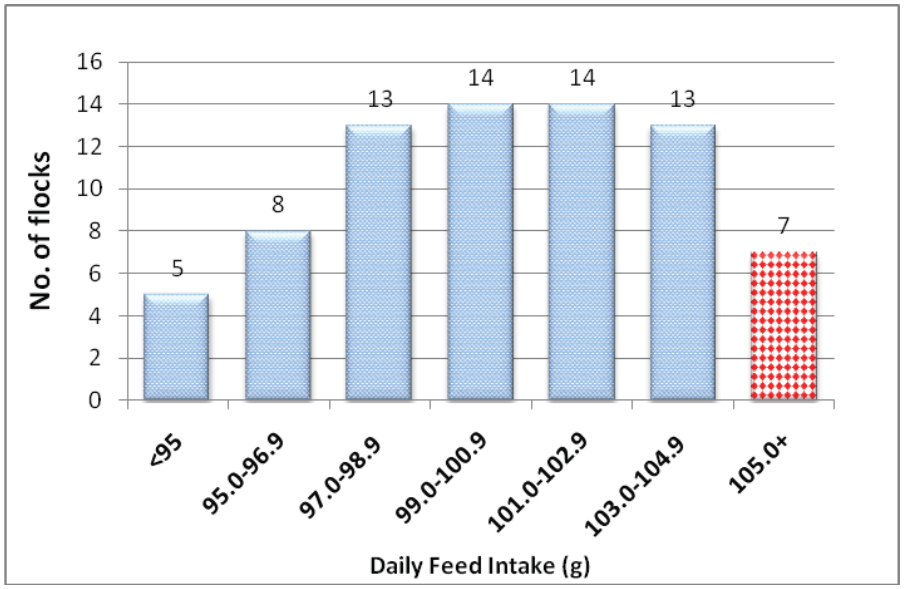
It depends upon how the egg producer works with the issue and whether or not he/she has acted accordingly to the information – assuming it is reliable. Table 5 lists the extreme observations for various feed consumption/conversion measurements. Note that individual rows are not necessarily the same flocks, but only selected data.

Table 5: Best and poorest flocks per trait (different rows contain different flocks) (19 to 60 weeks of age, no molted flocks) (74 flocks of LSL - Lite White Leghorn hens)

Trait	Best/Poorest 5 flocks		Best/Poorest 25% of flocks		Overall Study Results and Uniformity	
	Largest	Smallest	Largest	Smallest	Average	Std. Dev.
Flock Size (000)	185	26	138	38	80	N/a
	Best	Poorest	Best	Poorest	Average	Std. Dev.
Feed/day/hen (g)	93.1	107,4	95.8	105.1	100.4	3.87
Feed/day/ 100 hens (lbs)	20.4	23.8	21.1	23.2	22.1	0.86
Feed: lbs/dozen	2.73	3.51	2.85	3.36	3.09	0.20
Feed:egg ratio	1.79	2.10	1.84	2.04	1.94	0.08
Egg: feed ratio	0.56	0.48	0.54	0.49	0.52	

And finally, Figure 1 illustrates the distribution of different feed intake levels for the 74 flocks in our study. The most frequent feed consumption levels are between 97 and 105 grams per hen-day. This would be in the 277 to 300 kilocalorie range (assuming diets averaging 2860 kilocalories per kilo or 1300 kilocalories per pound). These represent the first lay cycle between 19 and 60 weeks of age.

Figure 1: Frequency of Av Daily Feed Consumption Rates - 19 to 60 wks.



The author has provided the reader with a list of references and suggested reading on feed consumption, feed conversion, performance standards, temperature management, technological change, and other related subjects. Most of the articles listed can be obtained from the author.

No attempt was made to make this an overall review of the two subjects listed in the title but instead, primarily the research and observations of the author within the last fifty-year period.

Zusammenfassung

Managementbedingte Varianz in der Leistung moderner Legehybriden als Herausforderung. Teil 2: Futterverzehr und Futterverwertung

Im zweiten Teil einer Serie von drei Beiträgen werden detaillierte Praxisergebnisse von 74 LSL Lite Herden in den USA hinsichtlich Futterverbrauch und Futterverwertung präsentiert. Das Leistungspotenzial heutiger Legehybriden ist wesentlich höher als in früheren Untersuchungen, und die meisten Legebetriebe arbeiten heute mit einer Stalltechnik, die eine Regulierung des Stallklimas gewährleisten sollte.

Die in Abbildung 1 dokumentierte Streubreite des durchschnittlichen täglichen Futterverzehrs im Alter von 19 bis 60 Wochen lässt in beiden Extremen (unter 95g bzw. über 105g) Herden- bzw. Farm-bezogene Besonderheiten vermuten, die aber im Einzelnen ohne genauere Informationen nicht erklärt werden können.

Aus der Literatur und eigener 50-jährigen Erfahrung in der Betriebsberatung zitiert der Autor Beispiele, um zu verdeutlichen, wie verschiedene Faktoren zur Variabilität des täglichen Futterverbrauchs beitragen können.

Um das Betriebsergebnis optimieren zu können, sind regelmäßige Aufzeichnungen des Futterverbrauchs und der Legeleistung, der Entwicklung von Körpergewicht und Eigewicht, der Temperatur in verschiedenen Stallbereichen und der Federverlust (vor allem in der zweiten Hälfte der Legeperiode bei niedriger Stalltemperatur) erforderlich, um die Futterzusammensetzung im Rahmen einer Phasenfütterung zu optimieren.

References

Bell, D.D. (1960) Factors that affect feed conversion. Pacific Poultryman, May, pp 15, 57.

Bell, D.D. (1965) Measuring feed consumption and adjusting your feeding program. Pacific Poultryman, November pp 18-21.

Bell, D.D. (1967) Phase feeding: cost cuter for large eggmen? Poultry International, October pp 26-32.

Bell, D.D. (1974) Feed consumption of White Leghorn hens. University of California Poultry Scratch, July.

Bell, D.D. (1975) Methods of measuring feed consumption in poultry flocks. University of California leaflet #2244.

Bell, D.D. (1979) Summer/Winter feed consumption. University of California, Poulry Letter, March.

Bell, D.D. (1982) Performance responses to temperature as affected by age in table egg flocks. World's Poultry Science Assoc. Israel branch proceedings, December.

Bell, D.D. (1984) Small performance differences count in the egg business. Poultry Digest, February, pp 72

Bell, D.D. (1993) The egg industsry of California and the USA in the 1990s: a survey of systems. World's Poultry Science Journal, vol. 49, pp 58-64.

Bell, D.D. (1995) Forces that have helped shaped the U.S. egg industry: the last 100 years. Poultry Tribune, pp 30-43.

Bell, D.D., (1998) The importance of managing laying house temperatures. World Poultry, November, pp 34-39.

Bell, D.D. (2005) . Contemporary layer flock performance record analyses - 2004-2005, Progress in Poultry #42. December.

Bell, D.D. (2008-2011) National Flock Performance Study, University of Callifornia, Egg Economic Update letters, nos. 285 to 335.

Bell, D.D. (2011) The challenges of management for today's high performing laying hens - Part 1: Egg production and egg size. Lohmann Information, October 2011, pp 8-15.

Kuney, D.R. (1996) Temperature mapping of cage layer housing. University of California Poultry Symposium prodeedings.

Sterling, K.G., D.D. Bell, G.M. Pesti, and S.E. Aggrey. (2003) Relationships among strain, performance and environmental temperature in commercial laying hens. Journal of Applied Poultry Research 12: 85-91

Summers, J.D. and F.E. Robinson (1995) Comparative feeding programs for poultry reproduction. IN Poultry Production, edited by P.Hunton, p 329.

Swanson, M.H. (1979) Energy needs of laying hen can be quantified. University of California Poultry Letter, June

Author's Address:

Donald Bell (emeritus)
Poultry Extension Dept.
University of California, Riverside
e-mail: donlucybell@charter.net

Management tools to influence egg weight in commercial layers

Hans-Heinrich Thiele, Cuxhaven, Germany

Introduction

Commercial layer varieties from various breeding companies are available on the market. Their product profile can be distinguished, and management guides contain tables with expected egg weight and grading results per week of age under defined conditions. Numerous non-genetic factors will influence the ability of pullets or layers of the same variety to achieve the goals specified by the breeding company. These factors include body weight and frame development, nutrition, bird density in cages or floor housing systems, feeder and water space, lighting programs, housing and climate conditions, beak treatment procedures, vaccination schedules and diseases. This paper will focus on factors which can be manipulated by farm management to optimize egg weight during a full laying cycle.

Product variety

Today's breeding companies and their multipliers offer a broad range of commercial layer varieties which differ mainly in shell colour, egg numbers and egg weight. If the demand of a given egg market is predictable on a long-term basis, the egg producers can choose a variety closest to market needs. Depending on these targets, the frequency of eggs in different grades can be optimized by choosing a commercial layer fitting to this demand. Table 1 indicates the range of average egg weight which may be found under identical conditions in a random sample test or on any farm.

Table 1: Results of 38th North Carolina Management Test, white egg strains, single production cycle from 119 – 595 days of age (North Carolina Cooperative Extension Service, 2011)

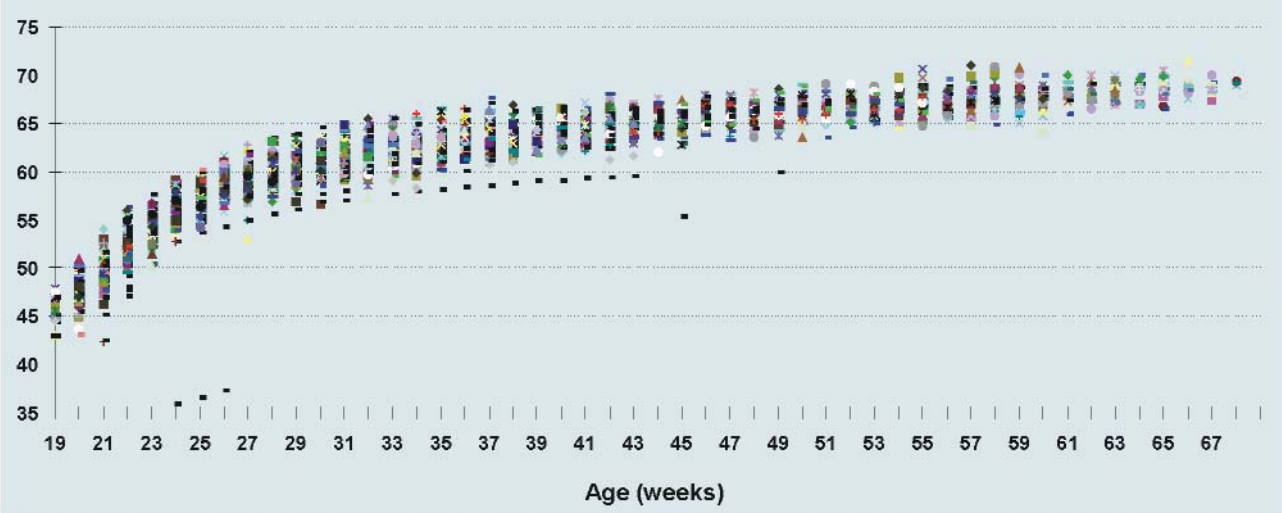
Strain	Mortality %	Age at 50%	No. eggs / H.H.	Egg weight g	Feed consumption (g/day)	Feed conversion g egg / g feed
Lohmann LSL-Lite	7.5	145	396	61.8	111	0.48
H&N Nick Chick	5.0	143	390	63.0	111	0.49
Hy-Line W-36	6.3	146	380	61.4	101	0.50
Hy-Line W 98	3.3	139	382	63.8	111	0.47
ISA Exp. White	11.7	139	389	62.4	108	0.49
Babcock White	3.8	142	399	62.2	106	0.50
Shaver White	11.7	151	384	59.8	98	0.51
DeKalb White	8.8	146	382	63.0	114	0.47
Bovans White	15.0	144	391	60.6	108	0.49
Novogen White	6.3	146	386	62.0	105	0.49
Bovans Robust	12.9	144	390	63.2	110	0.50

Compared to the rather small differences between strains in average egg size shown in tables 1 and 2, we find a huge variation in egg weight between hens of a flock at the same age, for the same hen at different age or between flocks of the same age and genetic background kept on different farms. Despite the rather high heritability of egg weight, it is also affected by major environmental effects. The egg weight curve in figure 1 documents field records with differences up to 5-8 g between commercial flocks with the same genetic potential, originated from a single GP flock.

Table 2: Results of XIXth International RST Ustrasice, Czech Republic, 18 to 74 weeks of age, average of conventional and enriched cages (MEZINÁRODNÍ TESTOVÁNÍ DRŮBEZE ÚSTRAŠICE, 2011)

Strain	Mort. %	Age 50 % days	Egg No. H.H.	Egg Wt. g	Egg Mass kg / H.H.	Feed g/day	F.C.R kg/kg
Lohmann Brown Classic	6.9	142	345	62.1	21.4	124	2.24
Lohmann Brown Lite	5.4	143	347	60.9	21.1	124	2.27
H&N Brown Nick	1.5	143	351	62.0	21.7	126	2.24
Hy-Line Brown	2.0	141	343	60.9	20.9	125	2.34
Tetra SL	5.4	144	337	60.9	20.5	127	2.38
Hy-Line Silver Brown	5.4	141	346	58.3	20.2	124	2.38
Bovans Brown	3.9	143	347	61.2	21.2	127	2.32
Hisex Brown	8.3	143	344	60.7	20.8	129	2.34
Isa Brown	2.0	144	350	60.4	21.1	125	2.31
Novobrown Classic	3.4	143	344	61.2	21.0	126	2.33
Novobrown Exp.	3.9	142	350	60.0	21.0	124	2.29

Figure 1: Variation in weekly egg weight between commercial brown-egg flocks with the same genetic potential (Preisinger, 2002)



Egg producers should be aware of this non-genetic variation and learn to adjust the management and feeding in rearing and production to optimize their results.

Development of bodyweight, frame size and appetite

The first need of laying hens is proper brooding management. Adequate climate in the brooder house and suitable equipment to meet the chicks' demands ensure a good start into their life. How to set up a brooding shed for layer chicks is described in all management guides for the different commercial varieties. The focus in rearing has to be on bodyweight development. After the chicks arrive and perhaps rest a bit after long travel, they should immediately start to drink and eat. A dense starter

feed, high in energy and protein (with appropriate amounts of lysine and threonine), highly digestible for young chicks, is essential to reach target bodyweight. The high energy content of a starter diet should never be achieved by adding fat or oil containing saturated fatty acids, because young chicks cannot digest them. Vegetable oils with high amounts of unsaturated fatty acids as soybean or sunflower oil are the first choice.

The change from starter to grower feed should be decided on target bodyweight, not at a fixed age. The grower feed is not as dense as the starter diet, but contains enough energy and protein to support further growth. The starter and the grower diets are fed ad libitum. Chicks have to be stimulated to eat as much as they can. Under normal conditions, they will easily reach their target weight. When they are 8 weeks old, a third diet, the so called developer feed, will be supplied. It contains a lower protein density, must have a good structure and 5 to 6 % crude fibre content. At this age, pullets should learn to empty the feeders: preferably every day, but at least several times a week. A balanced intake of coarse and fine feed particles and appetite before the next feeding will increase feed intake. The ability to consume large amounts of feed learnt during this phase will be crucial to the pullets after moving to the laying house, when feed intake has to increase sharply.

Sometimes modern layers have difficulties to consume enough feed shortly before and during the onset of lay, even if they are not selected for low feed intake like the Lohmann strains. In this case, they

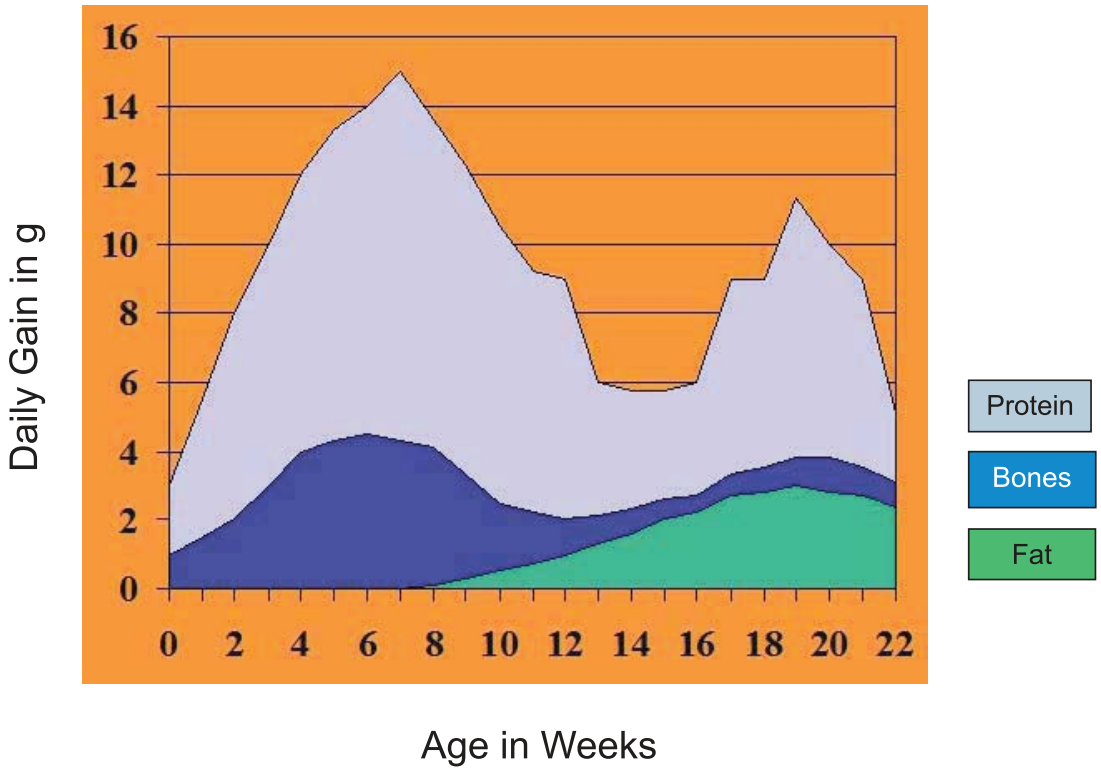
Table 3: Nutrient levels of different diets for LSL chicks and pullets (Recommended by Lohmann Tierzucht, 2011)

Diet type		Starter 1-3 weeks	Grower 4-8 weeks	Developer 9-16 weeks	Pre-Layer 17 wk. to 5 % prod.
Nutrient					
Metabol. Energy	kcal	2900	2750 - 2800	2750 - 2800	2750 - 2800
Minimum	MJ	12.00	1140	11.40	11.40
Crude Protein	%	20.00	18.50	14.50	17.50
Methionine	%	0.48	0.40	0.34	0.36
Dig. Methionine	%	0.39	0.33	0.28	0.29
Meth./Cysteine	%	0.83	0.70	0.60	0.68
Dig. M/C	%	0.68	0.57	0.50	0.56
Lysine	%	1.20	1.00	0.65	0.85
Dig. Lysine	%	0.98	0.82	0.53	0.70
Valine	%	0.89	0.75	0.53	0.64
Dig. Valine	%	0.76	0.64	0.46	0.55
Tryptophan	%	0.23	0.21	0.16	0.20
Dig. Tryptophan	%	019	0.17	0.13	0.16
Threonine	%	0.80	0.70	0.50	0.60
Dig. Threonine	%	0.65	0.57	0.40	0.49
Isoleucine	%	0.83	0.75	0.60	0.74
Dig. Isoleucine	%	0.68	0.62	0.50	0.61
Calcium	%	1.05	1.00	0.90	2.00
Phosphorus tot.	%	0.75	0.70	0.58	0.65
Phosphorus avail.	%	0.48	0.45	0.37	0.45
Sodium	%	0.18	0.17	0.16	0.16
Chlorine	%	0.20	0.19	0.16	0.16
Linoleic Acid	%	2.00	1.40	1.00	1.00

will not gain or even lose body weight and have difficulties to reach good early egg size. Sufficient early nutrient intake is essential for a successful start and to reach high peak rates. Once the appetite of a flock is developed it should be maintained when birds are transferred to the layer facilities. A smooth transition to the high calcium amounts of a layer diet can be achieved by using a pre-layer diet with only 2-2.5% calcium. This diet, about 1 kg per hen fed for 10 days, makes the transition period from growth to lay easier for the hen, helps to maintain the feed intake and is a tool to improve the uniformity of a flock.

Many people still think that bodyweight at start of lay is the most important factor in relation to later egg weight. Our experience at Lohmann tells us that a much higher correlation exists between frame size development, i.e. bodyweight at 12 to 13 weeks of age, and later egg weight. At the age of 12 to 13 weeks nearly 95 % of the body frame is developed. A reduced frame size with corresponding underweight at this stage of development will have a lasting negative effect on egg weight. If a pullet is too small at this age, it can't really catch up with bodyweight development. To gain bodyweight in the second half of rearing, some pullet growers push flocks with high feed densities. These birds will gain weight, but stay small and deposit more fat compared to properly reared birds. Pullets grown on high energy developer diets often exhibit poor feed consumption at the onset of lay (Elliot, 2002). They are not properly prepared for the laying period, because they are unable to eat enough at start of lay, often fail to reach the breeder's standard for egg production and sometimes show problems like obesity and prolapse. Figure 2 illustrates that efforts to force up bodyweight after 12 to 13 weeks of age may end up with a small framed, fat pullet.

Figure 2: Development of body tissues of a commercial pullet (Ysilevitz, 2007)



If chicks are housed in floor systems or under hot climate conditions, they sometimes struggle to grow. In the first case, they are "wasting" feed energy for the higher activity; in the second case, they are not eating enough, because it is too hot. In both situations the chicks should be fed with higher feed densities until they reach their target weights. Prolonging the period feeding a starter or grower diet will help to achieve the target bodyweight. The period of supplying a less dense feed – the developer – will then be shorter than normal, but should still be used to develop the feed intake capacity as well.

Lighting program

The lighting program (day length and light intensity) for pullets and laying hens is a key factor in determining the onset of sexual maturity and egg production. Lighting programs for pullets in windowless houses can de designed to achieve optimal growth and efficient preparation for the laying period, largely independent of the season.

After arrival of the chicks, the length of the day is gradually reduced; then, following a phase of constant day length, lighting is gradually increased to stimulate the onset of lay. The so called “step down” procedure in the early days of the chick’s life can be used to make the pullets more sensitive to light. After reaching a day length of 10 to 8 hours, the birds are kept for some weeks on constant day length. Although the light hours during this period affect the shape of the step-down and the following step-up procedure, it is of minor importance for the sensitivity of pullets to changing day length. The more time the birds have during this constant phase, the more they will eat and grow.

In case of difficulties to reach the target frame size of the pullets and target body weights, a longer constant day can help. Any step-up procedure or increase in day length from an age of 14 to 15 weeks will stimulate the birds’ sexual maturation. A quick step-up procedure will induce an early onset of egg production with high egg numbers and slightly lower egg weights. A slow step-up will delay the onset of lay and increase egg weight. The combination of the quick step-down and quick step-up procedure is recommended for early production and, vice versa, a slow step-down and slow step-up will delay it. If you want early egg production, high egg number and moderate egg weight, use the quick step-down / step-up variant; for larger egg size at the expense of numbers, a slow step-down / step-up variant should be chosen. Since hatching eggs have to be of a reasonable size, parent flocks should never get a quick step-up / step-down procedure.

To overcome the mentioned difficulties with young layers not consuming enough feed shortly before and during onset of lay, it is recommended to increase light by two hours when starting the step-up phase to give them two more hours to eat. For open housing conditions the lighting programs have to be adjusted to the season and the location where flocks are raised and kept for egg production. Recommendations are given by Thiele (2011).

Feeding and adjusting the nutrient intake in lay

Nutritionists are experts at formulating optimal diets for the changing needs of modern commercial layers, taking the genetic potential for egg numbers and egg weight, market preferences for different egg grades and the cost of available feed components into account. The computer program assures that adequate contents for energy, calcium, available phosphorus, sodium, chloride and choline, digestible lysine, arginine, methionine, methionine plus cysteine, tryptophan, threonine, isoleucine and valine are used for feed production. In practice, all diets have to be adjusted to the actual or expected daily egg mass production of a flock as well as daily feed intake. This requires fine-tuned phase feeding programs with at least three or more phases directed to a specific production profile (egg numbers and egg weight) to avoid wastage of expensive components and minimize feed cost.

The genetic potential of commercial layers continues to increase and is much higher today than a few decades ago, especially at peak production. This offers a challenge for farm managers and nutritionists to fully utilize the potential.

Sufficient nutrient intake at peak daily egg mass production is of utmost importance. Otherwise, laying hens will run into a nutrient deficiency and will not be able to utilise their full genetic potential. Neither egg number nor egg weight will reach the breeders’ standard. High density layer diets will help to overcome this situation, but needs to be combined with adequate appetite.

Bodyweight development, early egg weight and hen day production in this period will tell a farm manager whether his birds are getting enough nutrients from a balanced diet. If they don’t, a plateau in bodyweight development can be observed and egg weights will remain below the standard. Individual hens may struggle to get into full production and run into health and behaviour problems.

Figure 3: Standard for peak egg mass production of LSL Classic Layers (Management Guides, Lohmann Tierzucht, 1996; 2001; 2011)

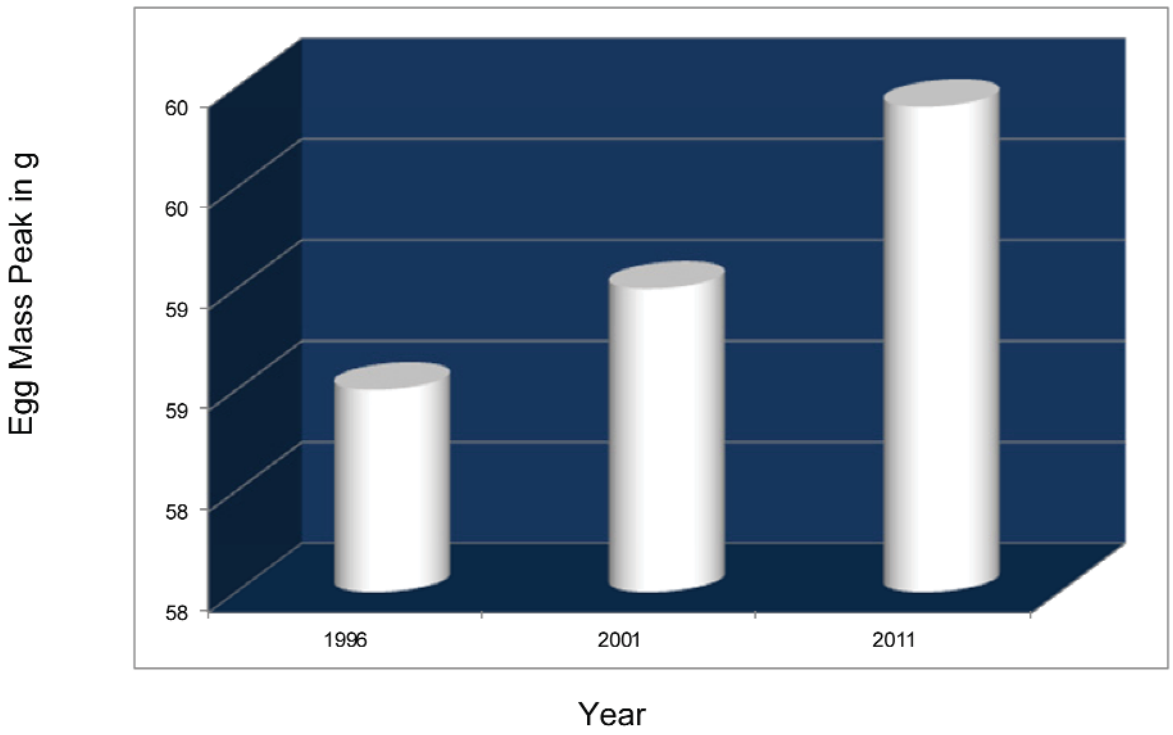
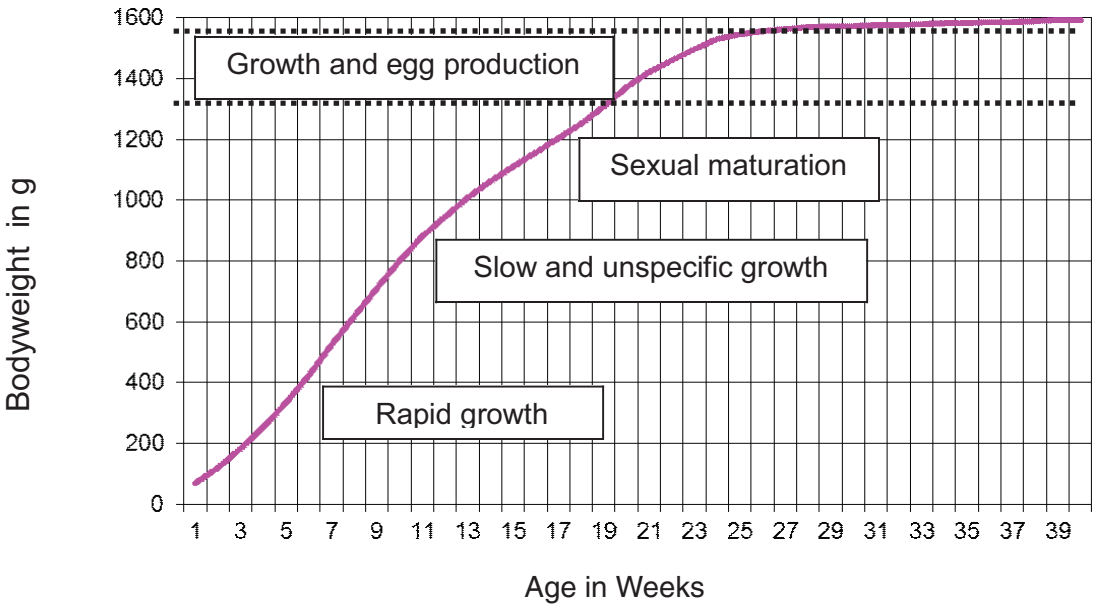


Figure 4: Bodyweight development of LSL Classic pullets up to 40 weeks



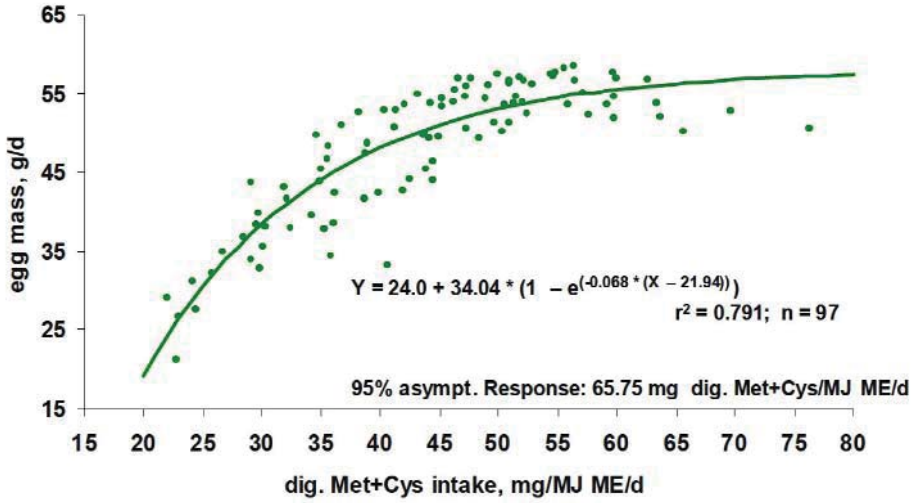
By about 30 to 35 weeks of age, all hens should have learned to eat enough, and insufficient nutrient intake is less frequent. From this time onwards fine-tuned phase feeding programs are the main tool to maintain high egg production at minimal feed cost. Nutritionists can help to achieve the desired egg weight development with feed ingredients, especially the sulphur amino acids and linoleic acid content of a diet.

Table 4: Influence of linoleic acid on egg weight of LSL Classic layers fed diets* with different linoleic acid contents (Pottgüter 2008)

Linoleic acid content					
	1.4 %		2.4 %		
Age (weeks)	Hen day production	Egg weight	Hen day production	Egg weight	Difference
20	15 %	40.8 g	13 %	42.5 g	+1.7 g
25	93 %	52.7 g	95 %	54.6 g	+1.9 g
30	93 %	58.0 g	94 %	59.7 g	+1.7 g
35	94 %	61.3 g	96 %	62.8 g	+1.5 g
40	95 %	621 g	96 %	63.8 g	+1.7 g
44	95 %	62.1 g	95 %	64.2 g	+2.1 g

*isocaloric diets and similar feed intake of trial and control group

Figure 5: Daily egg mass in 19 experiments plotted against the daily digestible methionine and cysteine intake standardised to the dietary energy content (Lemme, 2009)



Especially the digestible amino acid profile of layer diet has to be balanced. Recent publications of research results by Joly (2007), Bregendahl *et al.* (2008) and Lemme (2009) should be consulted regarding the needs of today's highly productive layers.

The research results of Lemme (2009) are based on trials with Lohmann Brown and LSL layers, and his results were used to update the management recommendations for all commercial layer varieties of Lohmann Tierzucht. For any given daily feed intake, optimal diets can be formulated on this basis. The AA profile is kept constant in all phases, which may not be "optimal" (Elliot, 2012), but is the most practical approach to formulate cost effective layer diets.

Table 5: Recommendations for digestible amino acid intake and diet contents for different daily feed intake (Dietary energy: 11.82 MJ ME/kg)

	dig. Lys	dig. Met	dig. Met+Cys	dig. Thr	dig. Trp	dig. Arg	dig. Ile	dig. Val
optimal ratios to Lys	**100**	**50**	**91**	**70**	**21**	**104**	**80**	**88**
intake, mg/d	**831**	**415**	**756**	**582**	**174**	**864**	**665**	**731**
Feed intake, g/d	**Digestible Amino acids in g/kg diet**							
80	10.39	5.19	9.45	7.27	2.18	10.80	8.31	9.14
85	9.78	4.89	8.90	6.84	2.05	10.17	7.82	8.60
90	9.23	4.62	8.40	6.46	1.94	9.60	7.39	8.12
95	8.75	4.37	7.96	6.12	1.84	9.10	7.00	7.70
100	8.31	4.15	7.56	5.82	1.74	8.64	6.65	7.31
105	7.91	3.96	7.20	5.54	1.66	8.23	6.33	6.96
110	7.55	3.78	6.87	5.29	1.59	7.86	6.04	6.65
115	7.23	3.61	6.58	5.06	1.52	7.51	5.78	6.36
120	6.92	3.46	6.30	4.85	1.45	7.20	5.54	6.09

Table 6: Recommended nutrient levels for different daily feed intake in Phase 1: LSL layers from 19 to 45 weeks of age; above 58.6 g egg mass/hen/day (Lohmann Tierzucht, 2011)

Nutrient	Requirement g/Hen/Day	Daily Feed Consumption in g			
		105	110	115	120
Protein (%)	18.50	17.62	16.82	16.09	15.42
Calcium (%)	4.10	3.90	3.73	3.57	3.42
Phosphorus (%) *	0.60	0.57	0.55	0.52	0.50
Av. Phosphorus (%)	0.42	0.40	0.38	0.37	0.35
Sodium (%)	0.18	0.17	0.16	0.16	0.15
Chlorine (%)	0.18	0.17	0.16	0.16	0.15
Lysine (%)	0.87	0.82	0.79	0.75	0.72
Dig. Lysine (%)	0.71	0.68	0.65	0.62	0.59
Methionine (%)	0.44	0.42	0.40	0.38	0.37
Dig. Methionine (%)	0.36	0.34	0.33	0.31	0.30
Met. + Cys. (%)	0.80	0.76	0.73	0.69	0.67
Dig. Met.+Cys. (%)	0.66	0.62	0.60	0.57	0.55
Arginine (%)	0.91	0.87	0.83	0.80	0.76
Dig. Arginine (%)	0.75	0.71	0.68	0.65	0.63
Valine (%)	0.74	0.71	0.67	0.64	0.62
Dig. Valine (%)	0.63	0.60	0.57	0.55	0.53
Tryptophan (%)	0.18	0.17	0.17	0.16	0.15
Dig. Tryptophan (%)	0.15	0.14	0.14	0.13	0.13
Threonine (%)	0.61	0.58	0.55	0.53	0.51
Dig. Threonine (%)	0.50	0.48	0.45	0.43	0.42
Isoleucine (%)	0.70	0.66	0.63	0.60	0.58
Dig. Isoleucine (%)	0.57	0.54	0.52	0.50	0.48
Linoleic acid (%)	2.20	2.10	2.00	1.91	1.83

*without Phytase

Table 7: Recommended nutrient levels for different daily feed intake in Phase 3, LSL layers from about 65 weeks of age (Lohmann Tierzucht, 2011)

Nutrient	Requirement g/Hen/Day	Daily Feed Consumption in g			
		105	110	115	120
Protein (%)	16.84	16.03	15.30	14.64	14.03
Calcium (%)	4.50	4.29	4.09	3.91	3.75
Phosphorus (%) *	0.55	0.52	0.50	0.47	0.46
Av. Phosphorus (%)	0.38	0.36	0.35	0.33	0.32
Sodium (%)	0.16	0.16	0.15	0.14	0.14
Chlorine (%)	0.16	0.16	0.15	0.14	0.14
Lysine (%)	0.79	0.75	0.72	0.69	0.66
Dig. Lysine (%)	0.65	0.62	0.59	0.56	0.54
Methionine (%)	0.40	0.38	0.36	0.35	0.33
Dig. Methionine (%)	0.33	0.31	0.30	0.28	0.27
Met. + Cys. (%)	0.73	0.69	0.66	0.63	0.61
Dig. Met.+Cys. (%)	0.60	0.57	0.54	0.52	0.50
Arginine (%)	0.83	0.79	0.76	0.72	0.69
Dig. Arginine (%)	0.68	0.65	0.62	0.59	0.57
Valine (%)	0.67	0.64	0.61	0.59	0.56
Dig. Valine (%)	0.57	0.55	0.52	0.50	0.48
Tryptophan (%)	0.17	0.16	0.15	0.14	0.14
Dig. Tryptophan (%)	0.14	0.13	0.12	0.12	0.11
Threonine (%)	0.55	0.53	0.50	0.48	0.46
Dig. Threonine (%)	0.46	0.43	0.41	0.40	0.38
Isoleucine (%)	0.63	0.60	0.58	0.55	0.53
Dig. Isoleucine (%)	0.52	0.49	0.47	0.45	0.43
Linoleic acid (%)	1.30	1.24	1.18	1.13	1.08

*without Phytase

Reduced digestible amino acids and linoleic acid content, combined with adjusted calcium and phosphorus levels towards the end of production helps to maintain shell stability and limits the increase of egg weight. The optimal age to switch from one phase to the next phase or layer diet depends on daily egg mass production. The most productive flocks will produce on a high daily egg mass level for many weeks. They should not be switched too early to the next diet quality. The maintenance of a desired egg weight profile requires early reaction (Elliot, 2002). Adjusting the feed quality too late will not help to control egg weight.

Egg producers interested in more large and extra-large eggs will switch later to diets containing a lower amino acid and linoleic acid density. They should be aware of the fact that the efficiency of calcium metabolism in the medullary bones declines with age and supply older hens with higher amounts of calcium. Added calcium will have positive effects on shell strength, bone strength, overall health and bird welfare.

Molting

A tool to increase average egg size on a farm is to molt flocks when production and shell quality start to decline. After a pause, hens return to a high level of production and produce mostly large eggs with improved interior quality and stronger shells (Ruzzler, 1996). After a starvation period with substantial weight loss, hens are supplied with a layer diet and will eat enough to regain bodyweight and reach a second peak of production. If a balanced diet is supplied, the healthy appetite of the birds assures sufficient daily nutrient intake to push the egg weight up.

In some countries molting is banned due to animal welfare regulations, in others the procedures have been modified to less stressful “non-fast molting programs”. As a result of genetically improved persistency of production and shell strength, molting is losing support in the egg industry. For situations with sufficient rearing space, a longer single cycle is usually more economical than molting. Seasonal fluctuations in egg demand, pullet contracts, cash flow and other short-term arguments may suggest molting to minimize losses rather than maximize farm income.

Summary

Genetic and non-genetic factors influence egg weight of commercial layers and should be controlled by farm management before production of a flock starts: the genetic profile of a strain cross with regard to egg weight and correlated traits, the light stimulation during rearing and the bodyweight or frame size development of the pullets. Once a flock is in production, the nutrient intake, especially the early feed intake, has a major effect on the egg weight curve. Modern layer nutrition is focused on meeting the demands of the birds at all times by adjusting the supply of nutrients according to daily egg mass production and daily feed intake. Precision supply of nutrients influencing egg size is a tool to adjust the egg weight on mid or short term basis. The option to increase egg size by molting, keeping hens for two or more cycles, is losing support due to economic and welfare reasons.

Zusammenfassung

Beeinflussung des Eigewichts durch optimiertes Herdenmanagement

Genetische und nicht genetische Faktoren beeinflussen das Eigewicht von Legehennen und sollten schon vor Legebeginn durch ein kontrolliertes Herdenmanagement beeinflusst werden. Solche Faktoren sind das genetische Potential einer Herkunft bezüglich ihres Eigewichtes und korrelierenden Merkmalen, das Lichtprogramm während der Aufzucht, die Entwicklung ihres Knochengerüstes und Körpergewichtes. Wenn eine Herde produziert, hat die Nährstoffaufnahme, speziell der Futterverzehr zu Legebeginn, einen großen Einfluss auf die Entwicklung des Eigewichtes. Eine moderne Legehennenfütterung ist darauf ausgerichtet, den Bedarf der Hennen durch Anpassung der Nährstoffzufuhr an die täglich von den Tieren produzierte Eimasse und den Futterverzehr zu decken. Mit einer präzisen Regulierung der Nährstoffaufnahme einer Herde lässt sich kurz- und mittelfristig das Eigewicht beeinflussen. Die Möglichkeit, das Eigewicht durch Mauser einer Herde und ihre Nutzung in einer zweiten oder weiteren Legeperiode zu erhöhen, verliert durch ökonomische und tierschutzrelevante Aspekte an Bedeutung.

Literature:

Ysilevitz, I. (2007): Pullet and Layer Nutrition, unpublished presentation.

Bregendahl, K., S. A. Roberts, B. Kerr, and D. Hoehler (2008): Ideal ratios of isoleucine, methionine, methionine plus cystine, threonine, tryptophan and valine relative to lysine for white Leghorn-type laying hens of twenty-eight to thirty-four weeks of age. Poultry Science 87: 744-758.

Elliot, M.A. (2002): Applied pullet and layer nutrition with an emphasis on problems commonly encountered in the field. Cornell Poultry Pointers, Vol. 52(3): 16-32.

Elliot, M.A (2012): New concepts in layer nutrition. Proceedings of 23rd Annual Australian Poultry Science Symposium, 217-231.

Joly, P. (2007): Re-evaluation of amino acids requirements for laying hens Part 1: Methionine and cystine requirements. ISA Hendrix Genetics: 13.

Lemme, A. (2009): Amino Acid Recommendation for laying hens. Amino News, 13/02: 1-11.

Lohmann Tierzucht GmbH (2011): Management guide layers – LSL Classic.

Pottgüter, R. (2008) personal communication

Preisinger, R. (2002) personal communication

Ruzzler, P.L. (1996): The keys to successful induced molting of Leghorn-type hens. Virginia cooperative extension service, Publication 408-026.

Thiele, H.-H. (2009): Light Stimulation of Commercial Layers. Lohmann Information, 44 (2): 28-37.

Author's Address:

Dr. H.-H. Thiele,
Lohmann Tierzucht GmbH, Postfach 460,
27454 Cuxhaven, Germany

e-mail: Thiele@ltz.de

Investigations on diet composition, litter quality and experimantal infection on the severity of foot pad dermatitis in young turkeys housed with or without floor heating

A. Abd El-Wahab[1], C.F. Visscher[1], A. Beineke[2], M. Beyerbach[3], S. Wolken[4], J.-M. Reperant[5] and J. Kamphues[1]

Introduction

Actions concerning animal health in the turkey production are coming more and more to the fore. Foot pad dermatitis (FPD) is a common challenge to poultry production. FPD, also known as plantar pododermatitis, is basically a type of contact dermatitis affecting the plantar region of the feet, with lesions that begin as small scaly brown scabs on the surface of the metatarsal and digital pads, becoming cracked and eroded and progressively larger over the first few weeks of life along with acute inflammation, swelling, hyperplasia and necrosis of the epidermis with deep ulcers occurring in severe cases (GREENE *et al.*, 1985; BREUER *et al.*, 2006). The ulcers are often covered by crusts formed by exudates, faecal material and litter. Although there are various estimates of its prevalence, it is difficult to compare findings because the scoring systems used in different experiments are not the same. In a survey carried out by EKSTRAND and ALGERS (1997) 98 % of Swedish turkey poults had signs of FPD. BERG (1998) estimated the prevalence of FPD in Swedish turkeys to be 20 % for severe lesions (ulcers) and 78 % for mild lesions (discolouration, erosion). FPD can achieve a prevalence of 91-100 % in fattening turkeys (HAFEZ *et al.*, 2004). Also, GROSSE LIESNER (2007) found that about 97 % of turkeys at slaughtering showed FPD lesions, but without any negative adverse effects on final body weight.

FPD is an important aspect of bird welfare, as in severe cases, the foot pad lesions may cause pain which together with a deteriorated state of health constitutes a welfare issue. The growing demand for least-cost, wholesome and convenient food products has been the driver for the expansion and diversification of the poultry industry. The rate of FPD incidence per farm is gaining recognition as a well-being indicator (BRADSHAW *et al.*, 2002; MARTRENCHAR *et al.*, 2002). Moreover, lesions on the feet may be a gateway for bacteria which might affect carcass quality (MAYNE *et al.*, 2006). The aetiology of FPD is a complex interaction of different factors. Some of these are related to dietary factors such as proportion of soybean meal and amounts of oligosaccharides, potassium and salt in feed that force wet litter conditions (JENSEN *et al.*, 1970; SMITH *et al.*, 2000; EICHNER et al., 2007; BILGILI *et al.*, 2009; YOUSSEF, 2011). Other factors are related to management and housing (litter quality, type of litter, stocking density and drinking system). YOUSSEF (2011) noted that lignocellulose litter showed the lowest severity of foot pad lesions on dry and wet litter and chopped straw (dry) was associated with higher foot pad scores. Finally, there are factors related to diseases caused by various infections. However, since decades litter moisture is considered to be a leading factor causing FPD (JENSEN *et al.*, 1970).

Therefore, distinct trials were conducted to find out the “critical” litter moisture content (that results in higher severity of FPD), to investigate the effects of litter type/floor heating, to quantify the impact of the dietary factors (surplus of electrolytes) and finally to test potential effects of a coccidial infection (wet litter as a consequence of an experimental infection) on the development and severity of FPD in young turkeys housed with or without floor heating.

Material and methods:

Four consecutive experiments were conducted on 2 week-old female turkeys (BUT-Big 6) over a period of 3 or 4 weeks. In each experiment, the birds were divided into 4 groups with 20 birds each (except in the first experiment 18 birds each). The external scoring for foot pads were done on a 7-point scale (0 = normal skin; 7 = over half of the foot pad is covered with necrotic scales) according to

[1, 2, 3, 4]University of Veterinary Medicine Hannover, Foundation, Germany
[5]French Agency for Food, Environmental and Occupational Health & Safety, France

MAYNE *et al.* (2007). Also, the histopathological scoring for foot pads was recorded on a 7-point scale (0 = normal epidermis; 7 = more than one rupture or "ulcer" of the epidermis) according to MAYNE *et al.* (2007).

Score 0 Score 3 Score 7

Photos by ABD EL-WAHAB *et al.*, (2010)

Experiment 1: "Critical" moisture content of litter

The control group was housed on dry wood shavings continuously, whereas each other group was divided into two equal subgroups and exposed daily for 4 or 8 h to different moisture contents in the litter (35 %, 50 % and 65 % DM) in adjacent separated boxes. These different moisture contents were achieved by adding water continuously as required. All turkeys were fed ad libitum an identical commercial pelleted diet. Foot pads were assessed weekly for external scoring and at the end of experiment for histopathologically investigations.

Experiment 2: Litter type and floor heating

The first 2 groups were kept on wood shavings (35 % moisture) with and without floor heating, the other 2 groups on lignocellulose (35 % moisture) with and without floor heating. Lignocellulose (Soft Cell®), made of natural lignocellulose which is processed into a soft and flexible material and is pelletized afterwards.The electrical floor heating system supplied with adjuster to control the temperature was used. Half of birds in each group were housed for 8 h/d in adjacent separate boxes where the litter was kept clean and dry (85 % DM) throughout the experiment. The temperature at litter surface varied at 35 °C in boxes with floor heating vs. 25 °C in ones without floor heating. All turkeys were fed ad libitum an identical commercial pelleted diet. Dust concentrations (PM10) were measured during the whole experimental period by using Air- Chek sampler (LISTED 124 U, Model: 224-PCXR8, SKC Inc. Pennsylvania, USA).

Experiment 3: High dietary electrolyte levels with and without floor heating

All birds were housed on wood shavings. Two groups were fed on normal dietary levels of electrolytes (1.7 g Na; 8.5 g K and 1.5 g Cl /kg), while the other two groups were fed on a diet with about doubled levels (3.3 g Na; 15.7 g K and 3.2 g Cl /kg). For each dietary treatment, half of the birds were exposed to floor heating. Half of birds in each group (n = 10) was exposed daily for 4 h in adjacent separate boxes on wood shavings litter with a "critical" moisture content (35 % water/ i.e. 65 % DM). In each experiment, foot pads were assessed weekly macroscopically and at d 35 for histopathological scores.

Experiment 4: Experimental coccidial challenge with and without floor heating

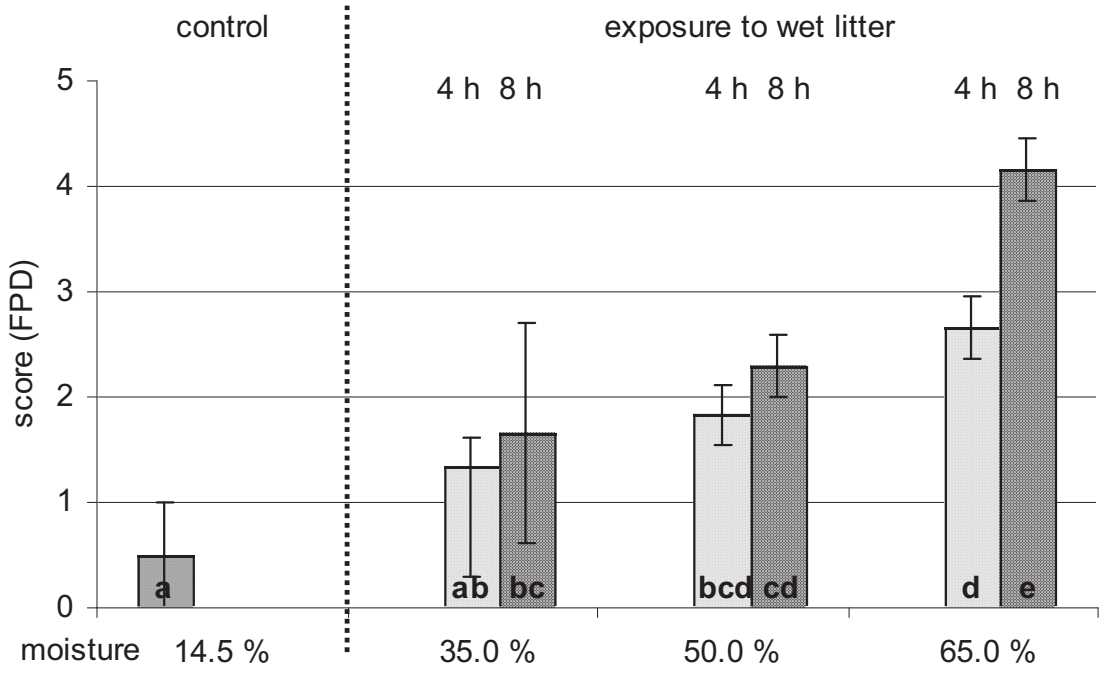
Two consecutive trials were done. All birds were fed ad libitum an identical pelleted diet without anticoccidia. The first 2 groups were kept on dry wood shavings with or without floor heating; the other 2 groups were housed on wet wood shavings litter with critical moisture content (35 %) with or without

floor heating. Only two birds in each group were experimentally infected at d 14 of life with E. adenoeides (~50,000 oocysts/bird) nominated as seeder birds and/or primary infected birds. Foot pads were assessed weekly for external scoring and at d 42 of life for histopathological scoring. The number of oocysts was determined repeatedly in the excreta of the primary infected birds as well as from the pooled excreta samples of the other ones (nominated as secondary infected birds).

Results:

1. In the **first experiment,** it was assumed that the "critical moisture content" for the development of FPD lesions is about 35 % litter moisture content. Furthermore, doubling exposure time (4—8 h) led to only slightly increased severity of FPD for the low litter moisture contents (35 and 50 % moisture) and a higher rise for the wettest litter treatment (65 % moisture) at the end of the trial.

Figure 1. External foot pad scores of young turkeys at the end of the experimental period (d 35) in relation to different exposure times to varying litter moisture (Mean ± SD); lowercase letters indicate significant differences with p < 0.05 between the groups (ABD EL-WAHAB *et al.*, 2012a)



2. In the **second experiment** regarding litter material, lignocellulose resulted in significantly lower histopathological FPD scores (1.43 ± 0.78) compared with wood shavings (1.76 ± 0.85). Using floor heating led to significantly lower FPD scores (0.86 ± 0.27) compared with groups without floor heating (2.0 ± 0.87). At using floor heating no significant differences were found between wet wood shavings and wet lignocellulose.

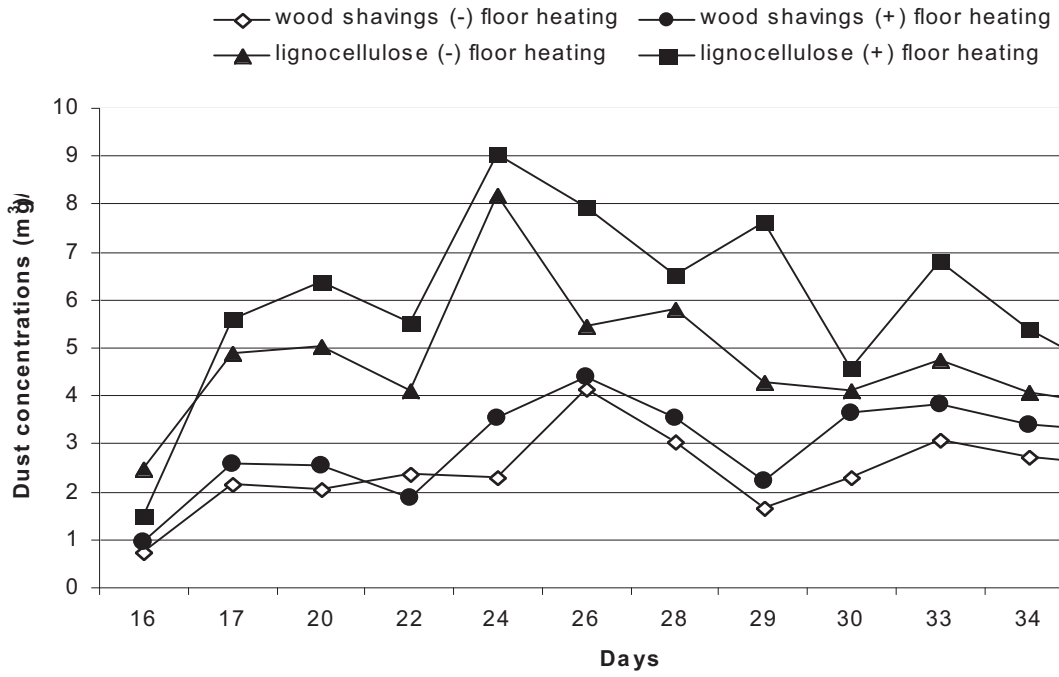
Table 1: Development of external and histopathological foot pad scores influenced by three factors (Mean ± SD by ABD EL-WAHAB *et al.*, 2011a)

criteria	treatment	day (duration of treatments)/FPD scores			
		external			histopathology
		21 (7)	28 (14)	35 (21)	35 (21)
		(n=40)	(n=40)	(n=40)	(n=40)
litter material	wood shavings	0.40 ± 0.53	0.78 ± 0.59	1.50 ± 0.82	1.76 ± 0.85^{A}
	lignocellulose	0.25 ± 0.41	0.60 ± 0.49	1.36 ± 0.89	1.43 ± 0.78^{B}
floor heating	-	0.45 ± 0.55	0.85 ± 0.62 A	2.00 ± 0.87^{A}	2.13 ± 0.85^{A}
	+	0.20 ± 0.35	0.53 ± 0.43 B	0.86 ± 0.27^{B}	1.10 ± 0.28^{B}
exposure to wet litter (h)	16	0.25 ± 0.39	0.58 ± 0.50	1.21 ± 0.62^{B}	1.38 ± 0.55^{B}
	24	0.40 ± 0.54	0.80 ± 0.58	1.65 ± 1.00^{A}	1.80 ± 0.99^{A}

^{A,B} Means in the same column with different superscripts are significantly different with $p < 0.05$

Moreover, in pens littered with lignocellulose highest amounts of dust compared with wood shavings was observed.

Figure 2. Dust concentrations in the air (mg/m^3; 75 cm above the litter surface) inside the pens (litter moisture 35 % for 24 h/d) during the experimental period (ABD EL-WAHAB *et al.*, 2011a)



3. In the **third experiment**, high dietary electrolytes increased the severity of FPD (3.65 ± 1), whereas floor heating decreased it significantly (2.36 ± 0.5) due to higher DM content in the litter. Combining low electrolyte levels with the floor heating system reduced the severity of FPD by about 60 %, compared to high dietary electrolytes levels without floor heating.

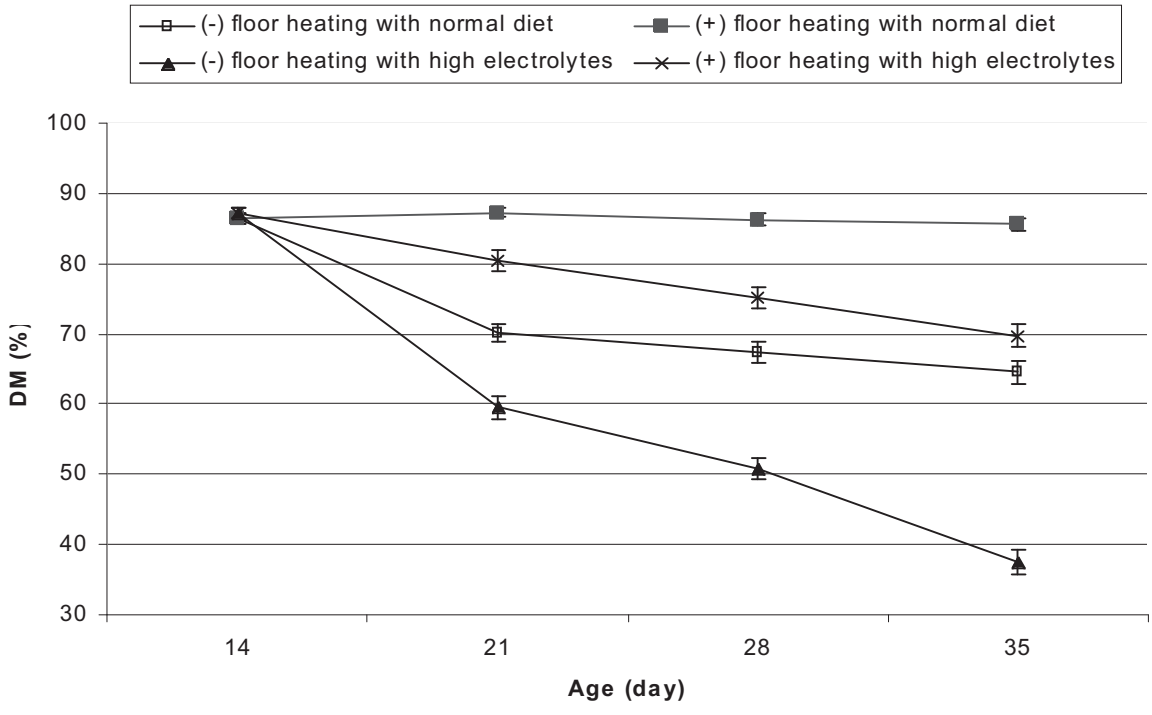
Table 2: External and histopathological foot pad scores (results of two factors variance analyses, mean ± SD) during experimental period (ABD EL-WAHAB *et al.*, 2011b)

factor*	treatment	Group (n)	FPD scores at day (duration of treatments)			
			external			histopathology
			21 (7)	28 (14)	35 (21)	35 (21)
dietary electrolytes	normal	G1+G2 (40)	1.31^{B}± 0.613	1.71^{B}± 0.534	2.48^{B}± 0.782	2.90^{B}± 0.743
	high	G3+G4 (40)	1.70^{A}± 0.882	2.68^{A}± 1.14	3.65^{A}± 1.03	4.26^{A}± 1.25
floor heating**	-	G1+G3 (40)	1.91^{A}± 0.807	2.81^{A}± 1.02	3.77^{A}± 1.00	4.40^{A}± 1.16
	+	G2+G4 (40)	1.10^{B}± 0.483	1.57^{B}± 0.460	2.36^{B}± 0.588	2.76^{B}± 0.575

A,B means in the same column within each factor with different superscripts are significantly different ($p < 0.05$)
*third factor (exposure to wet litter for 4 h/d) was neglected, as it resulted in no significant differences compared with birds housed for 24 h/d
**temperature at litter surface was about 35 °C

Furthermore, using floor heating resulted in higher water:feed intake ratios (2.9 and 3.6) for birds fed normal or high dietary electrolytes vs. ratios for birds housed without using floor heating and fed normal or high dietary electrolytes (2.3 and 2.8).

Figure 3: DM contents (%) of the litter in pens without adding water (dry litter) (ABD EL-WAHAB *et al.*, 2011b)



4. In the **fourth experiment**, using floor heating resulted in significantly lowered FPD scores (2.06 ± 0.735; 1.47 ± 0.734; trials 1/2) compared with groups housed without floor heating (3.88 ± 0.812; 2.73 ± 1.25) in both trials. Birds exposed continuously to wet litter (35 % moisture) showed significantly increased FPD scores (3.41 ± 1.23; 2.69 ± 1.34) compared with the group not exposed to wet litter (2.53 ± 1.00; 1.53 ± 0.683).

Table 3: Development of external and histopathological foot pad scores two factor variance analyses; mean ± SD (ABD EL-WAHAB *et al.*, 2012b)

	factor	treat-ment	day (duration of treatments)/FPD scores				
			external				histo-pathology
			21 (7)	28 (14)	35 (21)	42 (28)	42 (28)
			(n=40)	(n=40)	(n=40)	(n=40)	(n=40)
trial 1	floor heating	-	1.38^{az}±0.71	2.08^{ay}±0.89	3.02^{ax}±1.2	3.88^{aw}±0.81	3.53^{a}± 1.0
		+	0.825^{bz}±0.52	1.36^{by}±0.51	1.60^{bx}±0.62	2.06^{bw}±0.73	2.06^{b}± 0.66
	exposure to	0	0.837^{bz}±0.48	1.45^{by}±0.52	1.80^{bx}±0.82	2.53^{bw}±1.0	2.41^{b} ± 0.97
	wet litter (h)	24	1.37^{az}±0.78	2.00^{ay}±0.94	2.82^{ax}±1.3	3.41^{aw}±1.2	3.18^{a}± 1.2
trial 2	floor heating	-[1)]	0.935^{az}±0.40	1.21^{ay}±0.54	2.06^{ax}±1.1	2.73^{aw}±1.2	2.24^{a}± 0.84
		+[1)]	0.410^{bz}±0.42	0.782^{by}±0.41	1.02^{bx}±0.45	1.47^{bw}±0.73	1.51^{b}± 0.49
	exposure to	0	0.512^{bz}±0.48	0.950^{ay}±0.42	1.15^{bx}±0.52	1.53^{bw}±0.68	1.56^{b}± 0.57
	wet litter (h)	24[1)]	0.842a^{z}±0.43	1.04^{ay}±0.61	1.96^{ax}±1.1	2.69^{aw}±1.3	2.21^{a}± 0.82

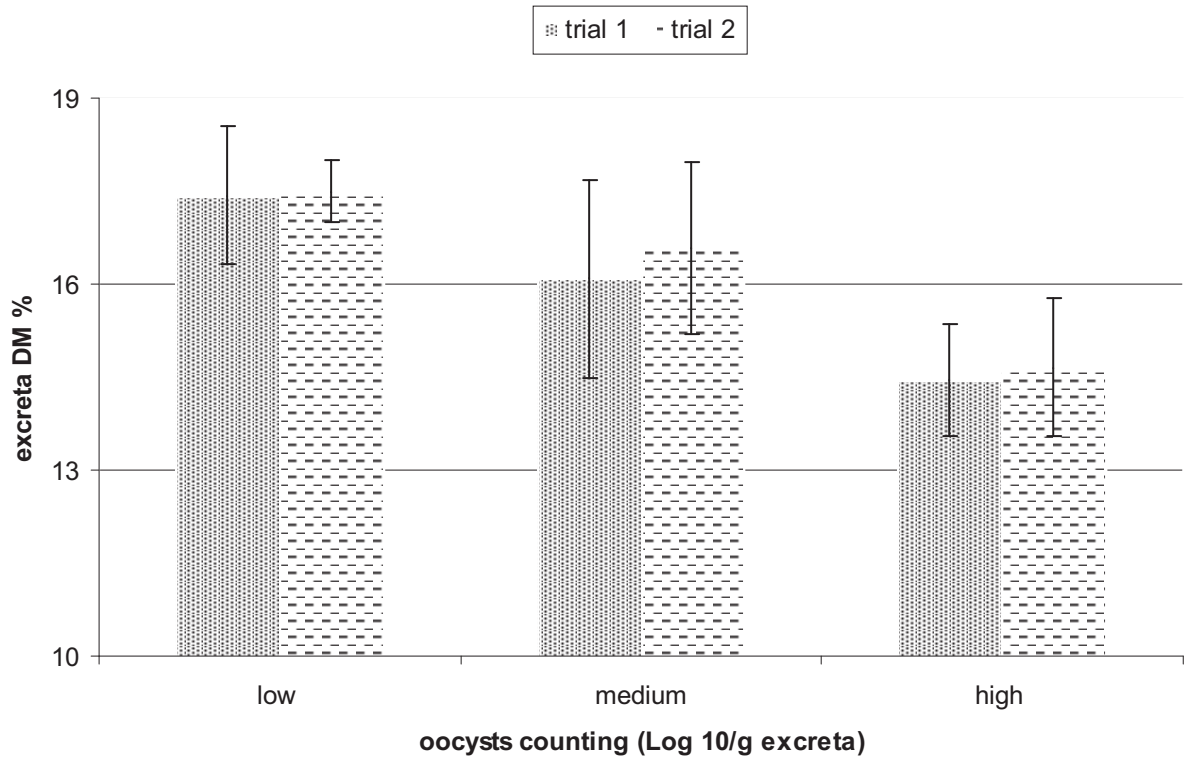
[a,b] Means in the same column within each criteria in each trial with different superscripts are significantly different ($p < 0.05$)
[w,x,y,z] Means in the same row within each criteria in each trial with different superscripts are significantly different ($p < 0.05$)
[1)] n=39

The coccidial infection resulted in markedly lowered DM contents of excreta and litter (14.8 and 58.0 %, 15.1 and 57.6 % in both trials, respectively) in the groups exposed to wet litter without using floor heating. However, in both trials using floor heating resulted in the highest mean DM content of litter (85.1 and 85.0 %) and also the highest body weights (2693 and 2559 g) despite coccidial infection. Furthermore, Figure 4 provides more details on the effects of the severity of coccidial infection on mean DM content of excreta, the oocyst count "Log 10/g excreta" classified into 3 categories (numbers 0-2 = low; numbers 2-3.5 = medium and numbers 3.5-5 = high). Accordingly, in both trials at low counts of oocysts in excreta there were significantly increased DM content of excreta (17.4 % ± 1.11 and 17.5 % ± 0.568) vs. (14.5 % ± 0.900 and 14.6 % ± 1.10) for the high oocyst count in excreta was observed.

General discussion:

A low prevalence and severity of foot pad dermatitis (FPD) are of great concern for many producers regarding both the bird's performance and product quality. The cause of FPD – as demonstrated here in each experiment - seems to be very complex.

Figure 4: Counts of oocysts in the pooled excreta related to dm content (%, mean ± SD) throughout the experimental period, the oocyst count "Log 10/g excreta" was classified into 3 categories (numbers 0-2 = low; numbers 2-3.5 = medium and numbers 3.5-5 = high (ABD EL-WAHAB *et al.*, 2012b)



Exposure to wet litter

Proper dry litter conditions are a prerequitite for healthy foot pads. Many authors have found positive correlations between litter quality, particularly moisture and the incidence of FPD (HARMS and SIMPSON 1977; EKSTRAND *et al.* 1997; YOUSSEF 2011). Pure water (without excreta) alone in the litter is sufficient to produce severe lesions (MAYNE *et al.* 2007; YOUSSEF 2011). The effect of **exposure time** was on focus for the first time in this experiment. However, an exposure of birds to wet litter containing 35 % moisture for only 4 h/d during the first week of experiment was definitely enough to induce a significant increase in external and histopathological FPD scores thus indicating that the critical moisture content in the litter may be at least 35 %. By doubling the time of exposure (8 h) the severity of FPD was only slightly increased compared with those birds exposed to only 4 h, primarily for lower litter DM content. This could be explained by the fact that standing on wet litter brings the feet in constant contact with moisture and has been suggested to cause the foot pad to soften and become more prone to damage, predisposing the bird to developing FPD (JENSEN *et al.*, 1970). But a critical question should be allowed: is the litter really the right focus? The litter is a mixture of bedding materials with increasing amounts and proportion of excreta (KAMPHUES *et al.*, 2011). At the end of the fattening period the proportion of excreta will exceed 90 %, it means that less than 10 % is coming from the litter material. Thus, it is presumably more important that the excreta (faeces and urine) release the water, which is transferred to the air and by the latter out of the barn. Under this aspect the ventilation in the barn is worth to be underlined. Then the question will arise on all factors that could influence the water release from the excreta and from the mixture of litter with excreta and the transfer to the air above the litter surface. It is well known that "layers of excreta" on the litter surface impair the process of drying markedly. Thus in future experimental studies, it should be tested what are the main influences that impair/prevent or facilitate the water release from fresh excreta.

Litter type

Only in one experiment lignocellulose was used as a litter material. It was found that at 35 % moisture content, lignocellulose was accompanied with significantly lower FPD scores compared with wood shavings. Nevertheless, from economical point of view, lignocellulose will never be used for the whole fattening period (20 weeks of turkeys), due to its high costs (12.5 kg/m² = 5 €/m²). But some people hypothesize that very good litter conditions in the rearing period would give advantages for the following fattening period. So, may be that using lignocellulose in the rearing period and wood shavings in the fattening period could be a solution acceptable from economical point of view. However, ABD EL-WAHAB *et al.* (2011, unpublished data) observed that lignocellulose in the first 6 weeks of rearing turkeys caused significantly lower FPD scores compared with wood shavings. Nevertheless, with shifting from lignocellulose (6 weeks rearing period) to wood shavings until end of the fattening period (20 weeks) did not result in marked differences in comparison to those housed continuously on wood shavings. Furthermore in a another study, ABD EL-WAHAB *et al.* (2011, unpublished data) found that lignocellulose is much better regarding health of foot pad than straw-granulate pellets (new bedding material) in the first five weeks of rearing turkeys. But due to high costs of lignocellulose and due to some technical problems during its processing which lead to increase airborne dusts in poultry houses seem to be the most limiting factors for using lignocellulose as litter material in the field. Therefore, lignocellulose could be not suitable as a litter material for rearing turkeys but a promising bedding material for rearing broilers due to fewer amounts of lignocellulose littered and shorter rearing period in comparison to turkeys. Therefore, lignocellulose could be a suitable litter bedding material for broiler (rearing period 35 days only) as well as due to small amount of lignocellulose used as a litter.

Floor heating technique

Independent of further factors (type of litter, diet composition, artificial infection) the use of floor heating resulted in desirable changes regarding prevalence and severity of FPD.

Up to now, these effects are supposed to be related to the drier surface of the litter.

By using floor heating in the own experiments, distinct interesting interactions could be demonstrated. For example, in spite of high sodium and potassium levels in the diet no detrimental effects occurred regarding litter quality and/or foot pad health. Although the water intake increased – when birds were housed with floor heating – the litter had higher DM content at the end of the trial (d 35), indicating that the floor heating favoured markedly the release of water (transfer to the air). But in general for the first weeks of birds' life, it could be a recommendable measure for the practice. Because in this early stage the birds need high ambient temperature, high protein diets (often high potassium levels due to high proportion of soybean meal). Nevertheless, there is a need to look on "side effects" of floor heating technique. For example, as it was observed in field studies that it seems to be a trend for higher airborne dust levels in barns when floor heating comes in use.

Diet composition

As demonstrated in details by YOUSSEF (2011), there are many ways by which the diet could interfere with FPD "a wide spread problem in poultry flocks". There are changes in the diet that could increase the risk of FPD, but also there are some other dietary strategies that could help to reduce or minimize the prevalence and severity of FPD (adding zinc and/or biotin in a surplus). In diet formulation it is easy to achieve a low Na content but using normal protein sources often results in K levels >10 g/kg diet.

In the present investigations it was demonstrated that surplus levels of dietary electrolytes did not result in detrimental effects on foot pad health when floor heating was in use. Thus, by using floor heating we will not realize those mistakes of diet composition/formulation.

But testing the diet composition, should not let us neglect the potential role of coccidiosis or – from the feed production point of view – the correct use/adding of an effective coccidiostat. However, the emergence of resistance to coccidiostats, consumer demand for using fewer feed additives, and European Union Regulations (withdrawal of antibiotic feed additives as a precautionary measure) might restrict

the use of coccidiostats (EUROPEAN COMMISSION REGULATIONS, 1997). If this happens, alternative strategies should probably be introduced to minimize the adverse effects of coccidia on animal health and production. Additionally, due to misdosing and/or inefficient anticoccidial additive in the diet, the excreta and bedding material will be markedly influenced by the coccidial infection resulting in higher scores of FPD. Thus, the consequences of own experimental studies are that in case of increased FPD problems/prevalence a chemical analysis of the diet (misdosing of nutrients/minerals) is recommended, but also counting the oocysts in the excreta is necessary to detect "sub-clinical coccidiosis". In field studies it seems to be worth to check concomitantly the FPD scores and the counts of coccidial oocysts. In the experiment 4, there was an interesting relation between the counts of oocysts in the excreta and the DM content of excreta that could be used in the field comparison (without neglecting the other enteric infections such as clostridia which could have identical effects and consequences). But here, the artificial infection with coccidia was chosen to demonstrate what could happen in a consequence of misdosing of additives or confounding diets (with/without coccidiostat).

Role of coccidiosis

To simulate a condition that could happen in a field, two replicated trials were done. It was observed that oocyst numbers in the excreta were closely correlated with changes in excreta quality. Experiment 4 provides a major great detail on the effects of the intensity of coccidia infection on mean excreta DM. The oocyst counting "Log 10/g excreta" was classified into 3 categories (numbers 0-2 = low; numbers 2-3.5 = medium and numbers 3.5-5 = high). Accordingly, it was observed that high oocyst numbers in excreta was accompanied with a significantly lower excreta DM content. Thus, coccidial infection acts additively on excreta/litter moisture contents. Additionally, combination of floor heating and dry litter resulted in markedly reduced oocysts shedding in the seeder birds "primary" as well as in secondary infected birds. Interestingly, medium oocyst counting "Log 10/g excreta" of secondary individual infected birds resulted in the highest FPD scores for the same birds and the high oocyst counting "Log 10/g excreta" of secondary individual infected birds did not correlate with the FPD scores of the same birds.

Using floor heating for infected birds resulted in significantly lower FPD scores compared with groups housed without using floor heating. Despite forced watery excreta due to coccidial infection, the litter became drier when floor heating was in use. Therefore, floor heating is likely to be highly effective in reducing the development and severity of FPD. However, the highest oocysts in the chymus were found in the group housed on dry litter with using floor heating. This is an interesting observation that is up to now not understood.

Additionally, it was observed that in similar factors (housing and feeding) the worst effect on foot pad was due to artificial infection with coccidia either with or without using floor heating (Table 4).

Table 4: Comparison between experimentally infected and not infected birds with coccidia on DM contents (%) of excreta and litter as well as on FPD scores at 35 d of life in young turkeys

floor heating	exposure to wet litter[1] (h/d)	trial without infection			trials with infection (1/2)		
		excreta DM %	litter DM %[2]	FPD scores	excreta DM %	litter DM %[3]	FPD scores
-	24	17.2	65.7	2.55	14.2/14.5	55.1/52.5	3.95/2.78
+	24	17.3	66.2	0.95	15.0/15.6	60.2/60.6	1.70/1.13

1) 65 % was intended by adding water continuously
2) half of birds were exposed daily to dry litter for 8 h
3) lower dm content of litter not only due to infection but also due to higher stocking density

Conclusions

The key point is that the prevalence and severity of FPD were clearly affected by the litter quality. Improving the general standards of rearing, considering housing facilities, equipment, management and stockman ship should be considered as these factors are mainly related to the animals' welfare. As demonstrated in these experimental studies litter quality has a great impact on the bird's welfare. The first marked increase of FPD lesions was observed after one week of exposure for 4 h/d at 35 % litter moisture with increasing severity of FPD for higher moisture contents. Both factors (moisture content/exposure time) significantly and additively influenced severity of FPD. Floor heating, even with wet litter (35 % moisture) and independent of litter type, resulted in reduced severity of FPD compared with birds in pens without floor heating. ABD EL-WAHAB *et al.* (2011a,b) observed that the significant effect of using floor heating on FPD scores could be due to the litter becoming dry as fresh litter or could be due to floor heating leading to warm foot pads (Table 4) causing vasodilatation of the blood vessels, increasing the blood flow to promote healing. The principle of the warming effect on blood flow in humans was stated by NISHA (2003). On the other hand, with the absence of floor heating the litter is quite cool and might lead to blood vessel constriction resulting in a cold-wet foot pad. The heat source in turkey houses hangs above the pens; so the upper surface of litter becomes warm but the colder, deeper litter eventually moves to the top. In addition, using lignocellulose as a litter material resulted in lower FPD compared with wood shavings. However, lignocellulose will never be used for the whole fattening period (20 weeks), due to its high costs (12.5 kg/m2 = 5 /m2). High levels of electrolytes increased the severity of FPD significantly. Despite of forced water intake the litter became drier when floor heating was in use. Doubling the electrolytes levels in the diet increased the FPD scores by 50 % compared with normal levels. Using floor heating reduced the FPD scores by 40 %. Coccidial infections led to watery excreta and a poor litter quality and hence resulted in significantly increased severity of FPD which can be overcome by using floor heating.
In the puzzle of factors that could result in FPD, here experimental studies were done to demonstrate diverse field relevant interactions. A lot of exact data were generated that might be used for epidemiological studies (for example, the value/range of critical moisture content in the litter). But the main result and experience of the four own different experiments is whenever you change one factor of the above called "puzzle" – willing or not – you change the parameters and findings in another part of the puzzle. It is the time to consider all factors in the puzzle (in a more holistic way?).

Zusammenfassung

Experimentelle Untersuchungen zu Auswirkungen der Futterzusammensetzung (Elektrolytgehalt), der Einstreuqualität (Art, Feuchte) und einer Kokzidieninfektion auf die Entwicklung und den Schweregrad der Fußballenerkrankung junger Puten bei unterschiedlicher Haltung (ohne/mit Fußbodenheizung)

Sowohl Vorkommen als auch Schweregrad der Fußballenerkrankung (Foot Pad Dermatitis, FPD) werden maßgeblich von der Qualität der Einstreu bestimmt. Es ist bekannt, dass es sich bei dieser Störung um ein multifaktorielles Geschehen handelt, in dem die Haltung, die Fütterung, das Management, aber auch Infektionen eine maßgebliche Rolle spielen.

Ein erster deutlicher Anstieg der FPD-Läsionen war nach einwöchiger Exposition für 4h/d bei 35% Feuchtigkeit der Einstreu zu beobachten. Sowohl die Feuchtigkeit als auch die Expositionsdauer hatten einen signifikanten, d.h. additiven Effekt auf den Schweregrad der FPD. Der Einsatz einer Fußbodenheizung führte auch bei feuchter Einstreu und unabhängig vom Einstreutyp im Vergleich zu Tieren, die ohne Fußbodenheizung gehalten wurden, zu einem verringerten Schweregrad der FPD. Nach eigenen früheren Untersuchungen kann unterstellt werden, dass der signifikante Effekt der Fußbodenheizung auf die Ausprägung der FPD Scores darauf zurückzuführen sein könnte, dass die Einstreu trockener ist oder dass es aufgrund der Wärmeeinwirkung auf die Fußballen (Table 4) dort zu einer Vasodilatation kommt. Der hierdurch gesteigerte Blutfluss könnte den Heilungsprozess beschleunigen. Das Prinzip des Wärmeeinflusses auf den Blutfluss wurde bereits von NISHA (2003) beim Menschen festgestellt. Auf der anderen Seite ist die feuchte Einstreu ohne Fußbodenheizung

kühler und könnte zu einer Vasokonstriktion mit daraus resultierenden kühlen sowie feuchten Fußballen führen. Da die Heizquelle in Putenställen über den Tieren hängt, wird die Oberfläche der Einstreu wärmer, aber der kältere, tiefer gelegene Anteil wird unter Umständen auch wieder an die Oberfläche gekehrt. Weiterhin führte die Benutzung von Lignozellulose als Einstreumaterial im Vergleich zu Hobelspänen zu einer geringeren Ausprägung der FPD. Aufgrund der hohen Kosten (12,5 kg/m2 = 5 /m2) wird Lignozellulose kaum während der ganzen Mastperiode (20 Wochen) genutzt werden können. Hohe Gehalte an Elektrolyten im Futter erhöhten den Schweregrad der FPD signifikant. Trotz forcierter Wasseraufnahme war die Einstreu trockener, wenn eine Fußbodenheizung genutzt wurde. Eine Verdopplung der Elektrolytgehalte im Futtermittel erhöhte die FPD Scores im Vergleich zu normalen Gehalten um 50%. Die Nutzung der Fußbodenheizung reduzierte die FPD Scores um 40%. Die experimentelle Infektion mit Kokzidien führte zu wässrigen Exkrementen und einer entsprechend schlechten Einstreuqualität. Dadurch erhöhte sich der Schweregrad der FPD signifikant, was ebenfalls bei Nutzung der Fußbodenheizung verhindert werden konnte.

In dem „Puzzel“ des multifaktoriellen Geschehens um die FPD wurden hier Studien durchgeführt, um diverse praxisrelevante Einflüsse nachzustellen. Es wurde eine große Anzahl exakter Daten gewonnen, die für epidemiologische Studien benutzt werden können (zum Beispiel einen Wert/Bereich, ab dem von einer „kritischen Einstreufeuchte“ gesprochen werden kann). Das wesentliche Ergebnis der durchgeführten Untersuchungen ist, dass aufgrund der vielfältigen Interaktionen bei der Entstehung der Fußballenerkrankungen ein ganzes Spektrum möglicher Einflüsse differentialdiagnostisch bedacht werden muss. Es ist angebracht, alle Zusammenhänge zu betrachten.

References

In this paper, the results of four original articles published or accepted for publication in international journals are summarized:

1. Abd El-Wahab A., Visscher C. F., Beineke A., Beyerbach M. and Kamphues J. (2011a): Effects of floor heating and litter quality on the development and severity of foot pad dermatitis in young turkeys. Journal of Avian Diseases 55:429-434
2. Abd El-Wahab A., Visscher C. F., Beineke A., Beyerbach M. and Kamphues J. (2011b): Effects of high electrolyte contents in the diet and using floor heating on development and severity of foot pad dermatitis in young turkeys. Journal of Animal Physiology and Animal Nutrition. (Article first published online: 13 OCT 2011, DOI: 10.1111/j.1439-0396.2011.01240.x).
3. Abd El-Wahab A., Visscher C. F., Beineke A., Beyerbach M. and Kamphues J. (2012a): Experimental studies on the effects of different litter moisture contents and exposure time to wet litter on development and severity of foot pad dermatitis in young fattening turkeys. Arch.Geflügelk., 76 (1). S. 55–62, 2012, ISSN 0003-9098.
4. Abd El-Wahab A., Visscher C. F, Wolken, S., Reperant, J-M., Beineke A.,

Beyerbach M. and Kamphues J. (2012b): Foot pad dermatitis and experimentally induced coccidiosis in young turkeys fed a diet without anticoccidia. Poult. Sci. March 2012 vol. 91: 3 pp 627-635.

A complete list of references from the doctorate thesis entitled “Experimental studies on effects of diet composition (electrolyte contents), litter quality (type, moisture) and infection (coccidia) on the development and severity of foot pad dermatitis in young turkeys housed with or without floor heating” may be obtained from the supervisor and corresponding author:

Prof. Dr. Josef Kamphues
Institut für Tierernährung
Stiftung Tierärztliche Hochschule Hannover
Bischofsholer Damm 15
30173 Hannover
Josef.kamphues@tiho-hannover.de

Balanced Breeding of Turkeys for Health & Welfare Traits

Magnus Swalander
Aviagen Turkeys, Tattenhall, United Kingdom

Introduction

The role of the primary breeder is to supply turkeys that perform with the highest levels of biological performance and health status.

To achieve this, modern turkey breeding uses a broad selection objective including a range of health, fitness, efficiency, reproduction and meat traits. Care is taken to make sustainable and predictable year-on-year progress in all traits, to satisfy the requirements determined by our customers and society as a whole.

The primary breeder performs selection at the pedigree level, and then transmits the genetic progress through multiplication steps, i.e. great-grandparent and grand-parent level. The grand-parents produce the cross-bred parent stock. The parent stock male and female lines are then mated together to produce the commercial male and female turkeys. The time-line from pedigree level to commercial bird is approximately 4 years (Graph 1).

One of the most important assets for any breeder is having a large and diverse gene pool. This allows new line combinations and crosses to be developed to respond to changing requirements. Care is taken to preserve genetic variation by avoiding inbreeding in the populations. Aviagen Turkeys' gene pool includes a total of approximately 40 different turkey pure lines, which are of 14 different colour variants, suitable for both indoor rearing and for extensive outdoor rearing.

The observed bird performance results from a combination of genetics, stockmanship, housing, nutrition and health factors. It is only the genetic component, explaining typically 10% to 30% of the observed variation, which can be utilised to permanently improve a breed. However, the stockmanship, housing, nutrition and health factors, explaining the majority of variation, are extremely important considerations (diagram 2).

The primary breeders provide an extensive range of continually-updated technical and management recommendations to its customers and their farmers in order to enhance welfare and optimise performance further.

This paper describes the development of welfare traits in the Aviagen Turkey breeding programmes.

Balanced Breeding

Aviagen Turkeys operates a balanced breeding programme where health, fitness, welfare and production traits are taken into consideration.

To achieve this balance a high number of traits (>30) are measured on individual pedigree turkeys, and when the final selection of pedigree birds are made for the next generation, the selection decision is made on information from both the individual itself and the information from up to 250,000 relatives.

When performing balanced selection, traits that are either favourably or unfavourably correlated to each other are being selected for simultaneously. An example of an unfavourable correlation would be live weight and egg production, where heavier birds tend to lay a lower number of eggs. Similar adverse relationships can exist between production and health traits.

Diagram 1 Diversity of breeding stock, multiplication pyramid and feedback mechanism of Aviagen Turkey breeding programme. GGP = Great Grandparent Stock

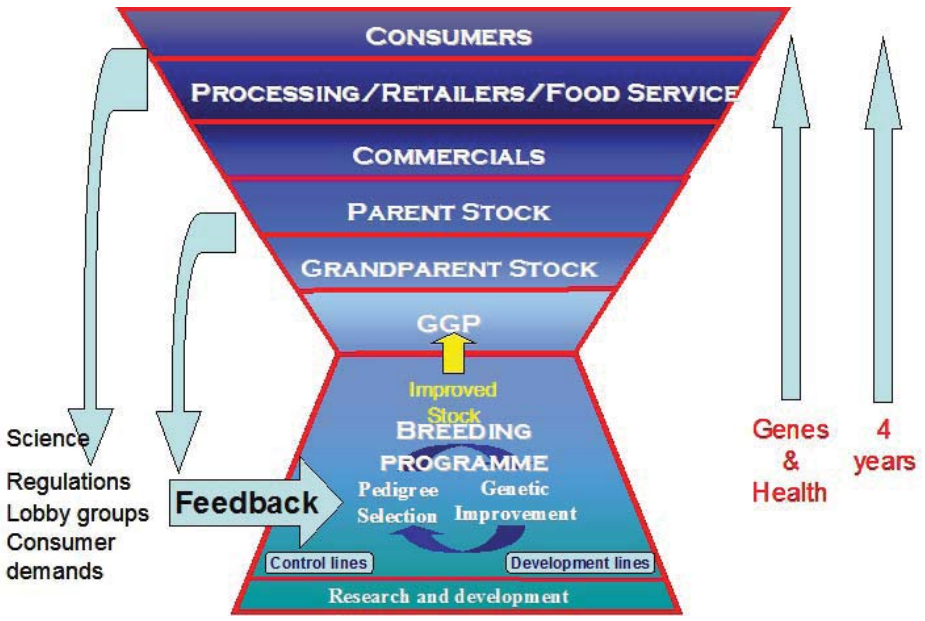
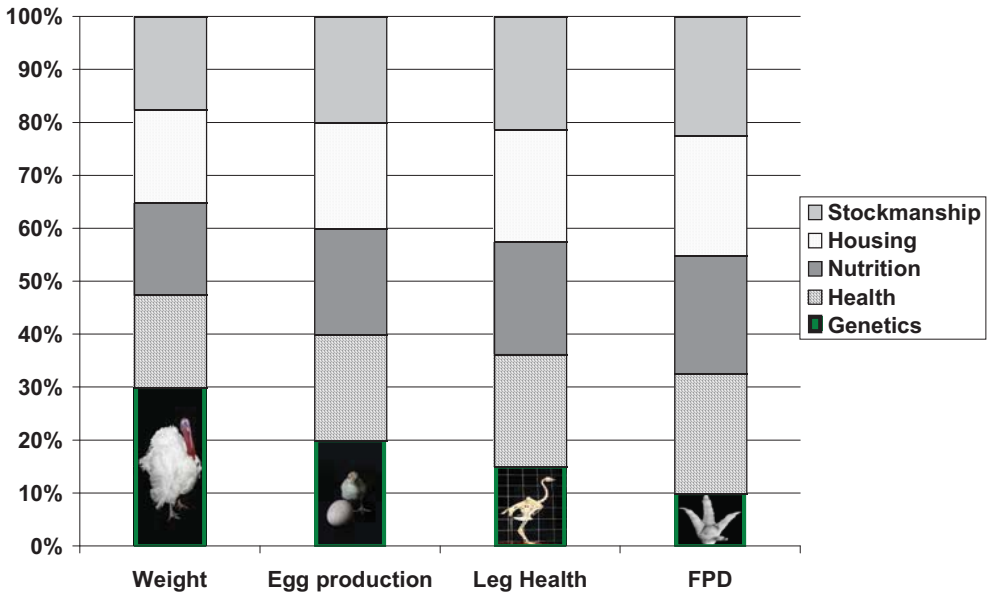


Diagram 2 Relative impact of genetics and management factors on traits in turkey production

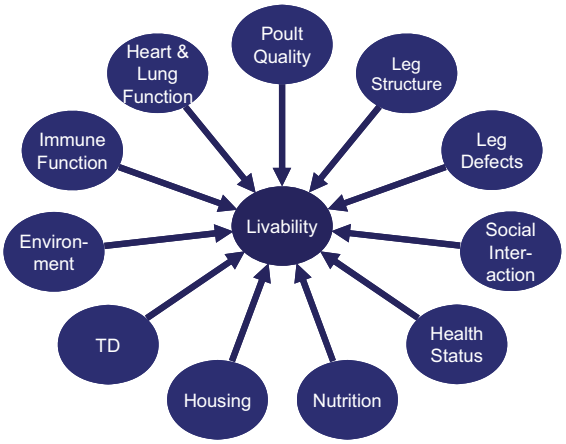


However, simultaneous selection can be made, making significant progress for all traits by:

1) Having large pedigree populations
2) Applying very large selection pressure
3) Useing advanced statistical methods such as Best Linear Unbiased Prediction or BLUP (e.g. PEST - Groeneveld, 1990).

These methods allow for simultaneous selection for a wide range of traits maximizing information from both the individual bird and all its relatives.

Diagram 3 Factors affecting liveability in turkeys



Selection for Liveability

Liveability (i.e. the opposite of mortality) is affected by a large number of traits, examples of which are described in diagram 3.

Selection for liveability is carried out through two different methods:

- Selection on direct trait – selection for liveability using the records on mortality from family members
- Selection on correlated traits targeting factors which contribute to having good liveability, such as leg health.

Liveability itself has a low level of heritability, which is the case for most 'survival' type traits. Using correlated traits as well when making the selections, improves selection accuracy and the amount of genetic progress delivered.

Selection for Leg Health & Fitness

The Aviagen Turkeys breeding programme has a long history of phenotypic selection for leg health, with walking assessment of individual turkeys, and culling for leg defects and poor walking ability since the 1970's. This has allowed continuous but moderate progress in leg health, in line with the low heritability of leg health traits (10-15% of observed variation explained by genetics).

In 2006, Aviagen Turkeys implemented a multi-trait family genetic selection for a wider range of leg health traits, which includes

- Gait scoring – each pedigree turkey is assessed for walking ability using the 5 point 'Bristol system' (Kestin et al, 2002)
- Leg defect scoring of the birds when walking (scoring valgus/varus type defect) – with automatic elimination if defect is present.
- Use of real-time X-ray methodology to eliminate incidence of Tibial Dyschondroplasia, a malformation of the bone which is characterised by an avascular plug of abnormal cartilage in the growth plate of long bones particularly the proximal tibiotarsus, (Orth & Cook, 1994).

Gait scoring and assessment of leg defects are traits to eliminate clinical signs of leg health issues. The inclusion of the information on x-ray images of the bone of the turkeys provides a powerful method of also eliminating sub-clinical leg issues.

As an example of the selection for a combination of leg health traits, phenotypic observations for a heavy pedigree line of turkey with regards to gait scoring (Gait), leg defects (Legdef), Tibial Dyschondroplasia (TD), conformation score at 18 weeks (CS18) and body weights at 14 (BW14) and 18 weeks (BW18) were analysed to assess their genetic relationships. The summary statistics are detailed in Table 1. Both male and female data was included in the analysis.

Table 1. Summary of phenotypic data on key leg health and growth traits in a heavy pedigree line of turkey

	# Rec.	Avg.	Min	Max	CV %
BW 14	66854	9.41	5.21	15.57	15.0
BW 18	87,515	12.55	6.43	19.99	20.8
CS 18	87,515	3.05	1	5	31.2
Gait	64,918	3.06	1	5	27.8
Legdef	92,568	13.7	0	100	34.1
TD	34,276	18.6	0	100	14.2

The data was analysed using VCE6 (Groneveld, 2010) using a statistical model including the fixed effects of sex, hatch, parent flock age, and the random effects of animal and a permanent environment effect (c^2). The results are presented in Table 2.

Table 2 Genetic parameters for key leg health and growth traits in a heavy pedigree line of turkey

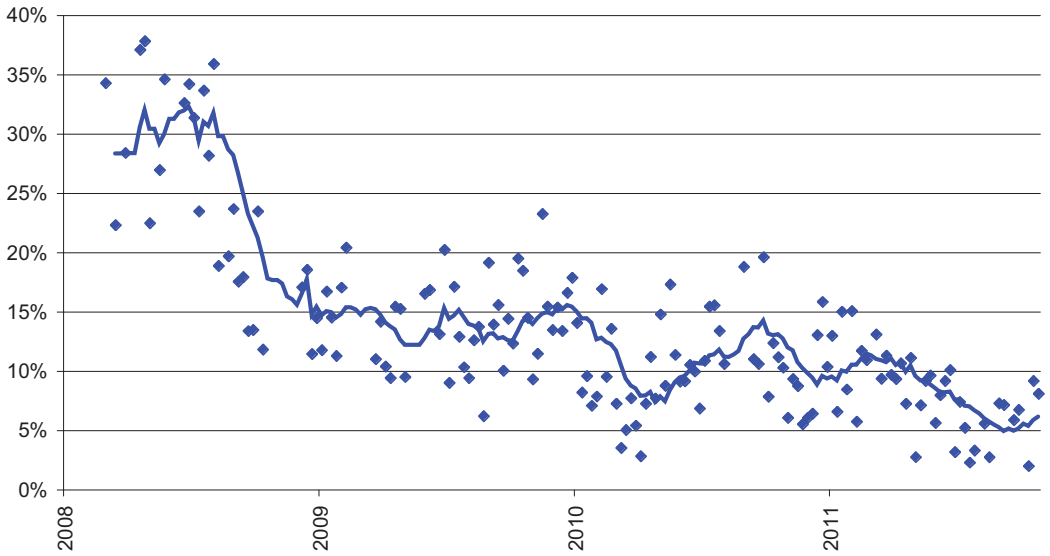
	BW 14	BW 18	CS 18	Gait	Legdef	TD
BW 14	**0.544**	0.957	0.820	0.469	0.468	0.100
BW 18		**0.492**	0.836	0.428	0.451	0.037
CS 18			**0.289**	0.569	0.550	0.135
Gait				**0.147**	0.845	0.342
Legdef					**0.110**	0.165
TD						**0.194**

As expected the growth traits showed the highest level of heritability, ranging from 0.49-0.54, whereas the leg health parameters were low to moderate, in the range of 0.11-0.19. Of the leg health traits the highest heritability was achieved for TD measurement (0.19). Interestingly the correlation between gait and leg defects is very strong (0.85) whereas the relationship between TD and gait is weaker (0.34). This demonstrates that a bird identified as having clinical Tibial Dyschondroplasia may not necessarily develop a leg defect or poor gait, but is at higher risk of developing such issues, in particular if at the same time undergoing a health challenge.

Thus, a strategy of combined selection for all three traits achieves progress for both clinical and sub-clinical leg health. This has proven highly successful – in the space of 4 years the incidence of TD has been reduced from 35% to 5-10% incidence (graph 1).

It is worth noting that this has been achieved at the same time as improving other commercial characteristics such feed conversion, liveability and growth rate, and is a good example of true balanced breeding. The impact of this selection will be present in commercial turkeys in 2012.

Graph 1. Percentage incidence of Tibial Dyschondroplasia in male line used for production of commercial turkeys.



Selection for foot pad health

Selection for increased foot pad health is a core part of the health selection objective for turkeys. The level of heritability for foot pad dermatitis (FPD) has been found to be low, in the range of 0.05-0.10 for turkeys, thus indicating that the management effects account for 90-95% of the observed variation. This means that genetic selection can improve foot pad health over time, but progress is moderate.

What is highly important is that selecting purely for foot pad score, improves the clinical expression (i.e. aspects of skin quality), but does not necessarily target the individuals causing high moisture litter content. Indeed, Mayne *et al* (2007) showed that litter moisture alone is sufficient to trigger a development of FPD, and there were little difference in this regard between different commercially available strains.

Thus, in order to maximise the progress through selection a two-pronged approach is taken:

1. *Direct selection on FPD* – each individual scored for foot pad health with the system as developed by Hocking group (Mayne *et al*, 2006).
2. *Recording individual water intake* – indicator trait for gut functionality and water retention ability.

The water intake data is recorded using a unique transponder based system developed by Aviagen Group which enables recording of each individual drinking session – the amount, duration and location. This data provides the crucial link between individual feed intake, individual water intake, litter moisture as well as the behaviour for both feeding and drinking. The quality of the data is reflected in a high heritability for water intake (h^2=0.34), which is used for direct selection eliminating individual birds causing high moisture litter.

Conclusions

Aviagen Turkeys operate a balanced breeding programme where fitness and health traits are considered as well as production characteristics. In the selection objective more than 1/3 of all selection pressure is dedicated to welfare and health traits, ¼ dedicated to reproductive traits and the remainder mainly to (feed) efficiency selection.

Significant advances have been made in leg health selection through use of gait scoring, leg defect scoring and use of X-ray techniques in multi-trait family selection. This has given a clear response in leg health (35% incidence of TD reduced down to 5-10% incidence in 4 years, and reducing further), which will be present in commercials in 2012.

Foot pad health is an integral part of turkey health selection, through both direct foot pad scoring and through using unique technology targeting individuals causing high moisture litter.

Aviagen turkeys are fully committed to the European industry with regards to participating and supporting research into management and genetics to increase health and welfare in turkey production.

Zusammenfassung:

Moderne Putenzucht unter Berücksichtigung von Gesundheit und Tierwohl

Im Zuchtprogramm von Aviagen Turkeys werden neben ökonomisch wichtigen Merkmalen der Mastleistung und Schlachtkörperqualität auch Fitness und Tiergesundheit entsprechend ihrer Bedeutung für die Praxis berücksichtigt. Über ein Drittel des Selektionspotenzials wird in Tierwohl und Gesundheit investiert, ein Viertel in Reproduktionsmerkmale, der Rest hauptsächlich in geringeren Futteraufwand je kg Zunahme.

Die Häufigkeit von Beinproblemen wurde innerhalb von 4 Jahren von 35% auf aktuell 5-10% verringert durch Mehrmerkmals-Familienselektion auf der Basis subjectiver Bewertung der Lauffähigkeit und Röntgenaufnahmen.

Auf intakte Fußballen wird routinemäßig selektiert, durch subjektive Bewertung von Defekten und eine besondere Technik zur Erkennung von Ausscheidern von nassem Kot.

Aviagen Turkeys hat sich gegenüber der Europäischen Putenindustrie verpflichtet, wissenschaftliche Untersuchungen zu genetischen und Management-bedingten Faktoren der Gesundheit und des Tierwohls von Puten zu unterstützen.

References

Groeneveld, E. (1990). Pest users manual. Federal Agricultural Research Centre (FAL), Neustadt

Groeneveld, E. (2010). VCE6 users manual. Federal Agricultural Research Centre (FAL), Neustadt

Kestin SC, Gordon S, Su G, Sørensen P. (2002) Relationships in broiler chickens between lameness, liveweight, growth rate and age. Vet Rec. 17;148(7):195-7

Mayne RK, Else RW, Hocking PM. (2006). Foot pad dermatitis develops at an early age in commercial turkeys. Br. Poultry Sci. 47(1):36-42

Mayne RK, Else RW, Hocking PM. (2007) High litter moisture alone is sufficient to cause footpad dermatitis in growing turkeys. Br Poult Sci.;48(5):538-45.

Orth MW,Cook ME. (1994). Avian tibial dyschondroplasia: a morphological and biochemical review of the growth plate lesion and its causes. Vet Pathol.31(4):403-4.

Author's Address:

Mr. Magnus Swalander
Director of Global Genetics, Aviagen Turkeys
Chowley Oak Business Park
Tattenhall CH3 5LA,
United Kingdom

e-mail: mswalander@aviagen.com

The changing role of horses in our society

Hanfried Haring, Warendorf, Germany

Introduction

The domestication of horses and their progressive adaptation to changing human life styles has a long history. For thousands of years, horses were kept and improved by selective breeding to maximize their usefulness for transportation of people and goods in peace and war times. Technical innovations replaced work horses in agriculture and commerce, so that agricultural land could be used more profitably to produce food and feed.

Times have passed when sport was the nicest matter of secondary importance on earth. Nowadays sport is an important part of the entertainment industry and a remarkable economic factor in the highly developed countries. Worldwide the turnover for sport exceeds 500 billion US $, including 200 billion just for ticketing.

We should clearly differentiate between two kinds of equestrian sport: the sport practiced daily by millions of people and the sport covered in the media. The first kind contributes significantly to the quality of life in a society: it involves learning and practicing fair play, responsibility, cooperation, efficiency and commitment as honorary office holders in local horse clubs.

The sport we know from the media is completely different. It concentrates on heroes who attract large audiences to commercially valuable TV-minutes and print media who cover victories and defeats, transfer money, personal interviews and scandals at great length. TOP SPORT is entertainment for the masses, the performance of the athletes are goods of the entertainment industry. This part of the sport is increasingly organized by commercial agencies. Regrettably, an important part of the potential value is being lost due to corruption, manipulation, cheating and violence.

Sport is “big business”, and the economic importance is reflected in annual spending, in Germany estimated at 40 billion EUR or about 500 EUR per capita.

In equestrian sport, the borderline between leisure sport and competitive sport is less clearly defined than in other sports. Unique for equestrian sport is the feature that it is performed together with a living partner, who cannot speak and for whom the rider has to take full responsibility. Unique is also that women and men compete on equal terms.

In forecasting future developments, numerous factors should be taken into account, including tradition, wealth, degree of organization, stage of technology, emotionality and priorities in defining quality of life.

Development of the German horse industry since World War II

Germany has a long tradition in horse breeding as well as in horse sport. At the end of World War II, about 1.5 million horses were kept in Germany. The horse population decreased rapidly with the changes in agriculture and industry. The working horse was replaced by the motor, while agriculture focused on efficient production of food. By the early 1970s only 250,000 horses were counted in Germany, and some “experts” predicted a future with horses only in zoos.

But then two developments rescued the horses: with increasing living standard, more and more families could afford one or more horses for hobby and sport, and with the introduction of more technology in daily life, there was a strong trend “back to nature” and to keep companion animals.

The horse industry in Germany was well organized and able to satisfy the growing demand for riding horses. This in turn generated a strong demand for trainers, coaches, training facilities etc. With the boom in the 1980s, the number of horses in Germany increased to more than one million. Details are shown in table 1.

Table 1: Statistics describing the horse industry in Germany:

Clubs		7,694
Competitors at shows (80% females)		736,870
Horses		1,000,000
Riders/Drivers		1,200,000
Horses competing		138,428
Shows national		3,669
Shows international		118
Starts at shows		1,462,885
Broodmares	- sport horses	68,265
	- draft horses	5,000
	- ponies	25,434

These figures reflect Germany's position as No. 1 horse breeding nation in the world.

Similar developments took place in some neighboring countries like France, Great Britain, The Netherlands, Sweden, Denmark, Italy and Belgium, in some cases with a considerable time lag.

Looking ahead to the future, the chances for further growth of the horse business appear to be limited, not only in view of the demographic development with a declining and aging human population in Germany and other developed countries. The outlook for countries in Eastern Europe (especially Hungary, Poland and Russia), Asia, South America and even parts of Africa is more optimistic. With increasing personal purchasing power, some of these countries are likely to develop their own horse industry and enter the international competition.

The equestrian sport, like sport in general, is recognized by politicians as an important activity to reach people. Worldwide about 75% of all people are thought to be interested in sports, in Germany probably close to 85% of the population. This is a strong argument for politicians to be seen at major sport events and to express personal support. Unfortunately, political involvement is not always helpful for the sport in question.

The sport we see today developed during past decades in response to economic and political influence, and the result – whether we like it or not – seems irreversible. Today we discuss about TV-rights, merchandising, mobile leisure time society, sport tourism, betting industry, clothing and accessories - to mention just the most important factors. In some countries the contribution of sport to the GSP is in the region of 4% - with considerable potential for further growth with more leisure time. Not surprisingly, sport became an important factor for European policy in Brussels.

How important is the equestrian sport compared to other popular sports? In terms of club members, equestrian sport ranks only 7th in Germany, but in economic terms it involves much more turnover, because this sport requires the horse as an expensive partner. A study initiated by the German Horse Riders Association (IPSOS, 2000) estimated that equestrian sport contributes 5 Billion EUR to GSP, including 2.6 Billion EUR expenses for running costs and generates more than 300,000 jobs (3 - 4 horses per caretaker); more than 10 000 supply factories are living directly from the horse business.

These estimates demonstrate the economic importance of the horse industry. They are in line with corresponding figures in Switzerland, Austria, Sweden, Great Britain, France and the United States. Big events are of growing importance for national, regional and local economics. The operational budget of the World Equestrian Games in Aachen 2006 was about 20 Million EUR, of the WEG 2010 in Kentucky 64 Million US Dollar. A World Cup Final shows a budget of 5 Million EUR, a large national event between 1.5 and 3.0 Million EUR with growing tendency, resulting in increasing regional business. The contribution of the WEG in Aachen to the region (Germany, Belgium, the Netherlands) was more than 230 Million EUR, for Aachen 60 Million taxes only. The United States of America calculated for the WEG Kentucky 2010 more than 200 Million taxes, 128 Million directly (restaurants, hotels, gate money) and 73 Million indirect (services, food, suppliers). These are good reasons for communities and regions to invest in these tournaments, and this is valid for smaller shows as well.

The future for this kind of horse business looks extremely positive. Presently the equestrian sport is strongly concentrated on Europe, especially Germany, France and Italy. About 80% of all equestrian activities (shows etc.) are taking place in Europe, about 10 % in North America and less than 10 % in the rest of the world. Encouraging is the fact that the increasing numbers are not (only) coming from the development in the traditional horse sport regions, but above all from upcoming nations.

Table 2: Increase in number of horse shows during the past 10 years

	Number of shows 2010	Increase last decade %
Show Jumping	945	240
Endurance	700	850
Eventing	500	300
Dressage	300	350
Driving	180	550

We expect that the interest in equestrian sport will continue to grow and that the most important growth will come from developing regions of the world. This is good news for the horse industry.

Zusammenfassung

Die wirtschaftliche Bedeutung des Pferdes in der heutigen Gesellschaft

Breiten- und Spitzensport sind in den letzten Jahrzehnten zu einem bedeutenden Faktor in Politik und Wirtschaft geworden. Die Industrie rund um das Pferd leistet in Deutschland jährlich einen Beitrag zum Bruttosozialprodukt in Höhe von etwa 5 Milliarden Euro. Die zukünftige weltweite Entwicklung wird trotz einer Stagnation in einigen traditionell starken europäischen Ländern aufgrund des Nachholbedarfs in Osteuropa und der schnellen Entwicklung in Asien und auch Südamerika, von der Deutschland wirtschaftlich profitiert, ausgesprochen optimistisch beurteilt.

Author's Address:

Dr. Hanfried Haring
Brookstr.13
48336 Sassenberg, Germany

e-mail: hharing@fn-dokr.de