New Balance In Animal Husbandry

Prof.dr Elsbeth N. Stassen

Farewell address upon retiring as Professor of Animals and Society at Wageningen University & Research on 21 November 2019

WAGENINGEN
UNIVERSITY & RESEARCH

New Balance In Animal Husbandry

Prof.dr Elsbeth N. Stassen

Farewell address upon retiring as Professor of Animals and Society at Wageningen University & Research on 21 November 2019

WAGENINGEN
UNIVERSITY & RESEARCH

DOI xxxx-xxx-x

ISBN 978-94-xxxx-xxx-x

New Balance In Animal Husbandry

Dear mr Rector, colleagues, friends and family.

Imagine 1971, in that year I started my study at the Veterinary Faculty at Utrecht University to become a vet. At that time most farms were limited in size, quite often combining stock and arable farming, and whole families were involved in caring for the animals. Veterinary farm visits were predominantly for individual sick farm animals that represented high emotional and financial value to the farmer. However, due to a shift in the human animal relationship the keeping and treatment of animals changed rapidly[17]. The so called large animals became production animals and the small animals became companion animals.

In my farewell address I would like to take you along the interesting world of the human animal relationship and the importance of resilience of animals and systems. Concluding I would like to look forward, how a new balance in animal husbandry with respect for humans, animals and the environment can be realised.

Let us look at the developments in animal husbandry over the years

Since the fifties, agriculture transformed in response to the increasing demand for ample food of constant quality, and affordable[43]. The transformation was supported by incentive measures of the government, new breeding techniques, mechanisation and growing knowledge about diseases and better treatment. In the 70ties farmers rapidly embraced new farm concepts that were more intensive and with higher production rates[2,16,43]. Animals, their housing, nutrition and management, constantly adapted in order to cope with challenges of these new farm concepts. Increasingly farmers relied on cheap labour and technological tools to look after their herd[28].

The developments have been so successful that the Netherlands has become the second largest export country in the world of animals and their products . At present 70% of animal production is exported rendering animal production increasingly dependent on international trade[2]. The main focus of Dutch farmers is to be competitive on the low cost prize market[22,25,43]. Compared to other countries in the EU the price of animal products are relatively low for Dutch consumers.

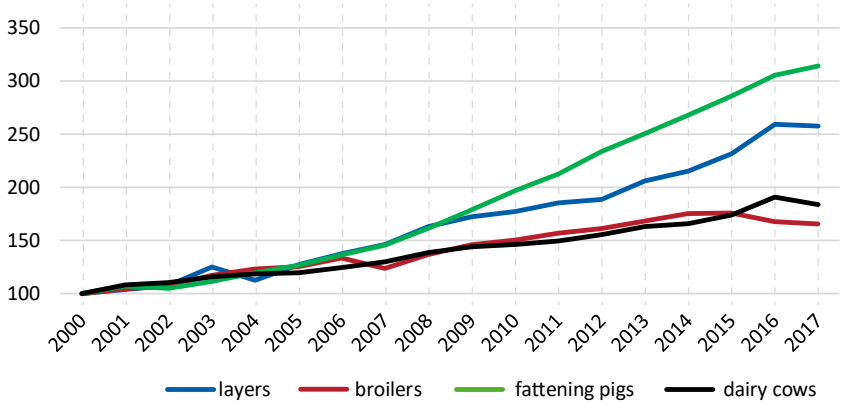

Figure 1: increase of number of animals kept per farm, expressed in percentages, between 2000 and 2017

So far so good. Animal agriculture has achieved the goals set in the fifties to supply ample food available to all. However, the increasing production per animal, the keeping of large herds (*fig.1*), the transport of animals over long distances through Europe and beyond, led to specific health and welfare problems in the animals[36,51]. The system became more dependent on antibiotics, vaccines, interventions and input of animal scientists and veterinarians to address these issues[25,33,42,43]. The main focus was to optimise the biological functioning of the animals to support the increasing production of the animals and the viability of the farms. From the 80ties onwards concerns about the way we keep and treat livestock increased[5,9,18,43]. Awareness grew that certain ways of keeping and treating animals are beyond the adaptive capacity of animals and systems, making a system more prone to catastrophic events[24].

At the same time people are keeping more and more animals for other purposes. Nowadays a variety of animals is kept as backyard animals[18]. Dogs, cats and horses became important as companion animals. The ambiguous ways of keeping animals led to more concerns about specific issues and are expressed in public debates[18,49].

Why should we be concerned?

Dutch farming and their supporting professionals are innovative, are highly qualified and successful. Farmers do give good care to their animals within the boundaries of their farming system. In the nineties prof Brand already referred to cows as 'top-athletes' producing huge quantities of milk, but at the same time vulnerable to environmental factors. Therefore, management required improvement, and efforts of farmers and professionals, like animal scientists and veterinarians combined to improve animal health and welfare issues in animal husbandry[27,33].

In recent years public health and food safety issues, and the environmental impact of agriculture were further causes for concern[5,8]. Consequently, the government imposed measures on livestock farming to meet for example (inter)national regulation of phosphate, but their focus was merely on that single-issue problem and had not met the concerns about animal agriculture[5,27]. The real underlying problems were not addressed and measures unintentionally opened the way to further intensification of agricultural farming.

On top of that the IPCC report (2019) of the climate panel of the UN delineates a gloomy picture of the global food supply in 2050[34]. For a world population of by then 10 billion, increasingly land will be used for animal husbandry. The IPCC report stresses the urgency of the current climate changes, the potential food crises, the need for adaptation of farm systems and the consumption of animal products. What if a substantial part of the 10 billion people in 2050 also consumes 77 kg of meat/year as the average Dutch consumer does[16]? The earth simply can't provide for that.

Due to all these developments, potential conflicts might arise between interests of humans, animals and the environment, and between individual farmers and the sector and between commercial and non-commercial animal keepers.

How do animals matter in this discussion?

From the assumption that animals matter less than humans and therefore are given a lower moral status than humans, follows that humans are allowed to keep and treat animals in the way that meets their interests[24,25]. In the olden days a common argument was put forward that animals don't possess reason and cannot talk and thus humans have few moral obligations to animals, Already in 1789 Jeremy Bentham pointed out that animals can suffer[7]. The care for the wellbeing of animals and the environment was for a long time considered a private good to be addressed by farmers. With the introduction of intensive farming systems, concerns about the way animals were treated and used came to the fore.

Studies[13,24,30,43] from the past decades pointed out that our understanding of animal welfare is both value- and science-based. Animal welfare consists of three important domains; the basic health and functioning of the animal, the affective state- as animals can have positive experiences like pleasure and negative experiences like pain or stress-, and the ability of animals to express their natural behaviour[24]. Those domains overlap and together influence the level of welfare of the animal.

Even if we all would agree on this broad concept of animal welfare, we still could not solve the dispute of what a morally acceptable way of treating animals is. *Harrison[30]*, *Rollin[43]*, *Mepham[38]* and others pointed to the changing moral attitude of people towards animals. Animals are no longer merely valued for their functional value but are also valued emotionally, as sentient beings with a value of their own[17]. These changing values of animals require a rethinking of people's moral responsibilities towards animals[39].

Nowadays respect for the intrinsic value of animals, i.e. their own value apart of their functional value, is legally enshrined in Dutch Acts on Animals. From this starting point follows the no, unless .... principle. This means that people are not allowed to keep and treat animals unless animal welfare is secured. By law the keeper of animals is responsible for the welfare of the animals. However, moral principles[6] give no ready-made guidelines what our responsibilities are with respect to humans, animals and the environment. Whatever animal issue discussed, stakeholders or affected parties might view that issue from different perspectives. Consequently concerns might differ.

Farmers and professionals have made efforts to improve animal welfare in reaction to concerns in society. Critics of intensive farming systems felt that efforts of farmers, professionals and policy were mainly directed to stimulate animal production at the expense of animals and their welfare[5,25]. The disagreement about the level of animal welfare in different husbandry systems is not merely about factual issues supported by scientific research, but it is about what parties consider more or less important for animals to have a good life[24,26,27].

How can we explain differences in attitudes towards animals?

Farmers and the professionals in this field, are faced with a diversity of issues related to humans, animals and the environment (*fig. 2*). Such as their animal production system, the viability of the farm[14], public health and food safety[5,8], animal welfare and environmental issues[18]. Issues that are quite often conflicting. These issues will influence their attitude regarding the welfare of the animals[5].

Figure 2: farmers are faced with a diversity of issues

Farmers and professionals claim that they are knowledgeable about and experienced in husbandry systems. Their personal context will, however, influence the way they apply their knowledge and how they value different interests[4,9]. Research shows that farmers that keep animals indoors in an intensive way mainly focus on production[5]. They consider animal welfare in terms of affective state and biological functioning of the animal. Furthermore, they will emphasise possible negative aspects of keeping livestock outdoors and do not consider natural living as an important constituent element of animal welfare[5]. Veterinarians directly involved in supporting livestock production broadly share the views of the farmers on animal welfare[5]. Interesting to note is that these professionals not necessarily have more knowledge about the natural behaviour of the animal species they keep[5]. Moreover, studies reveal that farmers and their professionals might underestimate the potential public health risks of diseases, the use of antibiotics and the negative welfare impact of a system[5,11].

Can we talk about convictions and opinions of the general public?

When presenting an animal issue, you might argue that your opinion is totally different from that of your neighbours. As just explained, when involved in animal husbandry one might shape one's knowledge and experience to the system of reference. But when not involved, convictions and judgement about a farming system will probably be independently from the context of that system. Most citizens

value animals for their intrinsic value as living beings with their species specific needs, separate from the functional value of the animal[5,10,18]. Consequently, they will consider natural living of animals of importance for animal welfare. The main concerns are the number of animals per square meter, transport of animals, denying animals to go outdoors, public health risks and environmental waste[3,18]. Interesting to note is that organic farmers show more or less the same concerns as the general public[5].

Attitudes towards animals and husbandry systems are determined to the way people deal with economical-, social and environmental dynamics.

The capability to deal with change, in other words the resilience of a system, is crucial to ensure sustainable farming- and ecosystems in future[47].

Living creatures, farming systems and ecosystems are constantly exposed to changes such as new breeding goals, nutrition, pollution, management[42]. When the changes occur gradually over time, animals and the systems have the ability to adapt to the new situation, because they have resilience. Scheffer[47,48] explained the importance of internal and external conditions to the resilience of a system. A loss of resilience renders an animal or a system more vulnerable to catastrophic events or will lead to a poorly state of the animal or the system. It is interesting to use this model to consider issues in animal agriculture. I would like to give a few examples.

Example one: animal welfare

In intensive farming systems it might be argued that animals have lost resilience to overcome challenges. In an enriched environment, pigs can satisfy their behavioural needs to forage, root and explore for food[22]. What happens when pigs are kept in barren conditions, which do not allow them to perform their natural behaviour? A tipping point will be reached (*fig. 3*). Pigs will then turn to their pen mates to satisfy their behavioural needs resulting in maladaptive behaviours such as tail and ear biting and fighting. Especially, when exposed to environmental stressors like heat stress, switch of food or health challenges the intrinsic need to forage increases, which can lead to the abrupt onset of the catastrophic event pig farmers are afraid of; large scale tail-biting outbreaks leading to serious welfare and production losses[22]. These are clear signs of loss of resilience. To prevent such risks the keeping of fattening pigs now relies on the routine tail docking of young piglets. Already 25 years ago the EC forbid the routine tail docking in pigs, but still much needs to be done to make this happen.

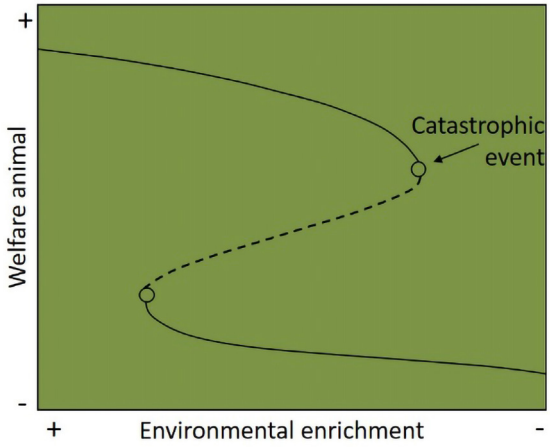

Figure 3: effect of condition environmental enrichment on resilience of animal welfare

From the work of van Dixhoorn[20] we learn that enriched housing also reduces disease susceptibility. The adaptation of breeding practices, the environment and management to the species-specific needs of animals will positively influence their welfare and health and the resilience of the animals will improve. Thus making the keeping of animals less dependable on interventions, antibiotics and vaccine schemes.

Example two: animal transport

Current farming systems lack buffer capacity to deal with the continuous influx of young animals or conditions to house heavy weight animals and thus the resilience to challenging events will decline[54]. During summertime problems with animal transport to slaughterhouses occur, such as overheated animals. The heat protocol forbids the transport of animals when the outside temperature is above 35 ^{0}C[46]. Full-grown slaughter animals, due to their physiological characteristics, are vulnerable to heat stress, with serious negative impact on their welfare. No farmer or professional will dispute that[46]. Why then such a high threshold? The problem is caused by the organisation of the production chain, that has lost resilience to cope with periods of heatwaves. Farms for the production of fattening pigs or broilers have only a few spare days between transport to slaughterhouses and arrival of a next group of animals. Slaughterhouses work with set weights for slaughter animals and they depend on a continuous influx of animals.

Other examples: the environment and farmers' income

The resilience model could also help to explain the impact of current animal agriculture on the environment and on farmers' income. Farm lands are now predominantly transformed to mono-cultures of grass and maize. Biodiversity has reached a critical point, concerning insects, birds and 'pest' animals[35,45]. The population of Lark (Leeuwerik) and Gotwit (Grutto), that depend for their survival on Dutch grounds, are rapidly losing their habitats and thus their resilience.

Another issue is the worrying developments in farmers' income. Questions can be raised about the viability of the majority of animal production that competes on a low cost market[2,25]. Is following that path not a dead end and are farmers not forced in that direction? The export market of the especially non-land-based farming increasingly feels the pressure of increasing production in other countries. In Brazil and the Ukraine production costs are lower and thus will increasingly compete with the low cost production segment in the Netherlands[2].

These examples clearly show that the further ongoing intensification of animal husbandry systems will lead to a further loss of resilience in animals, the environment and the viability of farms. Animal welfare will continue to lead to heated discussions. Farmers feel the negative impact of criticism and lack of support, but are locked in a system of demand and supply[15,44]. So, could I not challenge you as professionals to use this resilience model to start an open discussion about problematic issues in animal agriculture without being tied beforehand to the context of the current dominant farming systems?

In this, an essential question is: who are responsible for the system we seem to be locked in?

As most citizens are concerned about the welfare of animals in farm systems should it then not be visible in their purchase behaviour[31]? Farmers and professionals often state, even a veterinarian in the tv-program Our Farms, that citizens are hypocrites as they ask for more animal welfare but do not purchase welfare plus products. One might argue that there seems to be a 'citizens-consumers duality'.

How to understand the difference between peoples' expressed willingness to pay for welfare friendly products[21] versus their actual purchasing behaviour. Several factors are responsible, just to mention a few. *First*, who are the consumers as on average 70% of animal products are exported[2]? It seems questionable to blame Dutch consumers as the majority of the market outlet of agriculture is exported to other countries. Dutch consumers increasingly do buy animal products with welfare

quality marks. *Second,* people won't because they simply don't bother or consider it the governments' or farmers' responsibility to safeguard animal welfare[31]. *Third,* information on labels is inadequate. By buying 'free-range barn eggs' ('scharreleieren') or milk cartons with illustrations of former times or inadequate labelling, consumers are under the impression that they have purchased welfare or environmental friendly, where in reality the welfare and environmental improvements are minimal[25,31]. *Fourth,* since animal friendly products are considered as luxury products, retail margins for these products are often high. Consequently, animal friendly products' retail prizes are relatively high compared to delivery prizes for farmers. *Finally,* when extra effort searching for animal friendly products is required. Consumers may not be motivated to spend their time and money on it, and will favour other important basic needs[31].

So, an answer to the question who are responsible for the welfare of animals are all actors in the animal production chain, from animal food production to slaughterhouses, the government, farmers, professionals, retailers, and consumers .

From this we should conclude: there is a need for a new balance

But, "We cannot solve the problems we have created with the same thinking we used in creating them." – **Albert Einstein**

Animal agriculture is constantly exposed to complex problems, which are difficult to identify, involve conflicting and changing interests, and will create problems in other fields when finding solutions for the one problem (*fig. 4*).

Figure 4: conflicting and changing interests in animal agriculture

Finding a new balance is only possible when we integrally consider all elements of food production and include all actors relevant in the chain. Sustainable animal agriculture of the future will ultimately close cycles, contribute to food supply, has a high animal welfare standard, and have farmers that can count on the support they deserve by society. In future the Netherlands will take the lead in seeking a new balance in animal agriculture. Dutch agricultural export will then be acknowledged for their innovative new farm products, -concepts and -technologies.

There are several actors relevant in this new balance:

We are all responsible for animal agriculture to make the *paradigm shift* from intensive farming to circular farming. Consumers should be stimulated to adapt their consumption behaviour. Retailers should invest more in enticing consumers to adapt their purchasing behaviour. Consumers are willingly to pay for sustainable welfare plus products[21]. But, appealing to the romantic agrarian view of people by imaging packages of former times or applying inadequate labelling is not helpful.

Minister Schouten has sketched the transformation to circular agriculture in which cycles are closed and biodiversity is preserved. Such animal production system should be more value-driven than prize-driven[28]. Steps are taken to stimulate the transformation[41]. However, with the views of the sector and the reaction by the Minister there is a prominent risk that the consequences of the transformation will lead to more technologies and further scale enlargement at the expense of animal welfare[25,50,55-59].

Plans focus on economy and environment, but what about the animals? Their position is underexposed. **Animal agriculture is about keeping animals!**

In a circular agriculture animals no longer need to adapt to the system, but the system is built around the species-specific needs of livestock[23,26]. Animal welfare will include the biological functioning, the affective state and the ability of animals to express their natural behaviour. New norms are set for current persisting welfare issues, like: longevity of livestock[14], the problems of mortality in piglets and calves, claw and leg problems in broilers and dairy cattle[51], routinely interventions on animals, and long distance transport of animals. The genetic selection of livestock will adapt to the demands of circular agriculture[42]. Training of workers will be a standard practise as the human factor in animal husbandry largely explains the diversity in animal welfare between farms[29,32].

Food supply, a healthy environment and animal welfare are all public goods that ask for direction, firm agreements, tight control and coordination by governmental organisations. The current agenda on sustainability needs to be more ambitious. To meet the challenges of the near future and to safeguard animal welfare and viability of farms the transformation needs to accelerate. Farmers will require clear-cut norms, set for longer periods of time, when investing in new farm systems. Because they should not to be confronted with continuous adaptations of standards, leading to unnecessary frustration. New norms and restrictions should be fair. That means that farms not responsible for exceeding the norms for emission gasses and other environmental issues, should not be restricted to meet the overall norms set in the Netherlands, as has been the case in restricting phosphate losses.

Several new promising farm concepts are developed based on the animals-specific needs:

For example: By addressing the most prominent welfare issue of hard flooring and bedding, free-range dairy cattle farms and free stalls promote the welfare of cows. The Starplus Pigfarm concept addresses the needs of animals, man and environment in a more integrated way.

Another example is the introduction of organic and in-between conventional and organic broiler production systems during the last decades[44]. Animals in these systems experience a better welfare. The Society of the Protection of Animals introduced a star system for these systems. The retail then introduced new farm concepts with respect to animal welfare, the so-called New Dutch Retail Standards. Currently in supermarkets, accounting for 30% of the total broiler production in the Netherlands, only poultry meat from slower growing broilers is available[44]. These developments stopped the ongoing trend of scale-enlargement in poultry husbandry. The number of broiler farms no longer diminishes, the number of animals kept in farms that produce for the Dutch market decreases, less antibiotics are being used[8] and the income position of poultry farmers is good[2]. It is expected that the standard for the domestic market will continue to shift towards at least one star. However, the main production is exported with other countries becoming more competitive to Dutch farmers. On the other hand in important countries for export of broiler products, such as Germany, the same developments as in the Netherlands occur, offering opportunities to further increase the number of animal welfare plus farms[44].

New farm concepts can be integrated in circular agriculture at regional and farm level. It is interesting to note that individual Dutch farmers embrace these new concepts. However, at the same time these farmers face many challenges as they are confronted with conflicting legislation and finding themselves a market position and share. Those frontrunners need support from governmental and financial institutions. Frontrunners can give an impulse to the whole animal sector as well as to individual farmers to change their mindset about animal farming and to stimulate the onset of the transition.

We should be aware that the introduction of new farm concepts will reveal new problems to be addressed.

A scientific contribution to a new balance is required.

An interdisciplinary approach is required[28], addressing current issues, stimulating the development and introducing new farm concepts. Such approach includes animal-, veterinary-, plant-, environmental-, social science and economics. Researchers with different background need to formulate joint research agendas. Redirection of funds to research innovative and more sustainable systems, including higher animal welfare, will lead the way to achieve the required transformation and will stimulate institutes to redirect their research program[24].

The current and future farming systems could benefit from a further development of precision livestock farming. Potential pitfalls of the introduction of smart technologies are however focus on predominantly the biological functioning of animals, further stimulating intensive farming systems and a lack of compliance by the farmer.

To contribute to the challenges set by among others in the IPCC report[34], research in other fields is also required. Just to mention a few: research into the potential of future foods for sustainable and healthy diets has to be further stimulated[40]. Future foods, such as insects, seaweed and cultured meat are interesting as the production of these foods have environmental benefits while safeguarding the intake of essential nutrients. More research is needed to address the loss of up to 50% in the animal production chain, starting at the level of food production for the animals, loss of healthy and sick animals, slaughter process, processing of animal products, storage and transport and waste at the level of the retail and consumers.

Next to scientific research, education could play a role:

Animal scientists and veterinarians do have an unique position, as they are directly involved in keeping animals healthy and well. Society considers animal and veterinary scientists as professionals and expect them to independently consider the interests of humans, animals and the environment[37]. As such they should not only be guided by the interests of farmers or other actors in the chain. The before mentioned heat stress measurements could count as an example.

To maintain their independent position and to avoid simplistic analyses of highly complex issues like 'the pursuit of maximum profitability leads automatically to improved animal and human welfare', it is challenging to teach future professionals that animal and veterinary sciences are not value-free[25,26]. Whether or not measures improve animal welfare rest on value-based beliefs concerning what is best for the animal, and might be viewed in the light of interests of other animals, humans and the environment[4,14,24,25]. It is important for future animal scientists and veterinarians to take part in debates about animal issues where the rights and wrongs of animal use are discussed. Professionals do have valuable knowledge to structure the debates. To be able to participate in those debates, the different views and arguments of people need to be understood. Therefore, one has to be familiar with the moral principles and the ethical theories behind these principles that are relevant in shaping these views. Future professionals have to be able to identify the potential risks of framing arguments, due to context dependency and personal moral views to the use of animals[6,38,39].

The real progress in addressing moral issues in the field of animal use can only be achieved with an informed dialogue[1] which goes beyond unreflective positioning of arguments by professionals.

To be effective animal ethics has to be integrated in courses in consecutive years of the BSc and MSc education. In future the input of animal and veterinarian scientists could benefit from a closer collaboration both in education as in research, where strong points of each profession will add up and will contribute to the development of sustainable agriculture. It would be interesting to study whether courses of applied animal ethics could be given to animal science and veterinary science students, in joint sessions, certainly in the light of new developments where animal science bachelors could gain access to the master of veterinary sciences.

Allow me to summarise my address with the following points:

1 Stimulated by policy, investments and research, Dutch agriculture has become a leading export sector focusing on the low cost market.
2 Dutch agriculture has lost its resilience with impact on animal welfare, environmental health and farm viability.
3 A new resilient balance can be found in the transformation to a circular agriculture.
4 Together we all are responsible for this transformation.
5 Initiatives of and cross-fertilisation among agriculture, society, science and education are important forces for this transformation.

Since 1971 the world changed radically and so did animal agriculture and the way we use and view animals. The world will continue to change. To cope with that, the assignment for the coming decades will be to move to a new sustainable balance in animal husbandry.

Dankwoord

Aan het eind van mijn rede wil ik graag een dankwoord uitspreken.

Tot 2004 heb ik aan de faculteit Diergeneeskunde gewerkt. Ik dank iedereen voor de prettige en stimulerende samenwerking. Het bestuur van de Koninklijke Nederlandse Maatschappij voor Diergeneeskunde dank ik voor de mogelijkheid om mij verder te verdiepen in de mens-dier relaties, door de benoeming tot bijzonder hoogleraar Relatie Mens Dier.

De Raad van Bestuur van Wageningen UR wil ik danken voor het in mij gestelde vertrouwen bij mijn aanstelling tot hoogleraar Dier en Samenleving.

Mijn leerstoel was eerst ondergebracht bij de leerstoelgroep Dierlijke Productiesystemen en vanaf 2011 bij de leerstoelgroep Adaptatie Fysiologie. Ik wil professor Bas Kemp bedanken voor zijn gastvrijheid en de mogelijkheid het vakgebied Dier en Samenleving binnen zijn leerstoelgroep inhoud te geven. Ik wil de staf van de leerstoelgroepen hartelijk danken voor hun prettige en inspirerende samenwerking.

Binnen en buiten Dierwetenschappen heb ik samengewerkt met vele mensen, dat verbrede mijn horizon en prikkelde de geest, dank daarvoor.

Het was een voorrecht om met vele studenten en promovendi te mogen werken, dank jullie voor de samenwerking.

Ter voorbereiding van deze afscheidsrede heb ik met een aantal mensen van gedachten gewisseld, Peter van Horne, Bas Kemp, Ron Bergevoet, Paul Galama, Geert van der Peet, Peter Groot Koerkamp, Monique Ooms en Marten Scheffer, dank daarvoor. Karien Scholten wil ik danken voor het prachtige weidemelk filmpje, Nina Cohen voor haar bijdrage aan de rede en Jorrit Noordhuizen voor de prachtige tekeningen.

Lieve familie en vrienden hartelijk dank, dat ik altijd op jullie kan rekenen.

Dames en heren ik dank u voor uw komst.

Referenties

1 Aarts, N. 2015. The art of dialogue. Oratie Wageningen University.
2 Agrimatie. Wageningen Economic Research. 2019. https://www.agrimatie.nl/
3 Asselt van M., P.M. Poortvliet, E.D. Ekkel, B. Kemp and E.N. Stassen. 2018. Risk perceptions of public health and food safety hazards in poultry husbandry by citizens, poultry farmers and poultry veterinarians. Poultry Science, 97(2):607-619.
4 Asselt van M., E.D. Ekkel, B. Kemp and E.N. Stassen. 2019. The trade-off between chicken welfare and public health risks in poultry husbandry: significance of moral convictions. Journal of Agricultural and Environmental Ethics, 32(2):293-319.
5 Asselt van M. 2019. Conflicts between chicken welfare and public health risks in poultry husbandry; Stakeholders' perceptions and moral convictions. Thesis Wageningen University, May 10th. ISBN: 978-94-6343-580-2.
6 Beauchamps, T.L. and J.F. Childress. 1994. Principles of biomedical ethics. 4th Edn. Oxford University Press. Oxford. UK.
7 Bentham, J. 1789. In: Introduction to the principles of morals and legislation. London. UK.
8 Bergevoet, R, M. van Asseldonk, N. Bondt, P. van Horne, R. Hoste, C. de Lauwere and L. Puister-Jansen. 2019. Economics of antibiotic usage on Dutch farms. Wageningen Economic research. 2019-026. Pg 1-16.
9 Bergstra, T.J. 2014. Pig husbandry in a changing social and economic environment: societal attitudes, farm economics and animal welfare. Thesis Wageningen University, December 16th. ISBN 978-94-6257-205-8.
10 Bergstra, T.J., B. Gremmen and E.N. Stassen. 2015. Moral values and attitudes toward Dutch sow husbandry. journal of Agricultural and Environmental Ethics, 28(2):375-401.
11 Bergstra, T.J., H. Hogeveen and E.N. Stassen. 2016. Attitudes of different stakeholders toward pig husbandry: A study to determine conflicting and matching attitudes toward animals, humans and the environment. Journal Agriculture and Human Values. DOI 10.1007/s 10460-016-9721-4.
12 Bergstra, T.J., H. Hogeveen, E. Kuiper, W. Kuiper, A.G.J.M. Oude Lansink and E.N. Stassen. 2017. Attitudes of Dutch citizens toward sow husbandry with regard to animals, humans and the environment. Anthrozoos, 30(2):195-211.
13 Brambell, F.W.R. 1963. Report of the technical committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Her Majesty's Stationery Office: London, UK.
14 Bruijnis, M.R.N., F.L.B. Meijboom and E.N. Stassen. 2013. Longevity as an Animal Welfare Issue Applied to the Case of Foot Disorders in Dairy Cattle.

Journal of Agricultural and Environmental Ethics, 26(1):191-205.
15 Bruijnis, M.R.N., V. Blok, E.N. Stassen and H.G.J. Gremmen. 2015. Moral lock-in in Responsible Innovation: the Ethical and Social Aspects of Killing Day Old Chicks and its Alternatives. Journal of Agricultural and Environmental Ethics, 28:939-960.
16 CBS Statistics Netherlands. Centraal Bureau Statistiek. 2019. Data veehouderij. http://statline.cbs.nl/statweb/publication/.
17 Cohen, N.E., F.W.A. Brom and E.N. Stassen. 2009. Fundamental moral attitudes to animals and their role in judgment: An empirical model to describe fundamental moral attitudes to animals and their role in judgement on the culling of healthy animals during an animal disease epidemic. Journal of Agricultural and Environmental Ethics, 22(4):341-359.
18 Cohen, N.E. 2010. Considering animals. moral convictions concerning animals and judgement on the culling of healthy animals in animal disease epidemics. Thesis Wageningen University, November 17th. ISBN 978-90-8585-795-2.
19 Cohen, N.E., F.W.A. Brom and E.N. Stassen. 2012. Moral convictions and culling animals: A survey in The Netherlands. Antrozoos, 25(3):353-367.
20 Dixhoorn van, I.D.E., I. Reimert, J. Middelkoop, J.E. Bolhuis, H.J. Wissellink, P.W.G. Groot Koerkamp, B. Kemp and N. Stockhofe-Zurwieden. 2016. Enriched housing reduces disease susceptibility to co-infection with Porcine Reproductive and Respiratory Virus (PRRSV) and Actinobacillus pleuropneumoniae (A. pleuropneumoniae) in young pigs. PLOS ONE DOI:10.1371/journal. pone.0161832. pg 1-24.
21 Eurobarometer. 2005. Attitudes of consumers towards the welfare of farmed animals. 229. Brussel. Belgium.
22 EFSA (European Food Safety Authority). 2007. Scientific report on the risks associated with tail biting in pigs and possible means to reduce the need for tail docking considering the different husbandry systems. The EFSA Journal, 611:2-98.
23 EFSA (European Food Safety Authority). 2012. Scientific Opinion on the use of animal-based measures to assess welfare of dairy cows. The EFSA Journal, 10(1):2554.
24 Fraser, D., D.M. Weary, E.A. Pajor and B.W. Milligan. 1997. A scientific conception of animal welfare that reflects ethical concerns. Animal Welfare, 6(3): 187-205.
25 Fraser, D. 2001.The “New perception” of Animal Agriculture: Legless cows, featherless chickens, and a need for genuine analysis. Journal of Animal Science, 79:634-641.
26 Fraser, D. 2008. Understanding Animal Welfare. Acta Veterinaria Scandinavia, 50:SI. Pg 1-7.

27 Fraser, D. 2009. Assessing animal welfare: different philosophies, different scientific approaches. Zoo Biology, 28:507-518.
28 Fraser, D, I.J.H. Duncan, S.A. Edwards, T. Grandin, N.G. Gregory, V. Guyonnet, P.H. Hemsworth, S.M. Huertas, J.M. Huzzey, D.J. Mellor, J.A. Mench, M. Spinka and H.R. Whay,. 2013. General Principles for the welfare of animals in production systems: The underlying science and its application. The Veterinary Journal, 198:19-27.
29 Fraser, D. 2017. Animal welfare: the all-important human dimension. 10th Boehringer Ingelheim Expert Forum. June 2017, Rome, Italy. Pg 30-31.
30 Harrison, R. 1964. Animal Machines. Vincent Stuart Ltd, London.
31 Harvey, D. and C. Hubbard. 2013. Reconsidering the political economy of farm animal welfare: An anatomy of market failure. Food Policy, 38:105-114.
32 Hemsworth, P.H., G.J. Coleman, J.L. Barnett and S. Borg. 2000. Relationships between human-animal interactions and productivity of commercial dairy cows. Journal of Animal Science, 18(11): 2821-2831.
33 Holzhauer, M. 2006. Claw Health in Dairy Cows in The Netherlands. Epidemiological Aspects of Different Claw Disorders in Dairy Cattle in The Netherlands. Thesis Utrecht University. ISBN 90-393-4290-3.
34 IPCC. 2019. In: Climate Change and Land: an special report on climate change, desertification, land degradation, sustainable land management, food security and greenhouse gas fluxes in terrestrial ecosystems.
35 Kentie, R., N.R. Senner, J.C.E.W. Hooijmeijer, R. Marquez-Ferrando, J. Figuerola, J.A. Masero, M.A. Verhoeven and T. Piersma. 2016. Estimating the size of the Dutch breeding population of Continental Black-tailed Gotwits form 2007-2015 using resighting data from spring staging sites. Ardea, 10(3):2013-225.
36 Kornalijnslijper, J.E. 2003. Health and Welfare of high producing dairy cows. Thesis Utrecht University. ISBN 90-393-3457-8.
37 Meijboom, F.L.B. 2018. More than just a vet? Professional integrity as an answer to the ethical challenges facing veterinarians in animal food production.. food Ethics, 1(3):209-220.
38 Mepham, B. 2000. A framework for the ethical analysis of novel foods: The ethical matrix. Journal of Agricultural and Environmental Ethics, 12(2):165-176.
39 Palmer, C and P. Sandøe. 2011. Chapter 1: Animal ethics. Animal Welfare. 2nd edition. M. C. Appleby, J. A. Mench, I.A. S. Olsson & B. O. Hughes (Eds.). Kopenhagen. Denmark.
40 Parodi, A., A. Leip, I.J.M. DeBoer, P.M. Slegers, F. Ziegler, E.H.M. Temme, M. Herrero, H. Tuomisto, H. Valin, C.E. VanMiddelaar, J.J.A. VanLoon and H.H.E. VanZanten. 2018. The potential of future foods for sustainable and healthy diets. Nature Sustainability, 1:782-789.
41 Peet van der, G, F. Leenstra, I. Vermeij, N. Bondt, L. Puister en J. van Os. 2018.

Feiten en cijfers over de Nederlandse veehouderijsectoren 2018. Rapport 1134. Wageningen University & Research.
42 Rauw, W.M., E. Kanis, E.N. Noordhuizen-Stassen and F.J. Grommers. 1998. Undesirable side effects of selection for high production efficiency in farm animals: a review. Livestock Production Science, 56:15-33.
43 Rollin, B.E. 2004. Annual meeting keynote address: Animal agriculture and emerging social ethics for animals. Journal of Animal Science, 82(3): 955-964.
44 Saatkamp, H.W., L.S.M. Vissers, P.L.M. van Horne and I.C. de Jong. 2019. Transition from conventional broiler meat to meat from production concepts with higher animal welfare: experiences from The Netherlands. Animals, 9:483, pg 1-11. DOI:10.3390/ani9080483.
45 Sanchez-Bayo, F. and K.A.G. Wuyckhuys. 2019. Worldwide decline of entomofauna: A review of its drivers. Biological Conservation, 232:8-27.
46 Saveetra en Vee&LogistiekNederland. 2019. Protocol Veetransport onder Extreme temperaturen.
47 Scheffer, M, S. Carpenter, J.A. Foley, C. Folke and B. Walker. 2001. Catastrophic shifts in ecosystems. Nature, 413:591-596.
48 Scheffer, M, J.E. Bolhuis, D. Borsboom, T.G. Buchman, S.M.W. Gijzel, D. Goulson, J.E. Kamminga, B. Kemp, I.A. van de Leemput, S. Levin, C.M. Martin, R.J.F. Melis, E.H. van Nes, L.M. R omero and M.G.M. Olde Rikkert. 2018. Quantifying resilience of humans and other animals. PNAS. www.pnas.org/cgi/doi/10.1073/pnas.1810630115. Pg 1-8.
49 Schicktanz, S. 2004. Ethical considerations of the human-animal-relationship under conditions of asymmetry and ambivalence. Eursafe – Science, Ethics & Society: 76-80.
50 Schouten, C. 2019. Brief aan Tweede Kamer. Duurzame Veehouderij: DGA-DAD/19213164.
51 Somers, J.G.C.J., K. Frankena, E.N. Noordhuizen-Stassen and J.H.M. Metz. 2003. Prevalence of claw disorders in Dutch Dairy Cows Exposed to Several Floor Systems. Journal of Dairy Science, 86:2082-2093.
52 Tuyttens, F.A.M. 2005. The importance of straw for pigs and cattle welfare: A review. Applied Animal Behaviour science, 92(3):261-282.
53 Vanhonacker, F., W. Verbeke, F. van Poucke and F.A.M Tuyttens. 2007. Segmentation based on consumers' perceived importance and attitude toward farm animal welfare. International Journal of Sociology of Food and Agriculture, 15(3):84-100.
54 Wijffels, H.H.F., A.J.P. van den Berg, A.D. Boeve, G. van Dijk, A.A. Dijkhuizen, J.C.M. van Eijndhoven, C.J. Kalden, G. Meester, E.N. Noordhuizen-Stassen, J.C.P. Vogelaar and E.P. Woltjer. 2001. Toekomst voor de veehouderij: Agenda voor een herontwerp van de sector.

55 www.avined.nl
56 www.duurzamezuivelketen.nl
57 www.kalversector.nl
58 www.platformmelkgeitenhouderij.nl
59 www.vitalevarkenshouderij.nl

Foto te lage resolutie

Prof.dr Elsbeth N. Stassen

'Since 1971 the world changed radically and so did animal agriculture and the way we use and view animals. The world will continue to change. To cope with that, the assignment for the coming decades will be to move to a new sustainable balance in animal husbandry.'

ISBN 978-94-6173-163-0