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### ► To cite this version:

Sophie Brajon, Céline Tallet, Elodie Merlot, Vanessa Lollivier. Barriers and drivers of farmers to provide outdoor access in pig farming systems: a qualitative study. *Animal*, 2024, 18 (5), pp.101138. 10.1016/j.animal.2024.101138 . hal-04565725

**HAL Id: hal-04565725**

**<https://hal.science/hal-04565725>**

Submitted on 2 May 2024

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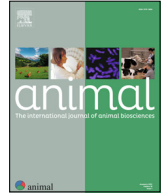


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# Animal

## The international journal of animal biosciences



### Barriers and drivers of farmers to provide outdoor access in pig farming systems: a qualitative study



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#### ARTICLE INFO

##### Article history:

Received 3 July 2023

Revised 13 March 2024

Accepted 14 March 2024

Available online 21 March 2024

##### Keywords:

Alternative systems

Breeder

Perception

Welfare

Work

#### ABSTRACT

Part of the farmers have chosen to raise pigs with outdoor access. However, providing outdoor access to pigs is not a simple matter, and many farmers are hesitating or feel powerless to engage in this transition. A better understanding of their needs and challenges could facilitate the development of innovations that generate commitment. This survey aimed to identify the French pig farmers' barriers to and drivers for providing outdoor access to pigs. A total of 36 farmers, aged 25–60, who worked in all types of pig farming systems (from full indoor to free-range) participated in a semi-structured interview that lasted 1.25–2.25 h. The topics covered included a historical overview, a description of the farm and practices, as well as opinions about the impact of outdoor access on farmers, animals, production and economic performance, environment, and society. Qualitative data were analysed using thematic analysis. Most of the participants agreed that rearing pigs indoors is a different job from that of rearing pigs with outdoor access and that it is above all a matter of choice, farmer work conception, and work comfort. Farmers generally agreed that working outdoors is particularly arduous, but this could be compensated by the satisfaction of being in contact with nature and seeing animals in a more complex environment. A large majority of farmers managing a system with outdoor access raised the issue of lack of support, highlighting the need for refinement and diffusion of guides of practices as well as day-to-day support. The impact of outdoor access on the health and welfare of pigs was discussed, especially regarding climatic hazards and the risk of zoonoses, and several outdoor farmers explained how their relationship with the animals changes when pigs are raised outside. Given that zootechnical performance may significantly decrease in farms with outdoor access, various strategies can be employed to maintain profitability, such as feed production, circularity, direct sales, or work diversification. They could be either motivating or demotivating factors depending on the individuals. Concerns about social criticism were prominent among many indoor farmers while farmers providing outdoor access generally felt more serene and proud. Overall, this study can serve as a basis to identify levers that could remove barriers, foster the adherence of more farmers, and facilitate the transition towards more pig farming systems with outdoor access, provided that those systems are viable and beneficial for the welfare and health of the animals and farmers.

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#### Implications

Providing outdoor access to pigs is not a simple matter; thus, we investigated pig farmers' barriers and drivers for these types of systems. We interviewed 36 French pig farmers working in all types of pig production systems (from full indoor to free-range). Through semi-structured interviews, we identified various barriers and drivers related to farmers' work and satisfaction, animals' health and welfare, zootechnical and economic performance, and social and environmental impacts. Overall, this study will serve

as a baseline for identifying strategies to overcome barriers, foster adherence of more farmers and facilitate the transition towards more pig farming systems with outdoor access.

#### Introduction

Livestock farming systems are nowadays subject to significant criticism due to their environmental impact and social acceptability (Alonso et al., 2020; Busch et al., 2020; MacLeod et al., 2013). On the one hand, the transition toward more sustainable agriculture requires profound change and not simply marginal technical adjustments (Ollivier et al., 2018). One form of ecological moderni-

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sation agriculture concerns the biodiversity-based agriculture which aims to develop ecosystem services provided by biological diversity and suggests opening the farms outdoors (Duru et al., 2015; Zira et al., 2022). On the other hand, animal welfare in livestock farming, especially for species predominantly housed indoors like pigs, is a topic of debate in society. Indeed, in France, 95% of pigs from conventional farming are confined indoors on slatted floors (Sørensen et al., 2006), with limited access to natural light, few opportunities to exhibit exploration behaviours and frequent social stress caused by repeated mixing and social instability. Although conventional farms help to guarantee pigs' health and improve some aspects of welfare (e.g., less risk of diseases and parasites, decreased perinatal mortality, better feeding management), farms with outdoor access present numerous advantages for animals' welfare and health (e.g., opportunity to express natural behaviours, better comfort, better respiratory and digestive health) (for a review, Delsart et al., 2020). Yet, pig farming systems opened to the outdoors are in the minority and the pig production sector is facing challenges in transforming (MacLeod et al., 2013; Molnár, 2022).

The changing moral values accorded to animals in Western society nowadays, exacerbated by the intensification and confinement of farming, have led to a split between conventional farming and society. Because citizens have increasing influence on the evolution of livestock systems (e.g., The "End the Cage Age" Initiative), scientific research is carried out to better understand citizens' points of views and expectations ranging from individual surveys to co-design in participatory research projects of the future livestock farming involving citizens, such as in Coeugnet et al. (2023) for dairy livestock. A study in Canada found that citizens concerned about dairy welfare mention pasture access, space, fresh air, and sunshine (Ventura et al., 2016). Similarly, when asked to cite what matters for farm animal welfare, many French citizens emphasise the importance of natural behaviour expression, such as grazing and foraging (Delanoue et al., 2018). French citizens' perspectives on pigs are similar to those of other farm animals, and they do not really differentiate a pig from a ruminant in terms of outdoor access needs (Brajon et al., 2023a; Delanoue et al., 2017). Far from being localised phenomena, the desire for greater outdoor access for livestock is becoming widespread in developed countries, including for pigs (Sato et al., 2017). This is even considered the priority action to be taken according to the French citizens (Delanoue et al., 2017), although determining the ideal outdoor access conditions for farm animals remains complex for citizens (Brajon et al., 2023a).

For their part, most pig farmers from the conventional sector define animal welfare mainly based on the physical health and production level of the animals, instead of emotional aspects and ability to perform natural behaviour (Bock and van Huik, 2007), and do not have negative attitudes towards husbandry environment indoor (Bergstra et al., 2017). They rather have a negative attitude toward the impact of outdoor access on pig welfare that can be compromised by climatic hazards, risks of zoonoses and parasite infections, and they do not believe that consumers would be willing to pay more for meat products from pigs raised outdoor (Danne and Mußhoff, 2022). Moreover, opening the farm to the outdoors is not a straightforward process. Providing outdoor access may require significant infrastructure investments, potentially leading to significant drops in production due to health risks or exposure to climatic hazards and is associated with an unclear income effect, as this is also the case for cattle (Buchan et al., 2023). Beyond the economic aspects, farmers have to weigh the pros and cons and make decisions for changes that have profound implications on the farmers' work organisation and labour, the animals' welfare and health, the environment and social acceptability (Balzani and

Hanlon, 2020; Buchan et al., 2023). Consequently, sector professionals may refuse or hesitate to embark on this transition.

Nevertheless, other farmers decide to embark on outdoor farming, and researchers have identified that farmers' decision-making is driven by the *ability* to adopt (e.g., economic status of the farm, local context) but also the *willingness* to adopt a practice or a system, this latter being influenced by key constructs such as with attitude, beliefs, values and social norms (Mills et al., 2017). For instance, the social norms towards more animal welfare considerations in breeding can play a role in the decision, a social norm being defined by Bicchieri (2017) as rules of behaviour that people are prompted to conform to because they believe that most individuals in their reference network conform to them and believe they ought to conform to them. This can induce a social pressure to adopt animal welfare practices or generate and rely on personal beliefs (the degree to which a person has a favourable or unfavourable evaluation of a behaviour or object) and personal norms (self-expectations based on internalised values) (Mills et al., 2017). In practice, studies have shown that decisions to implement animal welfare practices can be driven by profitability and productivity considerations, either directly (e.g., improving the welfare of animals optimises their survival and growth), or indirectly (e.g., improving welfare attracts more people to purchase the products). Studies on cattle showed that other drivers include ethical reasons (e.g., improving animal welfare for the sake of animals themselves), and the pursuit of an improved quality of life for farmers (Hansson and Lagerkvist, 2015). In fact, good animal welfare has been associated with farmers' occupational well-being and reduced stress levels (Hansen and Østerås, 2019). Also, pig farmers' intention to adopt animal-friendly practices is mainly determined by their belief in their ability to do so (Borges et al., 2019). Regarding the provision of outdoor access, a recent study based on an online survey of 109 German pig farmers found that the main driver would rather be their trust in a beneficial effect on animals than their trust in the consumers' willingness to pay (Danne and Mußhoff, 2022). However, there is still a lack of qualitative studies investigating the barriers and drivers underlying farmers' decisions to provide outdoor access to pigs, especially French farmers, despite the potential for producing actionable knowledge on the conditions for success.

If a transition towards more "open" alternative systems is desirable as part of the necessary agroecological transition, it can only occur if stakeholders in the livestock industry have ample motivation for this transition and have strategies to overcome barriers. Farmers, in particular, play a crucial role as this transition can have significant implications for the nature and organisation of their work and may require additional investment. Moreover, farmers have hands-on experience in addressing ethical questions and challenges in agriculture (Meijboom and Stafleu, 2016), making them a valuable source of knowledge on the impact of the farming system and practices on pig welfare (Spooner et al., 2014). A better understanding of farmers' needs could also facilitate the development of innovative solutions that foster commitment. The present study aimed to explore pig farmers' acceptability of outdoor access and identify the barriers and drivers associated with it.

## Material and methods

### Conceptual framework

Dumont et al. (2020) recognise three heuristic frameworks to analyse a situation of agricultural transition, at three level perspectives: the *multilevel perspective* (to explain global structure shape and its impact on actors), the *comparative agriculture* (to explain

structure shape of agricultural production from a historical perspective and its impact on actors and the farming territories) and the *justification of practices* (to explain actors' sustainability visions, perceptions of the structures and consequences of practices). We decided to follow this latter approach which proposes a pragmatic approach to transition to study the on-the-ground implementation of agriculture paradigms (e.g., the provision of an outdoor access) and enable us to understand the barriers and drivers underlying farmers' practices. From the literature review, we found that farmers face a complex interplay of work, economic, biosecurity and ethical considerations that shape their choices to offer or not outdoor access to animals. In this study, we aimed to understand *why* some farmers are motivated to provide outdoor access and not others, *how* they implement their principles and *what* are the levers to facilitate the transition towards more access to the outdoors, which was possible through the *justification of practices* framework. We hypothesised that the main barriers and drivers underlying the farmers' motivations to provide an outdoor access or not concerned farmer work labour and satisfaction, animal health and welfare, zootechnical and economic considerations, but we also wanted to bring out other dimensions that farmers might consider as part of the reflection, such as environmental impact or social acceptability.

#### Research team

The authors are livestock scientists working at the French National Research Institute for Agriculture, Food and the Environment (INRAE) who received formal training to perform inquiries by researchers in sociology and they followed recommendations for reporting qualitative research (e.g., O'Brien et al., 2014). All the interviews were performed by the first author, a woman scientist cumulating 10 years of experience in pig biology (pig husbandry, health and welfare) alone (28 interviews) or accompanied by another woman pig scientist (two interviews) or by two women geographer scientists and a man and a woman pig research technicians (three interviews). This latter situation concerned the three interviews performed in Corsica island where it is difficult to approach farmers and thus, support from the Corsican research team who knows the field and farmers was important to gain the trust of farmers. Despite the presence of other persons on these occasions, this is the main investigator who performed the interviews. The survey was designed in accordance with the General Data Protection Regulation (GDPR) which extends from the principles outlined in the European regulation (European Parliament and Council of the European Union, 2016) and the French regulation (France, 2018) on the protection of personal data. The authors benefitted from the guidance of a GDPR advisor from INRAE to ensure compliance with the GDPR.

#### Participant recruitment

This study did not aim for a quantitative mapping of the French pig farmer population, but rather sought to explore the diversity of points of view regarding farming systems with outdoor access. French farmers were thus selected in a manner designed to maximise profile diversity, taking into account various selection criteria. Selection criteria included the type of pig farming systems in relation to outdoor access (from full indoor to free-range), location in metropolitan France, farm size, breed (including local breeds), as well as participants' gender and age.

A total of 36 participants (on a total of 33 farms) were recruited. Due to the high diversity of pig farming systems in France, it was considered pertinent to use various sources to facilitate triangulation of multiple data sources and get a high diversity of participants (Cohen and Crabtree, 2006). Some participants (N = 13)

were recruited directly by utilising a network of contacts. This network of contacts was provided, first, by a co-author (CT) who contacted pig farmers she knows working in Brittany regions. A zootechnician from the research unit and a pig veterinarian from a private vet office also provided a list of contacts of Breton pig farmers. Then, the main investigator (SB) contacted a pig engineer specialised in the management of French local breeds to request a share of contact with pig farmers working with Basque Kintoa and Gascon pigs. She also contacted another INRAE research unit in Corsica to have access to farmers from this region. Then, several other participants (N = 4) were recruited thanks to referrals from interviewed farmers, by snowball sampling method. To complete the sample of participants and reach farmers with different characteristics (in relation to the selection criteria), the main investigator continued her participant recruitment through internet searches (N = 10) and outreach on Twitter or an agricultural union (N = 9).

Initial contact with farmers was established via telephone, during which information about the study was provided. The need for audio recording of the interviews, data usage, and confidentiality procedures was discussed. Upon agreement to participate, an individual interview date and time were scheduled, and an informed consent form was emailed before the interview. The consent form was also provided to the interviewee before the interview commenced to ensure comprehension, agreement with the terms, and completion and signing of the document. Participants had the opportunity to withdraw their participation or refuse to answer a question at any point, and this may favour honest responses of participants (Shenton, 2004). The sample size could affect the quality of data provided from the interviews but the variety of responses could triangulate the collected data and verify its consistency, filling any gaps left by any group of participants. After conducting interviews with 36 participants, the authors believed that the number of interviews provided a comprehensive, diverse, and rich account of the topic, achieving data saturation (Fusch and Ness, 2015), defined as "information redundancy" (Braun and Clarke, 2022), although this is inevitably subjective and tricky to judge when to stop data collection (Braun and Clarke, 2021). As a result, the inclusion of additional participants was deemed unnecessary.

#### Interview method

Interviews were conducted between November 2021 and April 2022 and lasted approximately 1.25–2.25 h each. Although in-depth face-to-face interviews (N = 23) were favoured since they can facilitate the researcher in building connections with participants and achieving the research goals, several interviews were done by phone (N = 3) or video conference (N = 10) to be able to pursue the investigation during a 2-month period of contact restriction (Jan–Feb 2022) due to Coronavirus disease 2019. A qualitative semi-structured approach was employed, which involved using preformulated open-ended questions to guide the discussion. Using this approach, the interviewer adopts a stance of "talking back" to the participants, where questions are used flexibly, being omitted, adapted or elaborated according to the individual contexts, in order to promote a two-way dialogue (Griffin, 1991). This method was chosen as it allows for understanding the context of the interviewees, and explores and provides deeper insight into their experiences and perceptions in their own wordings (Duval et al., 2017). The aim of this method is to know how interviewees describe their experiences or reasons their choices and actions as they experience it (Duval et al., 2017).

The interviews were recorded using a voice recorder, and the investigator took some notes to follow up on conversation. When interviews were conducted in person, they were most often done in the farm break room, in the farmer's home, or outside, but on

**Table 1**  
Demographic characterisation of the pig farmers and farms.

Characteristics	Number
Type of systems	
Indoor on concrete slatted floor	10
Indoor on straw and concrete slatted floor	3
Indoor with outdoor courtyards	9
Full outdoor	5
Free-range	2
Mixed indoor/outdoor access <sup>1</sup>	7
Farm orientation	
Farrow-to-finish	29
Farrowing	2
Growing-finishing	5
Farm size	
Between 8 and 60 sows	11
Between 70 and 140 sows	10
Between 200 and 600 sows	10
Without sow, 100–1000 growing pigs/year	5
Breeds / genetic lines	
"Common" genetic lines <sup>2</sup>	28
Nustrale	3
Basque kintoa	2
Berkshire x Duroc	1
Mangalitza	1
Gascon	1
French regions	
Brittany	11
Auvergne Rhône-Alpes	6
Nouvelle-Aquitaine	5
Pays-de-la-Loire	6
Corsica	3
Normandie	2
Centre-Val de Loire	1
Grand-Est	1
Bourgogne-Franche-Comté	1
Sex of participants	
Men	29
Women	7
Age of participants	
Between 25 and 39 years	11
Between 40 and 49 years	13
Between 50 and 65 years	12
Education level of participants	
Without higher agricultural education	8
Higher agricultural technician certificate	10
Agricultural technician certificate	10
Agricultural engineer certificate	8
Number of years of work experience in swine production	
Between 1 and 5 years	8
Between 6 and 10 years	7
Between 12 and 25 years	13
Between 26 and 37 years	8

<sup>1</sup> Mixed systems are farms that have both sections indoor and sections with outdoor access.

<sup>2</sup> "Common" genetic lines included pigs of pure genetic line or crossbred between, e.g., Large White, Landrace, Duroc, Piétrain.

one occasion, it took place while the farmer was at work. Most interviews were followed by a farm visit, but never the other way around. Thus, although the farm visits allowed the investigator to discover farming conditions and practices and to better understand the context, they did not influence the interview process (apart from the case of the interview having taken place while the farmer was working).

The interview script ([Supplementary Material S1](#)) outlined the predefined themes to be explored. It allowed for the identification of a variety of viewpoints and the representation of the diversity of farmers' patterns. Information collected during the interviews covered the following areas: (1) Introduction and motivation of the farmers in their career choice, (2) History and description of the

farm, (3) Farm development process and future projects (including the interest in the development of outdoor access, if applicable), and (4) Farmers' perceptions, barriers, and drivers to provide (or not) outdoor access to pigs. For this latter topic, the discussion was oriented to address the impact of outdoor access on farmer labour and satisfaction, animal health and welfare, zootechnical and economic considerations, since they are factors that can play an important role in the farmers' decision-making to open a farm to the outdoors. Environmental and social considerations spontaneously emerged and were also included as themes in the study, as they were addressed by most of the farmers during the interviews and they were also factors that can condition farmers' choices.

The discussion of each topic revolved around the participant's personal experience on their farm, as well as their opinions on similar farming systems (e.g., "Do you think this is something common on most farms of this kind?") or different farming systems (e.g., farmers working in full indoor were asked: "What do you think about the impact of an outdoor access on farmer work?", "To what type of outdoor access are you referring?"). The questions were asked as neutrally as possible to avoid influencing the participants in their responses.

To address the impact of the presence or absence of outdoor access on farmers, we asked about workload and job satisfaction, along with the work conditions (including outside work). Because pigs are large animals that can have unpredictable reactions and threaten the safety of farmers under certain conditions, farmers were asked if it was indeed a risk to be controlled, and how they ensure their safety with animals. The interview continued on the impact of the presence or absence of outdoor access on the welfare and health of animals. We questioned farmers to find out if they considered that having access to the outdoors (or not) was important for animals. They were asked about the criteria and signs used to evaluate the welfare and health of animals to better understand how they define the concept of welfare and better explain their point of view regarding the animals' health and welfare considerations. We discussed the level of satisfaction about animals' health and welfare, the equipment or enrichments used to guarantee welfare and the biosecurity measures put in place. Then, farmers answered questions regarding their opinion of the impact of the presence or absence of outdoor access on zootechnical and economic considerations. We did not request any zootechnical or economic data but rather asked them if they were satisfied with their production and incomes to gain insight into their own perception of their situation. The question of meat quality (e.g., organoleptic quality, texture) was also addressed.

Because the environmental impact of farming was also a topic of concern for many farmers, we collected the opinions of those farmers on the impact of farming systems with or without outdoor access on environmental pollution and ecosystem services. Realising that this was also a very important topic for many farmers, we collected farmers' opinions on the society's view of pig production systems and the impact on their work and well-being, as well as their integration into the local community as a farmer. At the end of the interview, and if this had not been done before, the investigator asked to develop more their opinion of other pig farming systems on farmers, animals, zootechnical, economic, environmental and/or social considerations. Finally, if not addressed before, she asked if they had a project or desire for construction work or farm transformation for the future and if they were interested in opening or, on the contrary, closing their farm to the outdoors.

#### Data analysis and results presentation

The data were analysed using a qualitative thematic analysis approach to report experiences, meanings, motivations and the



reality of participants (Braun and Clarke, 2022, 2006). The interviews were transcribed entirely by the main investigator or a research technician. They used the “Dictanote” note-taking app, which has a built-in voice-to-text integration feature. After thoroughly reading the transcripts, themes were developed and codes were generated during the readings and were not defined beforehand. These codes were then compared and organised in an Excel spreadsheet, using a thematic analysis grid that crossed the different themes with the different interviews. Sub-themes were then developed and refined throughout the analysis process, which involved constantly moving back and forth between the entire data set and the coded data extracts. Meaningful verbatim quotes that exemplified the identified themes were extracted and translated into English for presentation in the text. An identification code was assigned to each verbatim quote to ensure anonymity. The code consisted of the letter “F” (for farmer) followed by an interview number. If multiple individuals participated in the interview, the farmer number was also included in the code.

## Results

### Farmers and farms description

The demographic characteristics of the pig farmers and farms are presented in Table 1. The participants were involved in various types of pig farming systems, including full indoor farms with concrete slatted floors, full indoor farms with straw, indoor farms with outdoor courtyards (with dirt, concrete or slatted floor, and with or without straw), full outdoor farms (with fences), free-range farms (without fences, a traditional extensive production system found in Corsica island) or mixed farms with both indoor and outdoor sections. The category of mixed farms included five farmers who

owned a farm site offering different housing options depending on the developmental stage of the animals (e.g., indoor gestation and outdoor nursing), as well as two farmers who owned multiple farm sites of different types (e.g., one indoor farm with courtyards and one full indoor farm with concrete slatted floors). It should be noted that four farmers in the study bred not only pigs but also other animal species such as cows, sheep, and/or poultry and were not classified as mixed housing farms.

Regarding the farmers’ knowledge of different housing systems, twelve of them had practical experience with both indoor and outdoor access systems. This was either because their parents worked on a different type of farm (N = 2), they transitioned from one farming system to another (N = 3), or they owned mixed farms (N = 7). Six farmers based their economic model on direct sales (to customers, local shops, or restaurants). Fourteen farmers sold their pigs through the conventional supply chain but also engaged in direct sales, while sixteen farmers exclusively sold their pigs through the conventional supply chain and did not have direct contact with consumers. Despite efforts to capture a diverse range of farmer characteristics, there was an imbalance in the sex ratio of the participants. This was partly due to the gender imbalance in the pig sector, as well as the distribution of roles and responsibilities among farmers, but a higher number of women cancelled their appointments compared to men (7 out of 14 (50%) cancellations from women, compared to 5 out of 34 (15%) from men).

### Global trends on barriers and drivers to provide an outdoor access

The main barriers and drivers to provide outdoor access in pig farming systems, according to each theme, are summarised in Table 2. The main barriers and drivers concern those that were reported by most of the participants. Farmer labour and satisfac-

**Table 2**  
Summary of the main barriers and drivers to provide an outdoor access in pig farming systems for each theme.

Themes	Barriers	Drivers
Farmer labour and satisfaction considerations	Physical difficulty, high workload, work under harsh climatic conditions, farmer mental load, follow-up and acceptability of biosecurity regulation, difficult management, territorial inequalities of financial and technical support, lack or difficult access to technical references, lack of suitable tools or expensive (tailored-made) tools, isolation	In agreement with personal moral values, better work conditions, satisfaction with animal living conditions and welfare, pleasure to work outside, access to natural light, diversity of tasks, protection against climatic hazards possible ( <i>courtyards</i> ), mechanisation and automation possible ( <i>courtyards</i> ), better human-animal relationship ( <i>courtyards/outdoor</i> ), in agreement with farmer work representation ( <i>outdoor/free-range</i> ), tradition ( <i>outdoor/free-range</i> , if French local breeds)
Animal health and welfare considerations	Poor welfare under climatic hazards, piglet mortality, risk of disease, limited impact on animal welfare compared to full indoor ( <i>courtyards</i> ), limited animal tracking ( <i>outdoor/free-range</i> ), sow mortality and suffering due to heatwaves ( <i>outdoor</i> )	Freedom of movement and choice, expression of natural behaviour, reduction or absence of abnormal behaviour, physical activity, greater ease in resolving a health problem, better respiratory and visual comfort, enhanced immunity and robustness, diversified diet
Zootechnical and economic performance considerations	Lower reproductive performance, lower growth, higher feed expenses, piglet mortality, territorial inequalities of financial support, many expenses due to new regulations; high costs of building and debt load ( <i>courtyard</i> ); energy expenses ( <i>courtyards</i> , if building heated), equipment too expensive or non-existent ( <i>outdoor</i> ), difficult land access ( <i>outdoor</i> ), few outlets in the long chain and difficult marketing ( <i>outdoor</i> )	Better meat quality, good growth, high-quality products sold at high price, financial support ( <i>courtyards</i> ), secure contracts ( <i>courtyards</i> ), capacity of investment ( <i>courtyards</i> ), capacity to set the price according to charges ( <i>outdoor/free-range</i> ), access to diversified markets ( <i>outdoor/free-range</i> ), low charges ( <i>outdoor/free-range</i> ), use of on-site feed resources ( <i>outdoor/free-range</i> )
Environmental considerations	Risk of groundwater and river pollution, risk of manure leakage ( <i>courtyards</i> ), high-energy consumption ( <i>courtyards</i> , if building heated), large concrete surfaces and large gutters ( <i>courtyards</i> ), risk of land degradation ( <i>outdoor/free-range</i> )	Low energy consumption, ecosystem services, use of on-site feed resources or local wastes ( <i>outdoor/free-range</i> )
Social considerations	Criticism of price by consumers, risk of intrusion by activists or whistleblower	Clientele relationship, communication and farm visits, pride and serenity regarding the positive image displayed to citizens

The table summarises the main barriers and drivers that emerged from interviews with farmers working in any type of farming systems. Therefore, the barriers and drivers concern farming systems with outdoor access independently of the type of outdoor access (i.e., indoor with outdoor courtyard, full outdoor, free-range) but the strength of a factor can vary according to the system (e.g., full outdoor farms are more affected by climatic hazards than indoor farms with outdoor courtyards). Sometimes, the factor only concerns a type of outdoor access and this is specified between parenthesis with: *courtyards* = indoor farms with outdoor courtyards; *outdoor* = full outdoor farms; *free-range* = free-range systems. For mixed farms, type(s) of outdoor access(es) could be *courtyards* or full outdoor according to the animals’ developmental stage; therefore, they were concerned by barriers and drivers associated with the type(s) of outdoor access(es) present, e.g., barriers and drivers associated with full outdoor farms if some animals were housed in full outdoor.

tion, animal health and welfare, as well as zootechnical and economic considerations, played an important role in the decision of pig farmers to provide an outdoor access, as seen by the high number of barriers and drivers found in this study. However, environmental and social considerations were also important topics for many farmers and these themes were thus included in the study. The next result sections develop the main findings for each theme.

#### *Providing outdoor access deeply shapes farmers' work*

Most of the participants in the study acknowledged that the profession of indoor pig farmer is distinct from that of outdoor farmer. They believed that it primarily revolves around personal preferences regarding work conception and work comfort. Offering outdoor access to pigs, whether through simple concrete courtyards, full outdoor systems, free-range systems, or mixed systems, has significant implications for farming activities and the work environment, according to them, and it changes the relationship with the animals. Although raising pigs with outdoor access can be challenging and demanding, many farmers expressed that the lack of support is a limiting factor. This suggests that farmers may face difficulties in receiving adequate assistance or resources to effectively manage outdoor systems.

#### *Different values, sources of satisfaction, and inconveniences*

Barriers and drivers related to farmers' work were identified across all types of farming systems. Many farmers perceived outdoor work as a constraint, primarily due to the dependence on seasonal fluctuations and the lack of control caused by climatic hazards. One indoor farmer expressed his opinion, saying, "*Integral outdoor in Brittany (A region in north-western France), it's not worth it, it's slavery*" (F15). Nonetheless, some farmers mentioned the lack of contact with the outside world and nature as a drawback. For example, a young employee planning her setup in organic farming with outdoor courtyards said, "*It's something that I miss a little bit, not having more contact with the environment. I am disconnected from reality*" (F20). Farmers who provide outdoor access to pigs highlighted their enjoyment of working outdoors. One farmer stated, "*If you love nature, then you thrive in an outdoor setting. We are fortunate to be farmers in a hilly area with a magnificent view, and there's a river flowing down below*" (F29). They also expressed satisfaction in rearing and observing pigs with good welfare, greater freedom, and the ability to exhibit natural behaviour (e.g., exploration, social play) in a more complex environment.

Regarding indoor farms with courtyards, farmers see them as a good compromise between work comfort and satisfaction to raise animals and spend time outside. A young farmer explained his choices: "*We were looking for specifications that would differentiate us, [...] to have an added value for us and some commitment to [animal] welfare as well. We wanted farm sizes that would provide us with comfortable working conditions, automated feed distribution systems, and agricultural machinery...*" (F6). Furthermore, some farmers selectively adopted ideas and practices from various systems, combining them to create a farm that aligns with their own preferences. For instance, an innovative farmer developed a pig farm under a greenhouse, aiming to benefit from what he perceived as the advantages of the outdoors (such as soil and pasture, direct access to light) while retaining the benefits of a building structure (protection from climatic hazards, biosecurity, work comfort).

#### *Different causes of mental workload, arduousness, and health risks for the farmers*

Several barriers were found to be common among farmers, regardless of the farming system they operated in. These barriers included work overload, mental workload, and distress arising from constant regulatory changes (e.g., a ban on surgical castration

without anaesthesia and the implementation of new biosecurity standards). The latter particularly affected the farmers working in farms with courtyards, as these systems are relatively recent in France and still evolving. Many of these farmers also followed organic specifications (just as full outdoor farmers) and they had to deal with repeated changes in the organic specification and face uncertainties, as one farmer mentioned, "*We have made the initial plans, for example, for the gestation sector, it's already not up to [French] standards for 2026. [...] Nobody knows. It's complicated to keep up with*" (F6).

Another significant constraint faced by farmers in indoor farms with courtyards was the considerable amount of time dedicated to cleaning, managing straw, and handling manure. In contrast, outdoor farms placed less emphasis on cleaning and sanitation. As one farmer explained, "*From a sanitary perspective, there is natural disinfection of the land, so it provides an additional benefit in terms of hygiene. It is managed naturally [through] UV rays...*" (F8). However, plot and fence maintenance can be arduous. For instance, a farmer raising pigs in a steep region described the challenges: "*Sometimes you have to dig up the fences that are under 40 cm of soil. [...] You have to do everything by foot. So just going around the pig pens, the feedlot, I need 1.50 hours*" (F10).

Regarding farmer health, the development of new technologies, such as air scrubbers, has improved the air quality in indoor farms. On the other hand, most farmers working in systems with outdoor access agreed that working outside enhances breathing comfort and even, for some who transitioned from indoor farming, led to an improvement in respiratory health. Nonetheless, working in outdoor farms often involved greater physical exertion, increased risks associated with handling animals (e.g., around farrowing and with certain hardy breeds, this latter also concerned farmers from free-range systems), and a higher likelihood of accidents (e.g., use of tractor on steep terrain).

#### *Different relationships with animals*

Farmers who provided outdoor access to their pigs expressed a sense of satisfaction in offering their animals an environment that allowed for greater freedom of choice, control and autonomy. One farmer who raised pigs in the undergrowth highlighted this satisfaction, stating, "*Actually, what I also like is knowing that my pigs, if I'm not there for a day, well, they don't care at all, [...] And in fact, they have so much space, they have so many resources, they have so many things to do that, intellectually, they are fulfilled. And that's my satisfaction*" (F10).

The presence of automation on farms, which is common in both indoor farms with or without courtyards, was viewed differently by farmers. Some saw it as a risk that could distance them from their animals. However, others explained that automation allowed them to free up time for other tasks, including animal observation and monitoring.

While herd management may not change significantly in indoor farms with courtyards compared to full indoor farms (e.g., feeding automation is possible), working in outdoor or free-range farms entailed profound changes in the way farmers interacted with their animals, potentially altering the human-animal relationship. As one farmer described, "*In a building, to move a sow from one place to another, you have to be behind and push, all right? In an outdoor setting, to move a sow from one place to another, you need to be in front. You have to call her with food. You need to have a different kind of relationship with her*" (F29). Outdoor farmers with smaller herds often learn to recognise (some of) the individual breeder pigs and some even give them a name, which may participate in enhancing proximity and relationship with the animals. An exception to this was the Corsican model, where Nustrale (the Corsican pig breed) or "Corsican-type" pigs are traditionally raised free-range under very extensive conditions, with limited contact with farmers. The

production is seasonal, and there are periods when the pigs live in complete autonomy. The relationship between Corsican farmers and their pigs appeared to be more distant compared to continental farmers.

#### *Different levels of technical assistance and support*

Most farmers having outdoor access pointed to the lack of financial and technical support as a significant barrier. They expressed the need to learn through trial and error before finding solutions adapted to their situation. They also underlined the lack of suitable and affordable equipment, which often poses financial challenges. One farmer who had a full outdoor system mentioned, “Everything needs to be invented, you know. [...] Since we are few in number as farmers, everyone does their own thing in their own corner. We constantly have to find and adapt solutions, and always deal with the issue of price because there are often available solutions, but the price tag often has too many zeros to afford it.” (F7-2). The lack of technical support can also have serious financial consequences, especially for farmers who have invested in costly buildings with outdoor courtyards. One farmer described his experience, stating, “What was challenging was that there was no one to provide us with answers regarding the possibilities of using outdoor slatted floors. [...] We encountered a lot of difficulties with outdoor access. [...] And in fact, many things are not working properly. So now, I'm at the stage where I have to start over, reorganize everything to work better” (F5).

Importantly, large territorial inequalities were also observed, with farmers working in regions with less pig farming and weaker sector organisation facing greater challenges and receiving less support. This was particularly evident for Corsican pig breeders who work in very isolated conditions without even having access to rural veterinarians. In other regions, some farmers with more than 20 years of outdoor farming experience confided that nowadays there are knowledge and equipment available, and others organised themselves into structured and dynamic farmers' associations to share tips (e.g., in Auvergne-Rhône-Alpes). Finally, although they benefit from more technical support, the situation of full outdoor farmers in regions dominated by intensive indoor farming (Brittany, Pays-de-la-Loire) may experience isolation due to the significant differences in moral values with indoor farmers, the overwhelming majority. This could result in a feeling of social exclusion among stakeholders from the field.

#### *Concerns for the welfare and health of their animals in the outdoor*

Farmers had varying conceptions of animal welfare depending on the type of farming systems. Most farmers who provided outdoor access, indoor farmers who provided straw bedding as well as indoor farmers who were particularly engaged in animal welfare (i.e., constantly seek better welfare without necessarily having financial compensation, e.g., more environmental enrichments than required by the legislation), defined animal welfare primarily based on behavioural aspects, such as exploration and social relationships, as well as the mental state of the animals, including freedom of choice, fulfilment, and happiness. However, there was an exception with free-range farmers in Corsica, who rather based animal welfare on health indicators, such as good hair appearance, and performance criteria, like significant growth. Indoor farmers who were not more committed to animal welfare than required by regulation expressed concerns for the welfare of their animals but relied rather on survival (i.e., low mortality), health (e.g., absence of disease, normal skin appearance), and performance criteria.

#### *Management of pedoclimatic hazards*

Raising pigs indoors offers better control over environmental conditions, allowing for the provision of thermal comfort through

the appropriate adjustment of ventilation, heating, and cooling systems. One farmer pointed out: “We need to have control over everything, including mastering the climate change as well.” (F12). Another farmer working indoors added: “I would have a hard time accepting that a sow, just because the weather conditions aren't favourable [...], would end up with only seven or eight piglets. It would feel like I'm not talking about welfare at all.” (F11). The management of the welfare and health of animals in the face of climatic hazards posed significant challenges for outdoor farming systems. Barriers included risks of piglet mortality, thermal stress, dirtiness (e.g., courtyards quickly can get dirty due to the accumulation of faeces and rainfall, the ground outdoors can become muddy) and lameness (e.g., the concrete floor is slippery due to dirt).

However, farmers found ways to overcome these barriers by adhering to certain conditions. For indoor farms with courtyards, farmers recommended having insulated buildings, provisions such as plastic straps or doors for accessing the outdoors, outer slatted floors to prevent feces accumulation, and a roof to protect from rain and to prevent the pigs from getting cold or slipping on the concrete floors. Dry straw bedding was also crucial to maintaining warmth and dryness inside the facility during winter.

For full outdoor and free-range farms, farmers agreed that the farming system should be adapted to soil and weather conditions. Factors such as well-draining soil, the presence of vegetation, and a suitable climate played a role in ensuring good living conditions. The choice of suitable equipment was also at the heart of the considerations, and farmers advised providing huts with dry straw bedding, good insulation through the choice of appropriate material, plastic straps to access inside and even heating inside around farrowing and nursing for rainy and cold weather. Selecting breeds adapted to the local pedo-climatic conditions was also considered important. The selection of a breed adapted to the pedo-climatic conditions was part of the thoughts of this farmer who chose to raise Mangalitzta pigs, a breed adapted to her steep and draining terrain and to the climate of the region which can be harsh in summer and winter: “Recently, there have been 3–4 consecutive days of rain. The three [sows] gather together, and the piglets climb on the backs of everyone, curling up on their mothers' backs to sleep like that. [...] They are very resistant, huh!” (F10).

#### *Management of animal health and biosecurity*

Biosecurity and the risk of contact with wildlife were identified as important concerns by most farmers when it came to outdoor access for pigs. Many farmers recognised that keeping animals outside increased the risks involved in terms of disease transmission and contact with wildlife. An indoor farmer confided: “The more animals we put outdoors, the more risks we take, that's evident” (F17). One farmer who regularly had high piglet mortality and who experienced an episode of brucellosis in his outdoor maternity (which led to the slaughter of his herd) warned about outdoor farming: “People should not believe that by putting the animals outside, the animals will necessarily be better and everything will be fine” (F3).

However, several outdoor farmers claimed that animals raised outside are more robust, and loose-housing systems with lower animal densities can reduce the risk of health issues by alleviating sanitary pressures on the animals. They highlighted various other health benefits associated with outdoor access, including a significant reduction (farms with courtyards) or even an absence (full outdoor and free-range farms) of abnormal behaviours such as tail biting, improved breathing and visual comfort, decreased lameness, and a lower risk of digestive disorders, among other positive outcomes.

#### *Animal behaviour and welfare and environmental diversity*

Farmers providing outdoor access generally agreed that such access gives animals more opportunities to express their natural



behaviours and more freedom of choice and control over their environment. Access to a natural environment (e.g. trees, pasture, soil) also allows pigs to find resources to supplement their diet, as explained by a family of farmers raising pigs in a recycled poultry aviary with outdoor courtyards on earthen floors: “[The pig] will find some minerals, some stuff like that in the soil, stones...” (F4-2). Farmers also underlined the benefits during loading and transportation to the slaughterhouse, with animals already familiarised with diversified environments, especially outdoors, and less reluctant to being moved: “When they get into the truck, the drivers tell us, “It’s obvious that you’re in organic farming, that they are outdoors, because...” [...] When you deal with [pigs from] conventional farms, as they say, sometimes the pigs resist and you have to force them in the corridors” (F4-3).

However, the opinions regarding animal welfare were more nuanced for farmers having indoor farms with outdoor courtyards, with some expressing doubts about the added value compared to full indoor on straw, or even a farmer questioning it because, in his opinion, it restricts the animals too much.

#### *Providing outdoor access: an open door to differentiated markets and increased autonomy*

The zootechnical and economic performances were perceived differently by farmers according to the type of farming they had experience with. The relationship to performance, sources of economic margins, and the ways of economic risk management differed.

#### *Systems differently attached to the zootechnical performance of animals*

Great differences in the management of zootechnical performance were present, which can impact productive output. Some farmers of “classic” genetic lines providing outdoor access said they have excellent zootechnical performances, comparable to the performance in conventional systems. For example, a farmer with both a full indoor piggery on slatted floors and an indoor organic farm with courtyards performed technical–economic analyses and noticed: “I have better results with the organic than with the conventional farm. And compared to my [indoor] farm where I worked before, we wean almost one piglet more, we bring them a month earlier to the slaughterhouse. So obviously I am very satisfied! Regarding the economic consideration, we are far better” (F2).

On the extreme opposite side, the situation was very particular for the Corsican farmers raising free-range pigs and where animals are raised in total freedom, with little control of the herd, and where the farmers “collect” what they need at the time of the slaughter period. For those farmers, the relationship to performance was far different since they did not reason in terms of increased production. Rather, they reasoned in terms of what they were able to process and sell on their own, starting from the fact that producing a few more pigs, in anticipation of a high mortality rate, is not more expensive in this type of system (e.g., reduced time spent with animals, use of natural resources in the forest, no building). A farmer talked about the sow farrowing which is done freely: “We let it happen, then the sows bring back the piglets. If they don’t bring them back, that’s okay. Me if I have enough [pigs], I let them give birth outside. If she brings me two piglets like this now, I don’t care, I don’t mind, I already have my number for next year, I already know what I’m going to kill” (F31). Hence, the lower reproductive output was not necessarily a barrier, and the added value was mainly due to the product quality, as for many outdoor farmers to a lower extent.

#### *Different economic margin sources*

Farmers operating full indoor farms and those with outdoor access generated their margins in different ways. An indoor farmer explained: “To make a living, we are conditioned to achieve good technical results. [...] So we are constantly in this search, which is fascinating because we have tools to improve and control all that, and say to ourselves “Well, we can improve there, how can we improve, et cetera”. [...] For me, in outdoor farms, there is [higher] mortality, and also, you can’t look at the feed consumption index of a pig because that doesn’t make sense. If you start looking at that, the numbers are crazy. [...] For me, in outdoor farms, we value a product by its quality, by its breeding method, and so on” (F19). The economic profitability of farms with outdoor access (either full outdoor or indoor farms with outdoor courtyards) was thus based on the ability to market meat products to differentiated local markets. This was often achieved through organic certifications or protected designations of origin (PDO). However, various strategies, which can constitute a barrier or a driver depending on the farmers, were also necessary, as described below.

#### *Integration into the territory, circularity, and diversification of activities*

Some farmers providing outdoor access attempt to lower the leverage of input costs by producing feed at the farm, using resources available on-site (e.g., providing access to a forest plot to supplement feeding with chestnuts and acorns) or implementing circularity measures (e.g., utilising food wastes to feed pigs). Working in outdoor or free-range farms in regions where pig farming is scarce has also compelled many farmers to engage in multiple professions (e.g., feed producer, butcher, salesman) to add value to their products, reduce input costs, and reach differentiated local markets. Some farmers have chosen to combine pig farming activities with other productions (e.g., arboriculture, dairy milk production). While work diversification was seen as a constraint for some farmers, it was viewed as a source of motivation and autonomy for others seeking independence. One farmer expressed, “The must, it is somewhat the control of the entire value chain.” (F7-2). The diversity of tasks could also play a role in employee recruitment, either positively or negatively, depending on farmers’ opinions.

#### *Different ways of managing economic risk*

Indoor farmers strongly highlighted the financial risks associated with building courtyards and selling niche products, which contributes to their reluctance to embark on this type of construction on their farms. However, some farmers who provide outdoor access had thoroughly studied the question of economic profitability and conducted market studies before venturing into alternative production. Some have even travelled abroad to discover and draw inspiration from innovative alternative systems. One farmer shared, “We have a bit of tunnel vision and are not very open-minded in France. So, we went to see what was happening in other countries like the Netherlands and Denmark” (F6). Overall, many farmers providing outdoor access view it as a secure option for the future. One farmer explained, “I was interested [by an organic indoor farms with courtyards] because it was rare, and above all, it was super secure because there was this great demand, there were these 10-year contracts, with a good prospect of profitability” (F6).

Nevertheless, to navigate the climate of uncertainty faced by farmers, some of them who have recently renovated or built their buildings with courtyards have carefully considered the construction plans to make them versatile and adaptable to other productions. They opted for unspecialised buildings with high roofs, concrete floors, and large pens, allowing for easy modularity or adaptability in the event of a desire to sell or change production. Combining multiple productions simultaneously has also been a

way for several farmers, particularly those raising local breeds, to ensure financial security. This sense of financial security holds great importance for them.

### *Social and environmental challenges*

Farmers had different relationships with society, depending on the type of system in which they work and their connection to the local community. Additionally, farmers found it challenging to assess the advantages of indoor or outdoor farming in terms of environmental impacts.

#### *Different relationships with the consumer and the citizen*

Concerns about social criticism of pig farming and threats from abolitionist non-governmental organisations (NGO, e.g., from NGO publications questioning animal husbandry to activists' threats to intervene on their farms) were very prominent among most indoor farmers. One farmer raising his animals indoors expressed the sense of protection that walls provide: *"Having closed farms allows us to control who enters and also the message we want to convey about our production system"* (F12). They were particularly troubled by the negative perception of pig production among French citizens. In contrast, farmers with outdoor access, who aligned more with social expectations, generally felt more serene and proud. This does not preclude several farmers raising animals outdoors could share concerns: *"In fact, today, we constantly face pressure. I'm not immune to having an intrusion. When you hear dogs barking at night, you think, "What the hell is going on?""* (F3).

Not specific to indoor farmers, but farmers selling products through long supply chains felt threatened by economic globalisation and underlined the importance of distinguishing between the citizen (who demands higher welfare standards) and the consumer (who buys the cheapest product). They questioned whether consumers were willing to pay more for standard French pork products raised with higher welfare standards compared to cheaper imported products. On the other hand, other farmers have chosen direct sales or even opened their farm doors to citizens for visits (including a farmer with an indoor farm on slatted floor), believing that this is the best way to build closer relationships and instill confidence in consumers. The presence of outdoor access on farms could therefore serve as motivation for farmers to connect with their neighbours and consumers according to some farmers: *"The outdoor is a true calling card; it's very clear. People from the area come to spend their Sundays strolling around here"* (F29).

#### *A difficult comparison of systems concerning the environmental impacts*

Indoor farms with outdoor access, unlike those in full indoor farms, have the constraint of imposing more difficult manure management, which increases the risk of manure leakage from the outer pit into nature, according to farmers. However, farms with courtyards produce more solid manure (mixed with straw) than liquid manure, and a farmer explained why this is less harmful to the environment: *"We spread manure every 2 or 3 years on the plots, we manage to have a good cover of organic matter, the solid manure is not polluting. [...] In contrast, in industrial farming on slatted floors with liquid manure, there are inevitably issues with effluent storage and timing of spreading. They typically spread in autumn. [...] But cereals require nitrogen in February. [...] Of course, there is a huge washout"* (F33).

However, these courtyard systems can lead to higher energy consumption if they are heated and poorly insulated. Nevertheless, several farmers have opted for more passive, unheated, and energy-efficient systems.

Full outdoor farming, as do free-range systems, raised concerns about maintaining the soil in good agricultural and environmental

condition: *"Outdoor farming is not feasible on any type of land"* (F9). According to farmers, these challenges can be overcome by adhering to favourable conditions for outdoor pig farming, such as the presence of vegetation (trees, bushes), well-drained soil, and a suitable climate. In terms of soil coverage, the new regulations requiring double fencing were seen as a huge environmental risk factor for poor soil management, as mentioned by this farmer who discussed plot rotations *"It is the most suitable model for valorising pig manure. However, biosecurity regulations no longer allow it, or you would need to multiply the required space [double-fenced] for the pigs by three, which means we would need 60 hectares for biosecurity, nope. Even in the plain, I wouldn't do it! It's the absurd aspect of biosecurity because it undermines the coherence of the outdoor farming model associated with forage crop"* (F7-2).

## **Discussion**

This study was conducted with pig farmers working in a wide range of pig farming systems, from full indoor to free-range without any fences, which contributes to the richness of the dataset. We identified the drivers that drive pig farmers to provide outdoor access to their animals, whether related to tradition, quality of life, ethical values, the relationship with animals, or economic strategy. We also identified barriers which could explain the reluctance of the majority of indoor farmers to adopt outdoor access, which hinders the development of such systems. The interviews revealed that the decision to provide outdoor access is highly context-dependent (e.g., soil-climate context, social norms in the region) and depends on the farmer's subjective preferences and values (e.g., regarding risk, work conditions, animal welfare conception). Therefore, for the majority of indoor farmers, it is very unlikely that they could be convinced to convert to pig farming with outdoor access. Nonetheless, the profile of farmers who choose to have farms with courtyards is rather young, with a high educational level (agricultural engineers certificate) (Brajon et al., 2023b), and perhaps the transition to more farms with outdoor access will take place with the renewal of generations in this context of agroecological transition. In line with this, we identified levers that could help overcome or mitigate these barriers and facilitate a transition towards resilient and socially acceptable farming methods that offer outdoor access (Molnár, 2022). The main levers include ensuring good working conditions through appropriate equipment, promoting the "One Welfare" for both farmers and animals, improving financial security to cope with climate-related hazards and the risk of zoonotic diseases, and providing training and support for change.

#### *Promoting outdoor access that ensures good working conditions and the "One Welfare" of farmers and animals*

Both indoor and outdoor farmers considered their jobs to be different. Outdoor farmers were often proud and fond of the quality of life it confers, the satisfaction of raising and observing pigs in good welfare conditions, and the improved relationship with animals. Loose housing or organic systems that allow outdoor access can have a "welfare potential" for animals (Lund, 2006), and this was a source of fulfilment for outdoor farmers. However, while dairy farmers whose cows are housed in stall barns often consider outdoor access as still important for animals (Schuppli et al., 2014), this was barely the case for indoor pig farmers who mainly relied on the benefits of indoor facilities for health protection. According to many farmers, outdoor access can have beneficial effects on the health of both farmers and animals. For example, some of them argue that fresh air contributes to improved breathing and visual comfort for humans and animals. According to farmers, the natural

food resources available in outdoor or free-range systems also improve pigs' digestive health. Additionally, pigs raised with outdoor access are often considered more robust, particularly when they are hardy breeds.

A serious obstacle to good work conditions is that outdoor work is considered more challenging than indoor work, similar to the experience of dairy farmers (Smid et al., 2022, 2021), and this could increase with climate change (El Khayat et al., 2022). To our knowledge, no study has examined the association between musculoskeletal disorders and types of pig farming. While indoor farming may contribute to disorders associated with repetitive tasks, outdoor farming may lead to more disorders related to the manual transportation of loads (Barneo-Alcántara et al., 2021; Kouimintzis et al., 2007; Kuta and Brennensthal, 2015). Recent advancements in tools or equipment could facilitate the work of outdoor farmers and offer better living conditions for pigs. Despite a lack of consensus among farmers (Kling-Eveillard et al., 2020), outdoor systems could gain attractiveness to profiles of farmers who appreciate the technical aspect of pig farming, thanks to the development of digital solutions that assist farmers in decision-making, particularly regarding climatic hazards. Moreover, indoor farms with courtyards could be a good compromise to reconcile work comfort for farmers and the health and welfare of pigs living in a larger and more diversified environment, all in a system maintaining good biosecurity standards with a relatively high density of animals.

Providing outdoor access also changes the farmers' relationship with their animals. As outdoor farmers pointed out, working with animals in a full outdoor setting modifies the relationship. In this context, a power relationship between the farmer and the animal cannot be effective, and a different approach is necessary. Farmers need to attract the animals rather than push them from behind, which may help to foster a positive bond. Improving the human-animal relationship in farming systems with outdoor access, addressing both the animal dimension and the human dimension (Beaujouan et al., 2021), could contribute to fostering good stockmanship and sustainability. Human welfare and animal welfare are interdependent, as conceptualised by the "One Welfare" approach (Pinillos, 2018), and studies have shown that farmers for whom the human-animal relationship is central to their profession experience greater satisfaction in working with their animals (Kauppinen et al., 2012; Pol et al., 2021). This positive relationship results in more confident pigs and improved productivity (Pol et al., 2021).

#### *Providing equipment and know-how to cope with climatic hazards and the risk of zoonoses*

In the recent economic and epidemic context, indoor farmers have raised several barriers related to climatic hazards and the risk of disease outbreaks. Regarding the risk of disease outbreaks, fencing is regulated by French law (ANSES, 2021) and provides security. However, this causes tensions among some farmers who have faced difficulties in compliance, as this is also the case in Spain (Horriillo et al., 2022), and the risk of outbreaks still remains (Bellini et al., 2016; Jurado et al., 2018). Due to their contact with the soil and increased susceptibility to interaction with the wild fauna, outdoor pigs face a higher risk of contamination (Park et al., 2017). On the other hand, indoor pigs are penned in high stocking density and have an enhanced risk of contact with infected pen mates or their feces, thereby increasing the risk of zoonoses (Park et al., 2017). Overall, the risk of zoonose is a concern for all farming systems and requires vigilance and know-how to reduce the pressure.

Managing sanitation in farming systems that are exposed to climatic hazards and environmental fluctuations throughout the sea-

sons is challenging. Providing outdoor access thus requires excellent herd and health management skills, as well as adaptation of farming systems. Climate change raises concern for decades to come among farmers interviewed, especially indoor farmers, from the increased frequency of episodes of heat waves or heavy rains to the emergence of zoonoses. These factors may affect the various pig farming systems differently, and perhaps farms that perform well today may face greater challenges in the future. Levers to face climatic events exist today and are or must be shared between farmers, but agriculture is facing a brutal climate change that requires rapid adaptation and resilience. Hence, scientific studies should also focus on identifying levers to deal with "the unexpected" and creating resilient systems that encompass robustness, adaptability and transformability (Darnhofer, 2021; Meuwissen et al., 2019).

#### *Looking for sustainable production and financial security in systems with outdoor access*

Meat production rates in alternative systems vary widely, ranging from very low meat rates (e.g., in free-ranging systems) to meat rates comparable to those in indoor farming (e.g., in some indoor farms with courtyards). Enhanced meat quality is thus one way in which outdoor pig products can earn added value, although the difference in pork quality between farming systems with outdoor access and the indoor system is often limited to marbling and colour scores (Gentry et al., 2004). Economic profitability therefore often lies in the added value that outdoor access offers to consumers, such as ethical concerns, food safety, and local and sustainable products (Román et al., 2017; Sato et al., 2017).

This added value can be achieved through certification (organic label, PDO) or consumer confidence and word of mouth. Short food supply chains, where farmers are involved in various production tasks, processing (in some cases), and marketing, are common among full outdoor farmers. This strategy may enable subsistence in rural regions where pig production is weak, although net earnings are often low compared to the effort involved (Hochuli et al., 2021; Mundler and Jean-Gagnon, 2020). These farmers relied more on the marketing and sales to the local community and/or restaurants and they could adjust pork prices according to the production costs. Other farmers adopted a different strategy based on the diversification of activities, which allowed them to navigate more easily through adaptive cycles. Additionally, farmers who own arable land could produce part of pigs' feed, which is profitable in years when feed costs are high, but are not beneficial when feed costs are low.

Another strategy, well-described by Pfeifer et al. (2022), was to rely on the financial system of the pig sector through financial or physical capital or insurance schemes, or through sectoral mobilisation in the value chain to avoid a price reduction, similar to full indoor farmers. This strategy was reserved for indoor farms with courtyards, which are more specialised than full outdoor or free-range farms. They follow the lean production principle (Andersson and Eklund, 2014) and achieve financial security through secure contracts with distributors and/or cooperatives, as well as organic certification (Schukat et al., 2019). This type of farming is undergoing significant development in the organic sector in Europe (Wimmeler et al., 2022), particularly in France in recent years. For profitability matters, these systems concern almost exclusively farms with an organic agriculture label and, for example, half of the organic postweaning sector and almost all fattening sector were carried out in buildings opened to the outdoors in 2016 (FNAB, 2018). However, these farms may face economic challenges comparable to full indoor farms (Aderajew et al., 2019; Molnár and Fraser, 2020; Tell et al., 2016) and studies are needed to evaluate their sustainability and identify the condi-

tions of success. Overall, financial difficulties could concern all farmers, from full indoor farming to free-range, just like profitability, and an economic model that is favourable at a given period may become less favourable or even collapse in another period, forcing adaptation (Meuwissen et al., 2019). Hence, just as farms with outdoor access are varied, so are their economic trajectories and resilience strategies to shocks. Pig farmers, therefore, navigate these challenges according to their farming system, the local opportunities, their profile and their professional objectives.

#### *A strong need for innovation, training and support for outdoor farmers*

Contrary to indoor farmers who often have turnkey solutions, many farmers with outdoor access raised the lack of support and recommendations while, as developed above, working outside can be labour-intensive and requires strong management skills to deal with environmental fluctuations and sanitary risks. Outdoor farmers working in certain isolated regions (farmers met in Auvergne-Rhône-Alpes) organised themselves into farmers' associations, whereas others (farmers met in Corsica and some in New Aquitaine) felt particularly deprived. Day-to-day support of outdoor farmers in the field seems essential, as already do, for example, veterinarians or zootechnicians. Participatory activities and co-designing strategies and recommendations with stakeholders from the field, such as experienced farmers encountered in this study, could be a good lever for generating innovation adapted to their needs and supporting newly established farmers. On one side, it is indeed beneficial to encourage early adopters to communicate their experience since the feeling of control and the pride of being consulted on projects positively influence the pioneers' connection and engagement within a project (Baxter et al., 2022; Winkel et al., 2020). On the other side, their experience and practical knowledge could contribute to innovation and facilitate newcomers' training.

The fact that outdoor farmers are in the minority and that they are poorly supported and represented among the stakeholders may constitute a significant barrier to attracting new farmers on this transition. It is well-established that peers serve as invaluable sources of knowledge, and peer-to-peer learning and demonstration activities are important factors in encouraging the successful adoption of alternative practices (Sutherland and Marchand, 2021). Experience from abroad (Northern Europe) seemed to considerably influence outdoor farmers' decision-making, as already highlighted by Alarcon et al. (2014). Visibility and demonstration of alternative outdoor practices may strengthen the belief of indecisive individuals about their own capability to adopt innovative practices, referred to as perceived behavioural control, reinforcing their intention to adopt welfare measures (Borges et al., 2019).

## Conclusion

The strength of this survey is that respondents worked in a great diversity of pig farming systems (from full indoor to free-range systems), allowing at exploring the diversity of viewpoints regarding farming systems with outdoor access, from the most reluctant to the curious and the most convinced. A high number of barriers were identified by farmers working in systems with or without outdoor access, and many farmers may never be convinced to convert to farming systems with outdoor access. However, this survey also highlighted a high number of drivers for pig farming with outdoor access, whether they were related to farmers, animals, technical-economic, environmental and social considerations and this could be arguments to favour the development of outdoor access. Overall, this study will serve as a basis to identify and evaluate levers that could remove barriers, foster the adherence of more farmers, and facilitate the transition towards

more pig farming systems with outdoor access. One core aspect common to all the interviewed farmers giving outdoor access was that of having created a farm in their image, and outdoor access thus crystallised in different forms with various consequences on farmers, animals, and businesses. A fantastic challenge is therefore to address outdoor access in its diversity.

## Supplementary material

Supplementary material to this article can be found online at <https://doi.org/10.1016/j.animal.2024.101138>.

## Ethics approval

The compliance record for the national general data protection regulation (GDPR) was approved by the GDPR board of the "Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement" (INRAE, France).

## Data and model availability statement

None of the data was deposited in an official repository. The thematic analysis grid may be available by contacting the corresponding author upon request.

## Declaration of Generative AI and AI-assisted technologies in the writing process

Dictanote, a note-taking app with AI-based speech recognition, was used in the present project to transcribe speech into text. No other generative AI or AI-assisted technologies were used in this project.

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## CRediT authorship contribution statement

**S. Brajon:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **C. Tallet:** Writing – review & editing, Validation, Supervision, Resources, Methodology, Funding acquisition, Conceptualization. **E. Merlot:** Writing – review & editing, Validation, Methodology, Conceptualization. **V. Lollivier:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization.

## Declaration of interest

We have no conflicts of interest associated with this publication.

## Acknowledgement

The authors are truly grateful to François Charrier, Marie Gisclard and Bastien Trabucco for their support in inquiries in Corsica island as well as Carole Guérin for transcribing part of the interviews. They would like to express their gratitude to Evelyne Lhoste for reviewing the paper and providing constructive advice



but also Anne-Lise Jacquot for providing advices to improve the quality of the paper. Finally, last but not least, they would like to thank colleagues for providing farmers' contacts, and of course farmers for participating in the interviews.

### Financial support statement

Sophie Brajon received a BIENVENUE postdoctoral fellowship co-funded by the EU Marie Skłodowska-Curie Actions, Région Bretagne and the Institut Agro Rennes-Angers (grant agreement n°899546). This study is part of the PANORAMA ("PARTicipative design to enhance Outdoor Access of farM Animals") project and was funded by SANBA ("SANTé et Bien-être des Animaux en élevage", french for "Health and Welfare of Animals at farm") metaprogramme as the emblematic project 2021-2024.

### References

- Aderajew, T.S., Trujillo-Barrera, A., Pennings, J.M.E., 2019. Dynamic target capital structure and speed of adjustment in farm business. *European Review of Agricultural Economics* 46, 637–661. <https://doi.org/10.1093/erae/jby035>.
- Alarcon, P., Wieland, B., Mateus, A.L.P., Dewberry, C., 2014. Pig farmers' perceptions, attitudes, influences and management of information in the decision-making process for disease control. *Preventive Veterinary Medicine* 116, 223–242. <https://doi.org/10.1016/j.prevetmed.2013.08.004>.
- Alonso, M.E., González-Montaña, J.R., Lomillos, J.M., 2020. Consumers' concerns and perceptions of farm animal welfare. *Animals* 10, 385. <https://doi.org/10.3390/ani10030385>.
- Andersson, K., Eklund, J., 2014. Work environment, Lean and agriculture. In *Proceedings of the 11th International Symposium on Human Factors in Organisational Design and Management & 46th Annual Nordic Ergonomics Society Conference* (ed. O. Broberg, N. Fallentin, P. Hasle, P.L. Jensen, A. Kabel, M. E. Larsen, T. Weller), volume II. IEA Press, Geneva, Switzerland, pp. 661–666.
- ANSES, 2021. AVIS et RAPPORT de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif aux "dispositifs de protection des parcours de porcins en plein-air vis-à-vis des risques sanitaires". Saisine n°2020-SA-0026. Rapport d'expertise collective. ANSES, Maisons-Alfort, France.
- Balzani, A., Hanlon, A., 2020. Factors that influence farmers' views on farm animal welfare: a semi-systematic review and thematic analysis. *Animals* 10, 1524. <https://doi.org/10.3390/ani10091524>.
- Barneo-Alcántara, M., Díaz-Pérez, M., Gómez-Galán, M., Carreño-Ortega, Á., Callejón-Ferre, Á.-J., 2021. Musculoskeletal disorders in agriculture: a review from web of science core collection. *Agronomy* 11, 2017. <https://doi.org/10.3390/agronomy11102017>.
- Baxter, E.M., Moustsen, V.A., Goumon, S., Illmann, G., Edwards, S.A., 2022. Transitioning from crates to free farrowing: a roadmap to navigate key decisions. *Frontiers in Veterinary Science* 9. <https://doi.org/10.3389/fvets.2022.998192>
- Beaujouan, J., Cromer, D., Boivin, X., 2021. Review: From human-animal relation practice research to the development of the livestock farmer's activity: an ergonomics-applied ethology interaction. *Animal* 15. <https://doi.org/10.1016/j.animal.2021.100395>
- Bellini, S., Rutili, D., Guberti, V., 2016. Preventive measures aimed at minimizing the risk of African swine fever virus spread in pig farming systems. *Acta Veterinaria Scandinavica* 58, 82. <https://doi.org/10.1186/s13028-016-0264-x>.
- Bergstra, T.J., Hogeveen, H., Stassen, E.N., 2017. Attitudes of different stakeholders toward pig husbandry: a study to determine conflicting and matching attitudes toward animals, humans and the environment. *Agriculture and Human Values* 34, 393–405. <https://doi.org/10.1007/s10460-016-9721-4>.
- Bicchieri, C., 2017. *Norms in the wild: how to diagnose, measure, and change social norms*. Oxford University Press, New York, NY, USA.
- Bock, B.B., van Huik, M.M., 2007. Animal welfare: the attitudes and behaviour of European pig farmers. *British Food Journal* 109, 931–944. <https://doi.org/10.1108/00070700710835732>.
- Borges, J.A.R., de F. Domingues, C.H., Caldara, F.R., da Rosa, N.P., Senger, I., Guidolin, D.G.F., 2019. Identifying the factors impacting on farmers' intention to adopt animal friendly practices. *Preventive Veterinary Medicine* 170. <https://doi.org/10.1016/j.prevetmed.2019.104718>
- Brajon, S., Tallet, C., Merlot, E., Lollivier, V., 2023a. Pig farmers' and citizens' opinions on outdoor access for livestock. Joint International Congress on Animal Science co-organised by the European Federation of Animal Science (EAAP), the World Association for Animal production (WAAP) and Interbull, 26 August - 1 September, Lyon, France, p. 560.
- Brajon, S., Tallet, C., Merlot, E., Lollivier, V., 2023b. Providing outdoor access to pigs: what are the profiles of farmers working in those systems? Joint International Congress on Animal Science co-organised by the European Federation of Animal Science (EAAP), the World Association for Animal production (WAAP) and Interbull, 26 August - 1 September, Lyon, France, p. 559.
- Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 77–101. <https://doi.org/10.1191/1478088706qp0630a>.
- Braun, V., Clarke, V., 2021. To saturate or not to saturate? questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health* 13, 201–216. <https://doi.org/10.1080/2159676X.2019.1704846>.
- Braun, V., Clarke, V., 2022. Conceptual and design thinking for thematic analysis. *Qualitative Psychology* 9, 3–26. <https://doi.org/10.1037/qup0000196>.
- Buchan, M.S., Lhermie, G., Mijar, S., Pajor, E., Orsel, K., 2023. Individual drivers and barriers to adoption of disease control and welfare practices in dairy and beef cattle production: a scoping review. *Frontiers in Veterinary Science* 10, 1104754. <https://doi.org/10.3389/fvets.2023.1104754>.
- Busch, G., Kassas, B., Palma, M.A., Risius, A., 2020. Perceptions of antibiotic use in livestock farming in Germany, Italy and the United States. *Livestock Science* 241. <https://doi.org/10.1016/j.livsci.2020.104251>
- Coeugnet, P., Labatut, J., Duval, J., Vourc'h, G., 2023. Including citizens through co-design in a participatory research project to explore innovative agro-food systems: the case of future dairy livestock systems. *Frontiers in Sustainable Food Systems* 7, 1098295. <https://doi.org/10.3389/fsufs.2023.1098295>.
- Cohen, D., Crabtree, B., 2006. Guidelines for designing, analyzing, and reporting qualitative research. *Qualitative Research Guidelines Project*, Robert Wood Johnson Foundation. Retrieved on 23 November 2023 from <http://qualres.org/HomeGuid-3868.html>.
- Danne, M., Mußhoff, O., 2022. Farmers' willingness to accept animal welfare practices: a discrete choice experiment with German pig producers. *German Journal of Agricultural Economics* 71, 1–15. <https://doi.org/10.30430/gjae.2022.0158>.
- Darnhofer, I., 2021. Resilience or how do we enable agricultural systems to ride the waves of unexpected change? *Agricultural Systems* 187. <https://doi.org/10.1016/j.agsys.2020.102997>
- Delanoue, E., Dockes, A.-C., Chouteau, A., Roguet, C., Philibert, A., 2018. Regards croisés entre éleveurs et citoyens français : vision des citoyens sur l'élevage et point de vue des éleveurs sur leur perception par la société. *INRA Productions Animales* 31, 51–68. <https://doi.org/10.20870/productions-animales.2018.31.1.2203>.
- Delanoue, E., Dockes, A.-C., Chouteau, A., Philibert, A., Magdelaine, P., Roguet, C., 2017. Points de vue et attentes des consommateurs et citoyens vis-à-vis de l'élevage. Une étude quantitative auprès de 2 000 personnes en France. 49èmes Journées de la Recherche Porcine, 31 January - 1 February, Paris, France, pp. 295–300.
- Delsart, M., Pol, F., Dufour, B., Rose, N., Fablet, C., 2020. Pig farming in alternative systems: strengths and challenges in terms of animal welfare, biosecurity. *Animal Health and Pork Safety. Agriculture* 10, 261. <https://doi.org/10.3390/agriculture10070261>.
- Dumont, A.M., Gasselien, P., Baret, P.V., 2020. Transitions in agriculture: three frameworks highlighting coexistence between a new agroecological configuration and an old, organic and conventional configuration of vegetable production in Wallonia (Belgium). *Geoforum* 108, 98–109. <https://doi.org/10.1016/j.geoforum.2019.11.018>.
- Duru, M., Therond, O., Fares, M., 2015. Designing agroecological transitions; a review. *Agronomy for Sustainable Development* 35, 1237–1257. <https://doi.org/10.1007/s13593-015-0318-x>.
- Duval, J.E., Bareille, N., Fourichon, C., Madouasse, A., Vaarst, M., 2017. How can veterinarians be interesting partners for organic dairy farmers? French farmers' point of views. *Preventive Veterinary Medicine* 146, 16–26. <https://doi.org/10.1016/j.prevetmed.2017.07.013>.
- El Khayat, M., Halwani, D.A., Hneiny, L., Alameddine, I., Haidar, M.A., Habib, R.R., 2022. Impacts of climate change and heat stress on farmworkers' health: a scoping review. *Frontiers in Public Health* 10. <https://doi.org/10.3389/fpubh.2022.782811>
- European Parliament and Council of the European Union, 2016. Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). Retrieved on 7 January 2023 from <https://gdpr-info.eu/>.
- FNAB, 2018. *Elever des porcs en bio. Réglementation, débouchés, témoignages d'éleveurs, conseils pour construire son projet*. Fédération Nationale d'Agriculture Biologique, Paris, France.
- France, 2018. Law No. 2018-493 of June 20, 2018, on the Protection of Personal Data. Retrieved on 7 January 2023 from <https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037085952>.
- Fusch, P., Ness, L., 2015. Are we there yet? data saturation in qualitative research. *The Qualitative Report* 20, 1408–1416. <https://doi.org/10.46743/2160-3715/2015.2281>.
- Gentry, J.G., McGlone, J.J., Miller, M.F., Blanton, J.R., 2004. Environmental effects on pig performance, meat quality, and muscle characteristics. *Journal of Animal Science* 82, 209–217. <https://doi.org/10.2527/2004.821209x>.
- Griffin, C., 1991. The researcher talks back: dealing with power relations in studies of young people's entry into the job market. In: Shaffir, William B., Stebbins, Robert A. (Eds.), *Experiencing Fieldwork: An Inside View of Qualitative Research*. Sage Publications, Newbury Park, CA, USA.
- Hansen, B.G., Østerås, O., 2019. Farmer welfare and animal welfare- exploring the relationship between farmer's occupational well-being and stress, farm expansion and animal welfare. *Preventive Veterinary Medicine* 170. <https://doi.org/10.1016/j.prevetmed.2019.104741>



- Hansson, H., Lagerkvist, C.J., 2015. Identifying use and non-use values of animal welfare: evidence from Swedish dairy agriculture. *Food Policy* 50, 35–42. <https://doi.org/10.1016/j.foodpol.2014.10.012>.
- Hochuli, A., Hochuli, J., Schmid, D., 2021. Competitiveness of diversification strategies in agricultural dairy farms: empirical findings for rural regions in Switzerland. *Journal of Rural Studies* 82, 98–106. <https://doi.org/10.1016/j.jrurstud.2021.01.021>.
- Horrillo, A., Obregón, P., Escribano, M., Gaspar, P., 2022. A biosecurity survey on Iberian pig farms in Spain: Farmers' attitudes towards the implementation of measures and investment. *Research in Veterinary Science* 145, 82–90. <https://doi.org/10.1016/j.rvsc.2022.02.017>.
- Jurado, C., Martínez-Avilés, M., De La Torre, A., Štukelj, M., de Carvalho Ferreira, H.C., Cerioli, M., Sánchez-Vizcaino, J.M., Bellini, S., 2018. Relevant measures to prevent the spread of African swine fever in the European union domestic pig Sector. *Frontiers in Veterinary Science* 5, 77. <https://doi.org/10.3389/fvets.2018.00077>.
- Kauppinen, T., Vesala, K.M., Valros, A., 2012. Farmer attitude toward improvement of animal welfare is correlated with piglet production parameters. *Livestock Science* 143, 142–150. <https://doi.org/10.1016/j.livsci.2011.09.011>.
- Kling-Eveillard, F., Allain, C., Boivin, X., Courboulay, V., Créach, P., Philibert, A., Ramonet, Y., Hostiou, N., 2020. Farmers' representations of the effects of precision livestock farming on human-animal relationships. *Livestock Science* 238, <https://doi.org/10.1016/j.livsci.2020.104057> 104057.
- Kouimintzis, D., Chatzis, C., Linos, A., 2007. Health effects of livestock farming in Europe. *Journal of Public Health* 15, 245. <https://doi.org/10.1007/s10389-007-0130-4>.
- Kuta, Ł., Brennensthal, M., 2015. The causes of disorder's development among farmers as a result of mechanized tasks. *Scientific Papers Series "Management, Economic Engineering and Rural Development"* 15, 249–254.
- Lund, V., 2006. Natural living—a precondition for animal welfare in organic farming. *Livestock Science* 100, 71–83. <https://doi.org/10.1016/j.livprodsci.2005.08.005>.
- MacLeod, M., Gerber, P., Mottet, A., Tempio, G., Opio, C., Vellinga, T., Henderson, B., Steinfeld, H., 2013. Greenhouse gas emissions from pig and chicken supply chains: a global life cycle assessment. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- Meijboom, F.L.B., Stafleu, F.R., 2016. Farming ethics in practice: from freedom to professional moral autonomy for farmers. *Agriculture and Human Values* 33, 403–414. <https://doi.org/10.1007/s10460-015-9641-8>.
- Meuwissen, M.P.M., Feindt, P.H., Spiegel, A., Termeer, C.J.A.M., Mathijs, E., de Mey, Y., Finger, R., Balmann, A., Wauters, E., Urquhart, J., Vigani, M., Zawalińska, K., Herrera, H., Nicholas-Davies, P., Hansson, H., Paas, W., Slijper, T., Coopmans, I., Vroege, W., Ciecchomska, A., Accatino, F., Kopainsky, B., Poortvliet, P.M., Candel, J. J.L., Maye, D., Severini, S., Senni, S., Soriano, B., Lagerkvist, C.-J., Peneva, M., Gavrilescu, C., Reidsma, P., 2019. A framework to assess the resilience of farming systems. *Agricultural Systems* 176, <https://doi.org/10.1016/j.agsy.2019.102656> 102656.
- Mills, J., Gaskell, P., Ingram, J., Dwyer, J., Reed, M., Short, C., 2017. Engaging farmers in environmental management through a better understanding of behaviour. *Agriculture and Human Values* 34, 283–299. <https://doi.org/10.1007/s10460-016-9705-4>.
- Molnár, M., 2022. Transforming intensive animal production: challenges and opportunities for farm animal welfare in the European Union. *Animals* 12, 2086. <https://doi.org/10.3390/ani12162086>.
- Molnár, M., Fraser, D., 2020. Protecting farm animal welfare during intensification: farmer perceptions of economic and regulatory pressures. *Animal Welfare* 29, 133–141. <https://doi.org/10.7120/09627286.29.2.133>.
- Mundler, P., Jean-Gagnon, J., 2020. Short food supply chains, labor productivity and fair earnings: an impossible equation? *Renewable Agriculture and Food Systems* 35, 697–709. <https://doi.org/10.1017/S1742170519000358>.
- O'Brien, B.C., Harris, I.B., Beckman, T.J., Reed, D.A., Cook, D.A., 2014. Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine* 89, 1245–1251. <https://doi.org/10.1097/ACM.0000000000000388>.
- Ollivier, G., Magda, D., Mazé, A., Plumecocq, G., Lamine, C., 2018. Agroecological transitions: what can sustainability transition frameworks teach us? an ontological and empirical analysis. *Ecology & Society* 23, art5. <https://doi.org/10.5751/ES-09952-230205>.
- Park, H.-S., Min, B., Oh, S.-H., 2017. Research trends in outdoor pig production — a review. *Asian-Australasian Journal of Animal Science* 30, 1207–1214. <https://doi.org/10.5713/ajas.17.0330>.
- Pfeifer, C., Moakes, S., Salomon, E., Kongsted, A.G., 2022. The role of diversity and circularity to enhance the resilience of organic pig producers in Europe. *Animal - Open Space* 1, <https://doi.org/10.1016/j.anopes.2022.100009> 100009.
- Pinillos, R.G., 2018. *One welfare: a framework to improve animal welfare and human well-being*. CABI, Wallingford, UK.
- Pol, F., Kling-Eveillard, F., Champigneulle, F., Fresnay, E., Ducrocq, M., Courboulay, V., 2021. Human-animal relationship influences husbandry practices, animal welfare and productivity in pig farming. *Animal* 15, <https://doi.org/10.1016/j.animal.2020.100103> 100103.
- Román, S., Sánchez-Siles, L.M., Siegrist, M., 2017. The importance of food naturalness for consumers: results of a systematic review. *Trends in Food Science & Technology* 67, 44–57. <https://doi.org/10.1016/j.tifs.2017.06.010>.
- Sato, P., Hötzel, M., von Keyserlingk, M., 2017. American citizens' views of an ideal pig farm. *Animals* 7, 64. <https://doi.org/10.3390/ani7080064>.
- Schukat, S., Kuhlmann, A., Heise, H., 2019. Fattening pig farmers' intention to participate in animal welfare programs. *Animals* 9, 1042. <https://doi.org/10.3390/ani9121042>.
- Schuppli, C.A., von Keyserlingk, M.A.G., Weary, D.M., 2014. Access to pasture for dairy cows: responses from an online engagement. *Journal of Animal Science* 92, 5185–5192. <https://doi.org/10.2527/jas.2014-7725>.
- Shenton, A.K., 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information* 22, 63–75. <https://doi.org/10.3233/EFI-2004-22201>.
- Smid, A.-M.-C., Inberg, P.H.J., de Jong, S., Sinclair, S., von Keyserlingk, M.A.G., Weary, D.M., Barkema, H.W., 2021. Perspectives of Western Canadian dairy farmers on providing outdoor access for dairy cows. *Journal of Dairy Science* 104, 10158–10170. <https://doi.org/10.3168/jds.2021-20342>.
- Smid, A.-M.-C., de Jong, S., Inberg, P.H.J., Sinclair, S., von Keyserlingk, M.A.G., Weary, D.M., Barkema, H.W., 2022. Western Canadian dairy farmers' perspectives on the provision of outdoor access for dairy cows and on the perceptions of other stakeholders. *Journal of Dairy Science* 105, 4461–4473. <https://doi.org/10.3168/jds.2021-21237>.
- Sørensen, J.T., Edwards, S., Noordhuizen, J., Gunnarsson, S., 2006. *Animal production systems in the industrialised world*. Revue scientifique et technique - Office international des épizooties 25, 493–503.
- Spooner, J.M., Schuppli, C.A., Fraser, D., 2014. Attitudes of Canadian pig producers toward animal welfare. *Journal of Agricultural and Environmental Ethics* 27, 569–589. <https://doi.org/10.1007/s10806-013-9477-4>.
- Sutherland, L.-A., Marchand, F., 2021. On-farm demonstration: enabling peer-to-peer learning. *Journal of Agricultural Education and Extension* 27, 573–590. <https://doi.org/10.1080/1389224X.2021.1959716>.
- Tell, J., Hoveskog, M., Ulvenblad, P., Ulvenblad, P.-O., Barth, H., Ståhl, J., 2016. Business model innovation in the agri-food sector. *International Journal of Social Ecology and Sustainable Development* 7, 1–13. <https://doi.org/10.4018/IJSESD.2016040101>.
- Ventura, B.A., von Keyserlingk, M.A.G., Wittman, H., Weary, D.M., 2016. What Difference does a visit make? changes in animal welfare perceptions after interested citizens tour a dairy farm. *PLOS ONE* 11, e0154733.
- Wimmler, C., Vermeer, H.M., Leeb, C., Salomon, E., Andersen, H.-M.-L., 2022. Review: Concrete outdoor runs for organic growing-finishing pigs — a legislative, ethological and environmental perspective. *Animal* 16, <https://doi.org/10.1016/j.animal.2021.100435> 100435.
- Winkel, C., von Meyer-Höfer, M., Heise, H., 2020. Understanding German pig farmers' intentions to design and construct pig housing for the improvement of animal welfare. *Animals* 10, 1760. <https://doi.org/10.3390/ani10101760>.
- Zira, S., Rööß, E., Ivarsson, E., Friman, J., Møller, H., Samsonstuen, S., Olsen, H.F., Rydhmer, L., 2022. An assessment of scenarios for future pig production using a one health approach. *Livestock Science* 260, <https://doi.org/10.1016/j.livsci.2022.104929> 104929.