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Research Paper

Involving the animal as a contributor in design to overcome animal welfare related trade-offs: The dust bath unit as an example

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Allowing farm animals to have active control and influence over their environment through the expression of intrinsically motivated behaviours contributes to their (positive) welfare. However, farm animals are predominantly seen as passive receivers of what husbandry systems should provide for them. Additionally, designers and engineers of farming systems neglect the animals' potential in the design of husbandry systems, resulting in disadvantageous trade-offs between animal welfare and economic and environmental sustainability aspects. This paper describes, through the application of an interactive structured design approach, how laying hens can actively contribute to the functioning of the husbandry system by exercising their own goals. The ambition of this research was to allow animals to contribute to creating opportunities that might overcome existing trade-offs between animal welfare and other sustainability goals. The Reflexive Interactive Design approach was applied to achieve this ambition. This paper presents the methodological steps of the design process to contribute to the reduction of the (fine) dust problem in laying hen husbandry using the dust bath unit as an example. Also, this paper describes how we incorporated the laying hen as a contributor in the design process. We show that facilitating intrinsically motivated laying hen dust bathing behaviour can simultaneously resolve the environmental dust problem experienced in loose housing systems.

1. Introduction

Animal production is accompanied by ecological, social and economic side effects, such as biodiversity loss, land conversion and land degradation (Steinfeld et al., 2006), compromised animal welfare (Leenstra et al., 2007), and animal and human health risks (Gezondheidsraad, 2012). As a result animal production is the subject of sustained societal debate, which holds true for the Netherlands. Both the Dutch government (Verburg, 2008) and institutional actors (UDV., 2013) share the idea that animal production in the Netherlands should be ‘integrally sustainable’. Integral sustainability can

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be defined as a state in which the production system does not have structural negative effects on ecology, animal and man, and is economically viable. Achieving integral sustainability is a complex challenge, even more so given the expectation that global demand for animal produce will increase with rising population levels and income (FAO., 2009; Godfray et al., 2010).

Moving towards integral sustainability implies the difficulty of simultaneously solving multiple issues of sustainability, which is more complex than solving single issues. Agricultural production in general has excelled in optimising for singular goals. For animal production this is prominent for high production efficiencies, such as growth rate in broilers, milk yield in dairy cows and feed conversion in fattening pigs (Havenstein, 2006; Rauw, Kanis, Noordhuizen-Stassen, & Grommers, 1998). However, improvements for individual goals generally lead to unintended and undesirable effects, like poor air quality in the barn in the case of substrate provision to poultry and pigs, and higher energy use in the case of air scrubbers. These side effects are often denoted as trade-offs: a compromise between two desirable features that cannot be attained at the same time. A trade-off can be the result of either a fundamental contradiction (eating meat cannot be done without mutilating or killing the animal), or stem from a conscious or unconscious (design) decision based on the current state of technology, economic considerations, or practical implications. For example: it is difficult to provide straw for pigs kept on the (widely used) slatted floors, because of the straw falling through the slats and getting out of reach and blocking the manure handling system. With a different manure handling system, straw does not create this problem. Thus, providing straw for welfare is not inevitably connected to manure handling problems. While some trade-offs may be fundamentally inevitable, others are only inevitable given certain system characteristics that have grown dominant because of historical preconditions.

Some trade-offs in animal production are related to animal welfare. Often, improving animal welfare decreases environmental performance (Dekker, Aarnink, De Boer, & Groot Koerkamp, 2012), health of the animals (Groot Koerkamp, Van Hierden, Meerburg, Struik, & Wienk, 2006; Hovi, Sundrum, & Thamsborg, 2003), production yields (Kemp & Soede, 2012), and increases production costs, e.g. when space for the animal is increased but is not equalled by an increase in financial return per system area. In North-Western Europe, animal welfare is considered to be an important part of sustainable animal production (Ingenbleek et al., 2013; Miele & Parisi, 2001), therefore overcoming possible animal welfare related trade-offs is important. Consequently, there is a need for a design approach that considers trade-offs between animals and other sustainability goals, such as the environment.

A trade-off between animal welfare and environment is illustrated by the development of husbandry systems in the laying hen industry. Since the ban on traditional cages in the European Union (CEC., 1999), the laying hen industry developed towards colony and aviary systems with more space, a nest box, perch and a substrate area for the hens to explore and forage; elements that are crucial in order to express certain behavioural patterns and to prevent extreme abnormal behaviour such as feather pecking and vacuum dust bathing. Laying hens kept in such loose-housing systems have a higher feed intake than in traditional cages, leading to higher use of land and natural resources, and more greenhouse gas emissions. Furthermore, especially in aviary systems, more dust is generated through the combination of substrate and laying hen activity, such as walking, scraping and dust bathing (Winkel, Mosquera, Groot Koerkamp, Ogink, & Aarnink, 2015). A high dust concentration negatively effects living conditions for the hen and impair labour conditions for the farmer and due to dust emissions also poses a health risk to the neighbourhood (Gezondheidsraad, 2012). So, improved animal welfare in this example comes at the cost of lower environmental and social performance.

Usually in animal production, animal welfare and the animals' needs are only considered relevant if they have economic or functional relevance. For example the animals' need for food is congruent with the livestock sector's ambition to produce animal products. In the design of the system especially those animal behaviours that are relevant for production goal(s) are considered (FAWC., 2011) (Farm Animal Welfare Committee). However, the societal demand for more animal welfare has led to the inclusion of animal needs that exceed these direct functional behaviours.

Scientific insights on animal welfare, based on ethology, veterinary and physiological studies, describe animal welfare in terms of fulfilling the animal's behavioural and physiological needs (Anonymous, 2001; Brambell, 1965). This view however regards the animal as a passive receiver of what the husbandry system should provide and neglects the potential of the animal to actively influence their surroundings. Allowing the animal to actively control and influence their surroundings through the expression of intrinsically motivated behaviours contributes to their welfare (Puppe, Ernst, Schön, & Manteuffel, 2007; Sambrook & Buchanan-Smith, 1997; Young & Lawrence, 2003). Allowing the animal to gain control and take care of itself goes beyond the fulfilment of its behavioural and physiological needs by other means, such as humans or technology. Maximizing this active role has profound consequences for the design and management of husbandry systems. In addition the advantage is that by expressing their innate behavioural repertoire animals actively contribute to other (system and human) goals, that is goals different from, but not contradictory to, fulfilling their own needs. Consequently, a more active role for the animal increases the possibility of attaining improved animal welfare as well as achieving other sustainability goals at the same time (Bos, Groot Koerkamp, & Groenestein, 2003).

The generation, concentration and emission of high levels of (fine) dust are currently a serious problem in laying hen husbandry (Cambra-López, Aarnink, Zhao, Calvet, & Torres, 2010; Le Bouquin et al., 2013; Winkel et al., 2009). High dust levels in the husbandry system pose health risks for both animals and workers inside buildings, while the emission of dust to the environment affects outside air quality, and is a risk for public health (Lelieveld, Evans, Fnais, Giannadaki, & Pozzer, 2015). The main source (80%) of dust in laying hen barns is manure, originating either from droppings on belts or from manure particles in the substrate on the floor in loose housing systems. The remainder comes from feed and the animals themselves (Cambra-López, Torres, Aarnink, &