FARMING SYSTEM DESIGN FOR SUSTAINABLE AGRIFOOD SYSTEMS: THEORIES AND PRACTICES

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Designing with animals and other stakeholders - first steps towards redesigning sustainable dairy goat barns

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Introduction

Dairy goat farming and other components of the agri-food system are undergoing a sustainable transformation. Citizens, consumers, policy makers and other stakeholders are becoming increasingly critical of the organization, practices, and impacts of food production, particularly about climate change, biodiversity loss and animal welfare. In this context, this research was conducted to generate knowledge and initiate an interactive redesign process, aimed at developing more sustainable housing systems for dairy goats in the Netherlands. The primary objective was to identify and develop multiple design principles and housing concepts for dairy goats that (a) reduce emissions of ammonia, methane, and other greenhouse gases, and (b) enhance animal health and welfare by, e.g., (environmental enrichment) increasing the choice options regarding resting areas and surface materials. This will subsequently lead to a better alignment with societal wishes and goals.

Methods

The design process was structured according to the 'reflexive interactive design' (acronym in Dutch, RIO) methodology. RIO is a participatory action research approach that enables researchers to synthesize the diverse and sometimes (seemingly) conflicting interests and priorities of stakeholders to design more sustainable livestock systems (Bos et al., 2009; Elzen & Bos, 2019; Puente-Rodríguez et al., 2019). Based on this synthesis, researchers collaborate with other stakeholders to develop feasible redesign strategies.

RIO is structured in four phases, namely: System analysis; structured design I & II and anchoring. To achieve the research objectives, this study performed some key steps of phase 1 and 2(3). First, a system analysis of the current common housing systems in Dutch dairy goat farming, i.e., the deep litter barn: Historical perspective and advantages and disadvantages of this system. Second, a literature review on the behavioral and physiological needs of dairy goats. This serves two main purposes: to develop better animal welfare standards and to explore whether goat behavior can be used for emission reduction purposes. Third, an experiment to observe the behavior of a group of fifteen dairy goats when given access to elevated platforms in a deep litter barn under practical farm conditions. The aim of the experiment was twofold: To explore ways to improve the quality and diversity of resting areas, enabling goats to select their preferred resting sites, while reducing the excretion surface area to reduce emissions. Finally, the gained insights were integrated into an interactive design process in which new barn concepts were developed. The governance of the project (≈ 2 years) was as follows: A core team (design process-oriented researcher and experts) and a group of stakeholders (7-10; policy makers, farmers, etc.) that acted as an advisory board. The first versions of the design concepts were generated in a design workshop. The results were communicated to farmers, the sector, policy makers and academics.

Results

The Dutch dairy goat farming sector relies on the deep litter housing system, with few alternative systems in use. For many stakeholders, this system is an integral part of goat farming. Moreover, there are romanticized ideas about animal farming in which straw plays a key role, and different stakeholders would like to keep it that way. However, several factors strengthen the case for its transformation, e.g., ammonia and greenhouse gas emissions, animal welfare challenges, and public health issues.

The literature review showed that experiments with goats are usually conducted with small groups, in short periods, and with different breeds. This leads to primarily qualitative results with little replication, making comparison challenging. However, despite individual and breed differences, a number of goat-specific behavioral traits can be identified to enhance positive animal welfare (Rault et al., 2025) such as, access to elevated platforms and outdoors runs, cognitive challenges, or enabling behaviors such as fission-fusion, fleeing, etc.

The pilot showed that the goats in the experiment used the platforms approximately 40% of the time – for climbing, walking, lying down and hiding/resting underneath. This indicates that such structures are interesting candidates for enriching dairy goat barns. Furthermore, the experiment showed that goats also excreted on the platforms, highlighting the need for further research to reduce the ammonia-emitting surface by better understanding and utilizing goat behavior.

Three barn design-concepts were developed: The Brook Valley Barn; The Grandstand Barn, and Dairy Goat Barn The Podium. These concepts integrate various principles and measures aimed at reducing ammonia and greenhouse gas emissions and improving animal welfare. Key innovations include coated iron flooring systems with a manure separation belt underneath, elevated resting platforms, innovative feeding systems and manure management practices.

Discussion and Perspective

Livestock farming, including dairy goat production, faces numerous sustainability challenges. In the Netherlands, design requirements are shaped by biodiversity obligations, climate commitments, public health, and animal welfare. The insights gained in this study regarding the current deep litter housing system and animal welfare needs inform these discussions and identify critical knowledge gaps.

The new barn designs presented here should inspire, stimulate discussion, and encourage experimentation. In the short term, pilot projects and longitudinal experiments should be conducted on different farms before choices are made about floors, manure management, and enrichment elements. The pilot study presented here provides an interesting experimental framework for studying the use of elevated platforms. In the long term, a balance must be found between the needs of goats, society, and farmers, to align sustainability goals with the economic viability of dairy goat farming.

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