

Chapter 4 ('Understanding chicken learning and cognition and implications for improved management') provides readers with a comprehensive overview of chicken cognitive abilities. The — incorrect — general assumption that poultry are not very bright highlights the importance of this chapter.

The following ten chapters (part 2: 'Welfare issues in breeding, management and housing'), focus more on the applied part of the poultry farming industry. It covers diverse welfare and health challenges related to different breeds and types of chickens, including broilers (Chapters 11 and 18), broiler breeders (Chapter 9), laying hens (Chapters 12, 16 and 17) and young layer chicks (Chapter 10). In addition, all chapters discuss current management and housing topics related to poultry welfare in detail, such as the role of perches (Chapter 13), catching and transport practices (Chapter 14) and slaughter procedures (Chapter 15). These chapters provide a relevant and well-written overview for a wide audience, making it possible for many to better understand and improve chicken welfare.

Chapter 10 is entitled 'Opportunities to improve the welfare of young chickens' and offers a thorough examination of the indirect effects of parental genetics and environment and of incubation conditions on young chick development and welfare. The role of neurobiology in chicken welfare is also described. This chapter manages to skilfully link several complex fields (including ontogeny, stress regulation, brain lateralisation, immunity and the external environment), while discussing current welfare issues and innovative solutions. Although the neuroendocrine mechanisms of chicken physiology and their relation to welfare are sparsely mentioned throughout the book, Chapter 16 ('Cause and prevention of injurious pecking in chickens') further relates these mechanisms and early life experiences to the development of feather pecking. This is a major welfare issue for laying hens and additionally stresses the importance of understanding chicken neurobiology to improve health and welfare.

Chapter 11 ('Welfare issues in poultry housing and management: broilers') starts with a clear introduction and outline of housing systems and management in broiler production. The information that over a period of fifty years, broiler growth has increased by 400%, while feed conversion has improved by 50%, brings into focus the rapid genetic alterations in broilers which may now have surpassed our knowledge on how to safeguard the health and well-being of these animals. This chapter also provides an in-depth discussion on pressing broiler welfare issues and presents clear avenues to pursue for future research, including studies focused on slow-growing breeds.

Chapter 15 ('Improving welfare in poultry slaughter') begins with an expert description of the unique avian respiratory system, highlighting how it differs physiologically from mammals, whilst also underlining the impact of these differences on gas slaughter techniques. The chapter also highlights the general lack of sufficiently humane slaughter methods and the urgent need for research and development of improved slaughter procedures for poultry.

In conclusion, *Understanding the Behaviour and Improving the Welfare of Chickens* is an expertly written, widely accessible book for all professionals in the field, which should provide increased understanding of chicken behaviour and welfare. The book offers valuable guidance, including future research focus to close substantial knowledge gaps, practical up-to-date management improvements and the development of novel housing systems and farming methods, all contributing to the improvement of welfare in poultry.

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### ***The Slaughter of Farmed Animals: Practical Ways of Enhancing Animal Welfare***

Edited by T Grandin and M Cockram (2020). Published by CABI Publishing, Wallingford, Oxon, UK. 336 pages Paperback (ISBN: 9781789240573). Price: £49.99, €60.00, US\$70.00.

This detailed and comprehensive guide to the complex field of welfare at slaughter is an extremely useful practical reference text and resource of evidence-based opinion, edited by two leading figures and with contributions by a number of key experts from across the globe.

The book is usefully divided into chapters which deal with a distinct area of the science or ethics of welfare at slaughter; beginning with generalised concepts of animal welfare, progressing through the various stages of transport, handling, restraint, stunning, slaughter, meat quality and auditing. The book concludes with several chapters which examine the ethical issues of slaughter from various standpoints. The book also objectively discusses the concept of welfare trade-offs and the practice of religious slaughter; often considered to be areas of sensitivity. Each chapter begins with a brief summary of key points and learning objectives, finishing with a concluding statement and expansive reference list. In this format, with its stated intention of acting as a resource for commercial abattoirs and for those conducting detailed scientific reviews, it should be considered an essential supporting text to any self-directed or structured programme of study. The international contributions authored by experts in both livestock and poultry slaughter from the UK and Europe ensure that the text is balanced in its coverage of red and white meat systems and avoids a North America-centric viewpoint.

The intended readership is listed to include anyone involved with or interested in the operation of a commercial slaughter facility, from students to animal welfare officers and factory managers. The level of detail and depth of discussion offers any reader the opportunity to expand their understanding of the practicalities and considerations in achieving high standards of welfare at slaughter. However, in this approach, there is inevitably an expectation of a baseline level of understanding of scientific principles, biochemistry, physiology and of commercial slaughter. Consequently, readers without a working knowledge of these prerequisites may

find some chapters more difficult to digest, when written in the scientific style and which use terms not generally familiar to those who have not undertaken specialised tertiary education. Nevertheless, these chapters — excellent in their evidence-based content — are balanced by the narrative style of Grandin's contributions which describe the approach she took in resolving animal welfare issues, and how her understanding of animal needs and human drivers has developed during her career. The differing styles of writing undoubtedly complement each other, though a glossary of key terms, perhaps at the beginning of each chapter, may have facilitated understanding.

The book itself is divided into 18 chapters and the final chapter (covering ethics) is further subdivided into five sub-chapters addressing various aspects of the ethical slaughter paradigm. The scope of the text is indeed so discursive that a review of each chapter is beyond the limits of this critique, which instead selects a smaller number of chapters for more detailed discussion.

Chapter 2 on 'Welfare issues at slaughter' which was written by Cockram, delivers an excellent introduction to the principles of animal welfare at slaughter, defining the concept of humane slaughter through citation and acknowledges the differing experiences found in developed and developing countries. After touching on ethics in welfare at slaughter, he goes on to briefly examine public ambivalence towards livestock and their place in the food production chain, leading on to an initial discussion of its realities and the influence of market and societal demands. This introduction to the 'real world' of meat production and the food supply chain sets the tone for the remainder of the chapter and those to come in its succinct and dispassionate explanation of drivers influencing the system and animals within it. The larger part of the chapter gives an equally excellent introduction to animal emotions and their intrinsic link to welfare, presenting the alternative term 'affective states' to facilitate a shift in readers' thinking towards understanding experiences from the animals' perspective, before moving on to examine the concept of pain, fear and stress, listing potential sources in detail, presented in tables with citations for each example. The tables are particularly practical for those in operational or supervisory roles, though their layout is perhaps a little challenging to follow. Cockram then introduces the principles of the 'Five Freedoms' as a measure of potential sources of stress, eg hunger or fatigue, leading on to a final section on welfare assessment techniques. This chapter, in its discursive detail of the foundation concepts and approaches, is the perfect set-up for the following chapter by Grandin which examines in detail the important concept of welfare trade-offs and her personal experiences of achieving balance in the commercial reality of slaughter.

Here, Grandin describes her experience of the challenges of trade-offs and their solutions. She examines how to establish cut-off limits to the trade-off principle and describes circumstances where they should never be accepted. The chapter progresses through the successive stages and aspects of slaughter, from handling and stunning

to staffing, transport and equipment, before considering animal factors which may introduce trade-off considerations, such as breed, sex, behavioural experiences and use of growth promoters, and lastly considering external factors, such as economics and the environment. The chapter tackles the essential task of addressing preconceived ideas of absolute right and wrong, presenting the nuanced reality of commercial slaughter to the reader in a positive light, offering it as an opportunity to succeed by degrees and to remain open-minded to all routes to positive welfare outcomes in a continually evolving environment.

Later, a highly informative chapter examines the nature of bruising in cattle; authored by Lilly Edwards-Callaway and Helen Kline. The condition, often referenced as an outcome of poor welfare and sometimes an issue of meat quality, is discussed in comprehensive detail, with an excellent summary of how lesions are formed and how they age. The chapter then offers the reader the opportunity to consider the incidence of bruising in its wider context as an indicator of poor welfare and presents useful tools for their monitoring and management. For this chapter alone, it is worth getting hold of a copy of the book — its principles of equal relevance to other farmed species.

The book then moves on to discuss slaughter in a religious context — an area which sometimes attracts sensitivities and divides opinion. Suitably titled; the chapter aims to describe common methods and approaches to improving welfare during operations, which may be considered a somewhat incendiary position, given that no other chapter is singled out as being inherently 'bad' for welfare. The authors Grandin and Erica Voogd are undoubtedly experienced in this area and in improving welfare and the chapter provides a sound objective discussion of *potential* welfare compromises arising from the non-stun slaughter process. Further, it acknowledges, in conclusion, that these can be effectively managed and offers an excellent evidence-based review of acceptable stunning methods. Nonetheless, expanding the discussion to conditions which do make stunning acceptable to religious authorities and the validation methods used elsewhere in the world for this purpose (eg New Zealand) could have added balance to the chapter. In the second half of the text, two excellent chapters explore unconsciousness and sensibility from a physiological and practical assessment perspective. Authors Grandin and Claudia Terlouw discursively cover the concept of determining and measuring unconsciousness in their respective chapters, the detail of which should simultaneously reassure any reader of the welfare merits of stunning whilst also providing substantive means of verifying the stunned state in a practical setting for those involved in the process. Purely from an individual perspective, it was felt that the chapters would have flowed better in reverse order — that is, with the theory before the practical application. This observation is almost entirely incidental since the chapters and subject should be considered essential reading for anyone with an interest or practical involvement in the application of stunning methods.

Some of the final sections of the book, including the value of data collection and several ‘mini’ chapters exploring various facets of the slaughter ethics paradigm, are perhaps better suited to those readers with a specific role or interest in the field since they require a degree of contextual knowledge. Nonetheless, it would be recommended that anyone picking up the book should take the time to dip into the latter, so as to broaden their appreciation for alternative perspectives of death and challenge their acceptance of the prevailing practices and opinions.

Conclusively, this text should be considered one of the definitive works in the field of welfare at slaughter — in its practice as much as the theory. It is of equal merit in both approaches and is befitting of Cockram and Grandin, following their decades of applied research in the sector. Whilst public opinion of slaughter and meat consumption continues to evolve, the general theories of achieving ‘better practice’ and currency of the underpinning literature reviews which support each chapter will remain valid for many years to come.

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