Bundesministerium
für Ernährung
und Landwirtschaft

BÖL
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ÖKOLOGISCHER LANDBAU

Schlussbericht zum Thema

Innovative tiergerechte Haltungsverfahren für die ökologische Schweine- und Rinderhaltung im Rahmen der geänderten EU-Öko-Verordnung

FKZ: 2822OE016, 2822OE071

Projektnehmer: Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL), Universität Kassel

Gefördert durch das Bundesministerium für Ernährung und Landwirtschaft auf Grund eines Beschlusses des Deutschen Bundestages im Rahmen des Bundesprogramms Ökologischer Landbau.

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Gefördert durch

Bundesministerium für Ernährung und Landwirtschaft

BÖL Bundesprogramm Ökologischer Landbau

aufgrund eines Beschlusses des Deutschen Bundestages

Schlussbericht

Innovative tiergerechte Haltungsverfahren für die ökologische Schweine- und Rinderhaltung im Rahmen der geänderten EU-Öko-Verordnung

Akronym: Indoor-Outdoor

Bundesprogramm Ökologischer Landbau (BÖL)

Projektdauer: 15.05.2022 – 28.02.2023 Verlängerung der Projektdauer bis: 28.02.2023

Förderkennzeichen: KTBL: 2822OE016; Universität Kassel: 2822OE071

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Das Vorhaben ist Teil eines Verbundes. Das Verbundprojekt wird in Zusammenarbeit folgendem Projektpartner durchgeführt: 2822OE071 – Universität Kassel

UNIKASSEL VERSITÄT | ÖKOLOGISCHE AGRAR WISSENSCHAFTEN

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Das Projekt ist Teil eines Netzwerks. Das gemeinsame Projekt wurde in Zusammenarbeit mit den folgenden Partnern durchgeführt:

FRIEDRICH-LOEFFLER-INSTITUT FLI Bundesforschungsinstitut für Tiergesundheit Federal Research Institute for Animal Health	Friedrich-Loeffler-Institut, Institut für Tierschutz und Tierhaltung (ITT)	Dörnbergstraße 25, 29223 Celle, Germany www.fli.de/de/institute/institut-fuer-tierschutz-und-tierhaltung-itt/
FiBL	FiBL Forschungsinstitut für biologischen Landbau, Schweiz	Ackerstrasse 113, 5070 Frick, Schweiz www.fibl.org/de/standorte/schweiz

Kurzfassung

In der ökologischen Rinder- und Schweinehaltung ist der Zugang zur Weide oder zum Auslauf obligatorisch. Daneben gibt es zunehmend innovative Systeme mit nicht klar getrennten Innen- und Außenbereichen, bei denen somit unklar ist, welche Abschnitte des Haltungsverfahrens als Stallfläche und welche als Außenfläche nach der EU-Öko-Verordnung anzurechnen sind. Trotz ausreichender Gesamtfläche kann es zu Unterschreitungen insbesondere der Flächenanforderungen im Stall kommen, ohne dass dies mit Nachteilen für die Tiere verbunden ist. Andererseits können solche offeneren Haltungsverfahren auch Vorteile in Bezug auf das Tierwohl bieten. Ziel des Projektes war es, unter Berücksichtigung der arteigenen Bedürfnisse von Rindern und Schweinen Haltungskriterien zu erarbeiten, mit denen unabhängig von der Aufteilung der verfügbaren Fläche auf den Innen- und Außenbereich beurteilt werden kann, ob die Anforderungen an eine besonders tiergerechte Haltung erfüllt werden. Unter breiter Expert:innen-Beteiligung wurden die Kriterien diskutiert und ihre Anwendbarkeit an Beispielen von Haltungsverfahren geprüft. In einem englischsprachigen Bericht wird der derzeitige Stand des Wissens zu den Bedürfnissen von Schwein und Rind mit besonderem Bezug zu Außenklimabedingungen und die abgeleiteten Haltungskriterien dargestellt und Beispiele innovativer, besonders tiergerechter Haltungsverfahren vorgestellt, die die erarbeiteten Kriterien erfüllen. Es wird der Schluss gezogen, dass bei den neuen, offeneren Haltungsverfahren die Unterscheidung zwischen Innen- und Außenflächen wenig aussagekräftig ist und stattdessen anhand der entwickelten Kriterien bewertet werden sollte, ob diese Verfahren Voraussetzungen für ein verbessertes Tierwohl bieten. In der Verordnung (EU) 2020/464 sollte es ermöglicht werden, im positiven Fall von den in Anhang I Teil I festgelegten Mindestflächen im Innen- und Außenbereich abzuweichen, soweit die geforderte Mindestgesamtfläche (Stall- und Außenfläche) geboten wird.

Abstract

In organic cattle and pig farming, access to pasture or an outdoor run is obligatory. In addition, increasingly innovative systems are used that do not allow a clear distinction between indoor and outdoor areas. Therefore, it is often uncertain which parts of the husbandry system are to be counted as indoor area and which as outdoor area according to the EU organic regulation. Despite sufficient total area, there may be shortfalls, especially with respect to the required indoor area without negative effects on animal welfare. On the other hand, such more open husbandry practices can offer advantages in terms of animal welfare. Therefore, the aim of the project was to develop husbandry criteria, taking account of the species-specific needs of cattle and pigs, to assess whether they are particularly animal welfare-friendly husbandry, irrespective of the distribution of the available space between indoor and outdoor areas. The criteria were discussed with large expert groups and their applicability was tested using examples of husbandry practices. In an English-language report, the current state of knowledge on the needs of pigs and cattle is elaborated with special reference to outdoor climatic conditions and husbandry criteria are derived. Examples of innovative, particularly animal welfare-friendly husbandry methods that fulfil the developed criteria are presented. It is concluded that for the new, more open husbandry systems, the distinction between indoor and outdoor areas is not very meaningful and instead it should be assessed on the basis of the developed criteria whether these methods offer preconditions for improved animal welfare. In Regulation (EU) 2020/464, it should be possible to deviate from the minimum indoor and outdoor areas laid down in Annex I, Part I, in the positive case, as long as the required minimum total area (indoor and outdoor area) is provided.

Inhaltsverzeichnis

Report

Abkürzungsverzeichnis

AP	Arbeitspaket
BLE	Bundesanstalt für Landwirtschaft und Ernährung
BMEL	Bundesministerium für Ernährung und Landwirtschaft
BÖL	Bundesprogramm Ökologischer Landbau
EGTOP	Sachverständigengruppen für technische Beratung bezüglich der ökologischen/biologischen Produktion
EU-VO	Verordnung der Europäischen Union
FiBL	Forschungsinstitut für biologischen Landbau
FLI	Friedrich-Loeffler-Institut
HSWT	Hochschule Weihenstephan-Triesdorf
KTBL	Kuratorium für Technik und Bauwesen in der Landwirtschaft
LfL	Bayerische Landesanstalt für Landwirtschaft
LLH	Landesbetrieb Landwirtschaft Hessen
LSZ	Landesanstalt für Schweinezucht (Boxberg)
LWK NRW	Landwirtschaftskammer Nordrhein-Westfalen
TI	Thünen-Institut

1 Einführung

1.1 Gegenstand des Vorhabens

In der ökologischen Schweine- und Rinderhaltung sind zunehmend innovative Haltungsverfahren verbreitet, bei denen sich die Stall- und Außenflächen (englisch: indoor and outdoor areas) nicht eindeutig voneinander trennen lassen oder bei denen stalltypische Funktionsbereiche nach außen verlegt sind (Rind: Barkema et al., 2015; Galama et al., 2020). Dadurch ist es häufig unklar, welche Teile des Haltungsverfahrens als Stallfläche und welche als Außenfläche nach der EU-Öko-Verordnung anzurechnen sind. Trotz ausreichender Gesamtfläche kann es zu Unterschreitungen insbesondere der Flächenanforderungen im Stall (indoor) kommen, ohne dass dies mit Nachteilen für die Tiere verbunden ist. Andererseits können solche offeneren Haltungsverfahren auch Vorteile in Bezug auf das Tierwohl bieten. Dazu gehören beispielsweise eine verbesserte Luftqualität durch offene Stallseiten (Außenklima), eine stärkere Stimulierung durch Klima- und andere Reize (z.B. visuell oder olfaktorisch) sowie die Wahl zwischen verschiedenen Mikroklimabereichen.

In Anhang 1, Teil I und III der EU-VO 2020/464 werden „Mindeststallflächen und Mindestaußenflächen“ für Schweine und Rinder vorgeschrieben. In der EU-VO 2018/848 und in der EU-VO 2020/464 sind die Begriffe „Stallfläche“ und „Außenfläche“ nicht definiert. Gleichzeitig ist eine ganzjährige Freilandhaltung mit Zugang zu Unterständen oder schattigen Plätzen zum Schutz vor Extremwetter für Rinder und Schweine im Rahmen der EU-Öko-Verordnung möglich, wenn es die Klimaverhältnisse gestatten.

In der ökologischen/biologischen Rinderhaltung ist der Zugang zur Sommerweide grundsätzlich obligatorisch, wenn die Umstände dies gestatten. Für männliche Rinder ab einem Alter von 12 Monaten ist auch der Zugang zu einem Auslauf ausreichend, sofern dieser ganzjährig zugänglich ist. Für alle Rinder, die im Winter in Laufställen untergebracht sind und im Sommer Zugang zur Weide haben, ist ein Auslauf am Stall nicht obligatorisch (Anhang II Teil II Nummern 1.7.3. und 1.9.1.1. der Verordnung (EU) 2018/848). Wenn bestimmte Bedingungen einigen Gruppen von Rindern jedoch keinen Zugang zu Weideland während der Vegetationsperiode erlauben, muss zusätzlich zur Mindestfläche im Stall eine bestimmte Mindestaußenfläche pro Tier vorgesehen werden, die teilweise überdacht sein kann (Anhang II Teil II Nummer 1.6.4. der Verordnung (EU) 2018/848 in Verbindung mit Anhang I Teil I der Verordnung (EU) 2020/464).

In ökologischen Schweinehaltungssystemen ist für alle Schweinekategorien ein Auslauf oder Freigehege vorgeschrieben (Verordnung EU 2018/848). In üblichen Bio-Schweineställen kann ein Außenlauf definiert werden als: "der Außenbereich eines Stallsystems, der (1) vom Innenbereich (Gebäude oder Unterstand, der an vier Seiten geschlossen ist) dauerhaft zugänglich ist, (2) einen Betonboden (massiv oder teilweise perforiert) hat und (3) teilweise überdacht sein kann." (Wimmler et al., 2022). Es gibt jedoch eine Vielzahl von nicht isolierten Ställen in der ökologischen Schweinehaltung, bei denen, wie oben beschrieben, keine eindeutigen Aussagen in Bezug auf Innen- und Außenbereiche gezogen werden können.

Um die Anwendung innovativer, besonders tiergerechter Haltungsverfahren zu ermöglichen, könnte eine Lösungsmöglichkeit darin bestehen, eine Summenregel anzuwenden, wenn bestimmte Voraussetzungen erfüllt werden. Zurzeit ist das laut EU-Kommission aber nicht rechtskonform.

Deshalb war es das Ziel dieses Projektes, einen Vorschlag zur Ergänzung oder zur Änderung der EU-VO 2020/464 zu entwickeln und abzustimmen, mit dem eine größere Rechtssicherheit in den genannten Fällen erreicht werden kann. Es sollten Kriterien zur Überprüfung der

Tiergerechtheit solcher innovativer Verfahren erarbeitet und an Haltungsbeispielen überprüft werden, bei deren Erfüllung im Wege einer Ausnahme die Summenregel angewendet werden kann.

1.2 Ziele und Aufgabenstellung des Projekts

Hauptziel des Projektes war die Erarbeitung einer Vorlage in englischer Sprache für die Sachverständigengruppen für technische Beratung bezüglich der ökologischen/biologischen Produktion (EGTOP). Der EGTOP berät die Europäischen Institutionen und stützt sich dabei auf Erfahrungswerte aus der Praxis, um für wirksame und verhältnismäßige EU-Vorschriften für Bio-Produkte zu sorgen (https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/co-operation-and-expert-advice_de). Da es in der ökologischen/Bio-Landwirtschaft ständige Fortschritte und zahlreiche Innovationen gibt, sollte somit sichergestellt werden, dass die EU in diesem Bereich auf der Höhe der technischen Entwicklungen bleibt.

Für diese Vorlage sollten auf Basis des aktuellen Wissenstandes relevante Bedürfnisse von Rindern und Schweinen dargestellt und Tierwohlkriterien abgeleitet werden sowie unter breiter Beteiligung weiterer Expert:innen auf ausgewählte Beispiele innovativer Haltungsverfahren angewandt werden. Ausgewählt werden sollten Beispiele, die erwartungsgemäß deutliche Vorteile in Bezug auf das Tierwohl bieten, aber derzeit kritisch in Bezug auf die Einhaltung der Verordnungen (EU) 2018/848 und 2020/464 sind. Auf dieser Grundlage sollte schließlich ein Vorschlag für eine Ausnahme von Kapitel II Abschnitt I und III in Verbindung mit Anhang I Teil I und III der Verordnung (EU) 2020/464 formuliert werden, der die Nutzung dieser innovativen besonders tiergerechten Haltungssysteme auch im ökologischen Landbau ermöglichen würde.

1.3 Planung und Ablauf des Projekts

In einer wissenschaftlich begründeten Darstellung aus Sicht des Tierwohls und der Verfahrenstechnik sollten die Ansprüche der Schweine und Rinder an den Innen- und Außenbereich erarbeitet werden.

Das Vorhaben sollte durch einen Projektbeirat begleitet werden, der bei der Bewertung der Haltungsverfahren hinsichtlich der Tiergerechtheit und ihrer zukünftigen Bedeutung sowie in Bezug auf die Darstellungsmöglichkeiten in der Durchführungsverordnung (EU) 2020/464 für die ökologischen Schweine- und Rinderhaltung eingebunden werden sollte und auch wurde.

Das Projekt ist für sieben Monate konzipiert worden und wurde vom KTBL koordiniert. Durch eine Verlängerung sollte das Projekt Ende Februar 2023 abgeschlossen und der englischsprachige Bericht verfasst sein.

Ein Überblick über den geplanten Ablauf des Projekts wird in Tabelle 1 und 2 dargestellt. Die Tabellen 1 und 2 fassen die vorab geplanten Zeit- und Meilensteinplanung zusammen.

Tab. 1: Zeit- und Meilensteinplanung

Arbeitspakete	Mai 2022	Juni 2022	Juli 2022	August 2022	September 2022	Oktober 2022	November 2022	Dezember 2022
AP1: Projektkoordination								
Abstimmung der Aufgaben und Vorgehensweisen im Projekt		M1						
Organisation der Abstimmungsworkshops								
Koordination der termingerechten Zwischenberichte								
Endbericht								M7
AP2: Bedürfnisse der Tiere								
Bedürfnisse Schwein								
Bedürfnisse Rind								
Erstellung Bericht			M2					
AP3: Beschreibung innovativer tiergerechter Haltungsverfahren in der ökologischen Schweine- und Rinderhaltung und Einschätzung ihrer zukünftigen Bedeutung								
Auswahl der Haltungsverfahren								
Beschreibung der Haltungsverfahren			M3					
Bewertung der Haltungsverfahren hinsichtlich Tiergerechtheit								
Einschätzung der jeweiligen Bedeutung								
Erstellung Bericht				M4				
AP4: Entwicklung von Darstellungsmöglichkeiten in der Durchführungsverordnung (EU) 2020/464 für die ökologischen Schweine- und Rinderhaltung								
Entwicklung von Definitionen für innen und außen in der ökologischen Schweine- und Rinderhaltung								
Prüfung der Kompatibilität dieser Definitionen z.B. zu Initiative Tierwohl oder in der TA Luft für tiergerechte Außenklimaställe								
Erstellung Bericht					M5			
AP5: Aufbereitung der Ergebnisse zur Vorlage EGTOP								
Erarbeitung der Darstellung und Abstimmung								
Übersetzung						M6		

Tab. 2: Meilensteine

Meilenstein	**Ergebnis**	**Termin**
M 1	Aufgaben und Vorgehensweisen innerhalb des Projektes ist vereinbart	15.06.22
M 2	Bedürfnisse der Tiere sind beschrieben	31.07.22
M 3	Haltungsverfahren sind beschrieben	31.07.22
M 4	Haltungsverfahren sind hinsichtlich Tiergerechtheit und ihrer zukünftigen Bedeutung bewertet	31.08.22
M 5	Abgestimmte Darstellungsmöglichkeiten in der Durchführungsverordnung liegen vor	30.09.22
M 6	Eine Vorlage für den EGTOP liegt vor	15.10.22
M 7	Endbericht ist form- und fristgerecht fertiggestellt und liegt dem BMEL vor	31.12.22

1.4 Übersicht über die beteiligten Personen und Institutionen

Mitglieder des Projektbeirats

Themenschwerpunkt		
Schwein	apl. Prof. Lars Schrader	FLI, Celle
	Prof. Dr. Wilhelm Pflanz	HSWT, Triesdorf
	Ralf Bussemas	TI, Trenthorst
	Dr. Barbara Früh	FiBL, Frick
	Christian Wucherpfennig	LWK NRW
	Dr. Christina Jais	LfL, Poing/Grub
	Dr. Eva Maria Görtz	Landesanstalt für Schweinezucht LSZ, Boxberg
	Nadja Böck	LLH, Marburg
Rind	Jörn Bender	Bioland
	Dr. Ulrich Schumacher	Bioland / BÖLW
	Dr. Wilfried Hartmann	KTBL
	Dr. Jan Harms	LfL
Rind und Schwein	Prof. Dr. Ute Knierim	Universität Kassel, Ökologische Agrarwissenschaften, Witzenhausen

Projektbearbeitende für den Bereich Schweine

Dr. Antje Schubbert	AP 2	FLI, Celle
Dr. Mirjam Holinger	AP 2	FiBL, Frick
Ulrike Westenhorst	AP 3	LWK NRW
Martina Kozel	AP 3	Naturland

Projektbearbeitende für den Bereich Rinder

Dr. Asja Ebinghaus	AP 2	Fachgebiet Nutztierethologie und Tierhaltung der Universität Kassel, Fachbereich Ökologische Agrarwissenschaften
Rebecca Franz-Wippermann	AP 2	
Christoph Drerup	AP 3	LWK NRW

Projektbearbeitende für Schwein und Rind

Georg Eckert	AP 3	ABCert, Esslingen

Projektkoordinierende

Dr. Katharina D. Seibt	AP 1	KTBL
Dr. Ulrike Klöble	AP 1	KTBL

2 Wissenschaftlicher und technischer Stand, an den angeknüpft wurde

2.1 Stand der Forschung und des Wissens

Das Projekt „Indoor-Outdoor“ knüpfte an das KTBL-Fachgespräch „Innovative tiergerechte Haltungsverfahren für die ökologische Schweinehaltung im Rahmen der geänderten EU-Öko-Verordnung“, welches vom 21.09.-22.09.2020 in Fulda stattgefunden hat, an. Hier wurde deutlich, dass aus Sicht der Beratung und der Praxis der ökologischen Schweinehaltung neue innovative Haltungsverfahren nicht eindeutig kompatibel mit den Vorgaben der Verordnung (EU) 2018/848 und der Durchführungsverordnung (EU) 2020/464 sind.

2.2 Stand der Forschung und des Wissens zum Platzbedarf von Schweinen und Rindern im Innen- und Außenbereich

Ein ausreichendes Platz-angebot ist bei allen Haustieren eine Voraussetzung für ein hohes Tierwohl, damit sie für die verschiedenen Verhaltensweisen unterschiedliche Funktionsbereiche nutzen, unterschiedliche Klimabereiche aufsuchen und eine natürliche Sozialstruktur aufbauen können sowie ausreichend Zugang zu Beschäftigungsmaterial haben (Schrader 2020). Entsprechend ist ein ausreichendes Platzangebot bei allen Haustieren eine Voraussetzung für ein hohes Tierwohl, aber ebenso wichtig sind die Gestaltung der Haltungsumgebung und das Management der Bewirtschaftung. Die Breite der verschiedenen, zu berücksichtigenden natürlichen Verhaltensweisen von Rindern und Schweinen kann in Funktionskreise eingeteilt werden, z.B. entsprechend Tembrock (1982) in die Funktionskreise: 1. Fortbewegung, 2. Ruhen und Schlafen, 3. Nahrungsaufnahme, 4. Ausscheide-verhalten, 5. Thermoregulation, 6. Körperpflege, 7. Erkundungsverhalten, 8. Sozialverhalten, 9. Sexualverhalten, und 10. Geburts- und Mutter-Kind-Verhalten.

Grundsätzlich kann davon ausgegangen werden, dass der Liege- und Ruhebereich Teil der Stallfläche ist, denn gemäß Verordnung (EU) 2018/818 Art. 1.9.1.2. Abs. b) müssen Ställe „ausreichend große, bequeme, saubere und trockene Liege- oder Ruheflächen aufweisen“, in denen „reichlich trockene Einstreu vorhanden ist“. Für den Außenbereich ist in Art. 1.6.5. definiert, dass er „teilweise überdacht“ sein kann. Nicht überdachte Teile eines Haltungssystems sind daher grundsätzlich der Außenfläche zuzuordnen.

Den Vorgaben in der EU-Öko-Verordnung liegt die Annahme zugrunde, dass ein größeres Platzangebot auch ein höheres Tierwohl zur Folge hat. Darüber hinaus wird Tierwohl aber vor allem vom Management des Tierhalters, der Fütterung, der Genetik und durch das Beschäftigungsmaterial beeinflusst. Dies wurde durch mehrere Studien deutlich, wie z.B. im BMEL Modell- und Demonstrationsvorhaben Tierschutz zu Schweinen (BMEL, MudTierschutz, 2021; https://mud-tierschutz.de/mud-tierschutz/netzwerke-demonstrationsbetriebe) und im Core Organic Projekt POWER (Proven Welfare and Resilience in organic pig production; Früh et al., 2022).

Während es eine größere Zahl von Untersuchungen zum Platzbedarf von Schweinen und Rindern insbesondere im Innenbereich gibt (z.B. Ekkel et al., 2003, Wechsler, 2011, Jais et al., 2017), liegt weniger Wissen zu den Auswirkungen der Verteilung der zur Verfügung stehenden Fläche zwischen Innen- und Außenbereich vor. Für die konventionelle Schweinehaltung wurden Empfehlungen zu Mindestflächen im Innen- bzw. im Außenbereich erarbeitet, die die unbeeinträchtigte Ausübung des Verhaltens ermöglichen sollen (BLE, 2018 und 2021). Im Core

Organic Projekt „Power“ wurden Empfehlungen zur Größe des Auslaufs für säugende Sauen und zur Größe des Ferkelnests erarbeitet (Früh et al., 2022).

Für die Mastrinderhaltung wurden auf Basis der vorliegenden Literatur (z.B. EFSA, 2001, 2012) Mindestflächenangebote vorgeschlagenen (Brinkmann et al., 2020), die deutlich unter den Vorgaben der EU-Öko-Verordnung liegen.

Ekkel et al. (2003) leiten den Mindestanspruch an den Raum bei Mastschweinen vom Platz ab, der zum Liegen in gestreckter Seitenlage minus „mit anderen Tieren geteilter Platz“ in Abhängigkeit vom Lebendgewicht benötigt wird. Dieser Mindestanspruch wird im Rahmen der EU-Öko-Verordnung in allen Haltungsabschnitten bei Weitem erfüllt (Schrader, 2020).

Die dem Tier uneingeschränkt zur Verfügung stehende Fläche ist aber nur ein Faktor, der hinsichtlich der Bewegungsfreiheit der Tiere relevant ist. Zusätzlicher Platz wird für aktive Verhaltensweisen wie Nahrungs-/Wasseraufnahme, Sozialverhalten, Erkundungsverhalten, Fortbewegung sowie Ausscheidungsverhalten benötigt. Weiterhin besteht Platzbedarf für die Strukturierung der Funktionsbereiche, wobei dabei zu beachten, welche Funktionsbereiche im Stall oder auch im Auslauf angesiedelt werden können oder sollen. Schrader (2020) schlägt aus diesem Grund vor, ergebnisorientiert vorzugehen und die Regelungen zum Flächenangebot mit tierbezogenen Indikatoren zu verknüpfen. Es sollte eine möglichst große Flexibilität für innovative Stallbaulösungen gegeben werden.

2.3 Stand der Forschung und des Wissens zu den innovativen Haltungsverfahren

Wesentliche Merkmale der innovativen Verfahren für die ökologische Schweine- und Rinderhaltung sind zum einen, dass der Stall- und Außenbereiche ineinander übergehen, wie beispielsweise bei Offenfrontställen, und zum anderen, dass Funktionsbereiche in den Auslauf, der überdacht sein kann, verlagert werden.

Da sowohl der Stall als auch ein Teil der Außenflächen überdacht werden dürfen, ist in manchen Haltungsverfahren nicht immer klar erkennbar, ob diese überdachten Flächen dem Stall oder der Außenfläche zuzuordnen sind. Sind Fütterungseinrichtungen, wie Tröge oder Futterautomaten, installiert, deutet dies beispielsweise darauf hin, dass es sich um einen Teil des Stalls handelt. Andererseits wird Raufutter üblicherweise im Freigelände angeboten.

Aus Sicht der im bereits erwähnten Fachgespräch (21.09-22.09.2020 in Fulda) anwesenden Praktiker wurde begrüßt, dass die EU-Öko-VO den Bereich Ferkelaufzucht bis 35 kg definiert. Es gibt aber im Gewichtsbereich 11 kg bis 35 kg nur eine Flächenvorgabe von 0,6 m^2 innen und 0,4 m^2 außen. Die Praktiker waren sich einig, dass es wesentlich besser wäre, für die Bio-Ferkelaufzucht zwei Gewichtsbereiche, nämlich vom Absetzen bis 20 kg und von 20 bis 35 kg einzuführen. Bei 0,6 m^2 je Ferkel im Stall ist es schwierig, die Stallungen im Winterhalbjahr ausreichend warm zu halten. Auch Kleinklimabereiche helfen hier nur bedingt weiter. In der Tierschutz-Nutztierhaltungsverordnung (2006) wurde hier differenziert.

3 Material und Methoden

3.1 Zielsetzung der einzelnen Arbeitspakete (AP)

3.1.1 Projektkoordination (AP1)

Die Projektkoordination wurde vom KTBL übernommen. Die Projektkoordinatoren stimmten sich mit dem Projektpartner Universität Kassel ab und waren für die Erreichung der Ziele und Einhaltung der Termine zuständig. Weiterhin stimmten sie das Vorgehen mit dem BMEL, dem Beirat und den Projektmitarbeiter*innen der Arbeitspakete ab.

Zu den drei geplanten und durchgeführten Abstimmungsworkshops wurden alle Projektbeteiligte eingeladen. Der erste und der dritte Workshop wurden als Online-Abstimmung geplant und sie fanden online statt. Der zweite Workshop fand zweitätig in Präsenz in Fulda statt.

Das KTBL übernahm die Projektkoordination und Vernetzung mit anderen Projekten und Vorhaben. Als eine vom BMEL institutionell geförderte Einrichtung mit Gremien mit externen Expert:innen hat das KTBL mit der Koordination interdisziplinär zusammengesetzter Verbünde langjährige Erfahrung. Die Projektkoordinatoren*innen stimmten während des gesamten Projekts das Vorgehen innerhalb und zwischen den einzelnen Arbeitspaketen mit den beteiligten Personen ab. Sie waren vor allem für die fristgerechte Erledigung der Arbeitsschritte und für die arbeitspaketübergreifenden Abstimmung zuständig.

Darüber hinaus koordinierten sie die Abstimmung mit dem Projektbeirat: Die Projektbearbeiter sollten mit dem Projektbeirat zu Beginn des Projekts ihr Vorgehen abstimmen. Der Projektbeirat sollte sich inhaltlich beteiligen in einem Workshop im AP3 bei der Bewertung der Haltungsverfahren hinsichtlich Tiergerechtheit und ihrer zukünftigen Bedeutung sowie im AP4: Entwicklung von Darstellungsmöglichkeiten in der Durchführungsverordnung (EU) 2020/464 für die ökologischen Schweine- und Rinderhaltung.

3.1.2 Bedürfnisse der Tiere (AP2)

Für eine wissenschaftliche Begründung des Anliegens sollten die Ansprüche der Schweine und Rinder an Haltungsverfahren aus Sicht des Tierwohls und somit in Bezug auf die Tiergesundheit und das Tierverhalten für die einzelnen Haltungsabschnitte auf Basis wissenschaftlicher Literatur beschrieben werden, wobei ein besonderer Fokus auf den Auswirkungen von Flächenangebot im Außenbereich lag.

Es sollten wissenschaftlich fundierte Erkenntnisse für Schweine (Sauen, Saugferkel, Aufzuchtschweine, Mastschweine) und Rinder (Milchvieh, Kälber- und Jungvieh sowie Mastrinder) hinsichtlich der Anforderungen an die Ausgestaltung von Funktionsbereichen innerhalb ihrer Haltung dargestellt werden. Hinsichtlich der Ausgestaltung sollten der Platzbedarf, klimatische Bedingungen, Bodengestaltung und Beschäftigungsmaterial berücksichtigt werden.

Erfahrene Projektpartner sollten im AP2 mittels Literaturrecherche und ggf. Expert:innen-Befragung wissenschaftlich fundierte Beschreibungen der Bedürfnisse von Rindern und Schweinen in den jeweiligen Haltungsabschnitten darstellen. Zum Beispiel sollten dafür die Literaturdatenbank Tierwohlindikatoren genutzt werden, die im Projekt NATIMON https://www.nationales-tierwohl-monitoring.de/ erstellt wurde (KTBL 2022). Hier war die Herausforderung, dass es sich dabei um einen Wissensbereich an der Schnittstelle zwischen Ethologie und Verfahrenstechnik handelte. Eigene wissenschaftliche Untersuchungen waren im geplanten Projekt nicht vorgesehen.

Die Bearbeitung dieses Arbeitspakets für den Bereich Rinder erfolgte in Kooperation mit dem Fachgebiet Nutztierethologie und Tierhaltung der Universität Kassel, Fachbereich Ökologische Agrarwissenschaften. Die Bearbeitung dieses Arbeitspakets für den Bereich Schwein erfolgte in Kooperation mit dem FiBL Schweiz und dem Friedrich-Loeffler-Institut (FLI).

3.1.3 Beschreibung und Bewertung innovativer tiergerechter Haltungsverfahren und Einschätzung ihrer zukünftigen Bedeutung (AP3)

Um möglichst alle der betroffenen Haltungsverfahren zu adressieren und zu bewerten, sollten die in der aktuellen Praxis relevanten innovativen Haltungsverfahren bzw. Stallsysteme für Öko-Schweine und Öko-Rinder in Deutschland für alle Haltungsabschnitte beispielhaft aus Sicht der Beratung und der Kontrolle dargestellt werden. Die Haltungsverfahren, die bezüglich der Erfüllung der aktuellen Anforderungen in Anhang 1, Teil I und III der EU-VO 2020/464 „Besatzdichte, Mindeststallflächen und Mindestaußenflächen“ für Schweine und Rinder kritisch sind, sollten im Vordergrund stehen. Bei dieser Beschreibung und Bewertung sollte der Fokus nicht auf Einzellösungen gelegt werden.

Die Projektbearbeiter des AP2 und des AP3 sollten gemeinsam mit dem Beirat die innovativen Haltungssysteme hinsichtlich ihrer Auswirkungen auf das Wohl der Tiere und ihrer zukünftigen Bedeutung einschätzen.

Die Haltungsverfahren sollten mit Bauskizzen mit Maßangaben dargestellt werden. Nach Möglichkeit sollten für die Bewertungen übergreifende Kriterien gefunden werden.

3.2 Entwicklung von Darstellungsmöglichkeiten in der Durchführungsverordnung (EU) 2020/464 für die ökologischen Schweine- und Rinderhaltung (AP4)

Auf Basis der Ergebnisse aus AP2 und AP3 sollten mit allen Projektbeteiligten Vorschläge erarbeitet werden, wie eine Ergänzung der Regelung in der Durchführungsverordnung aussehen könnten (AP4). Eine Kompatibilität mit den Formulierungen der geplanten verpflichtenden Haltungskennzeichnung des BMEL und mit weiteren Definitionen, z.B. im Rahmen der Initiative Tierwohl oder der TA Luft mit Bezug auf Vorgaben für tiergerechte Außenklimaställe, sollte gegeben sein.

Beispiele für solche innovativen Haltungssysteme, die eindeutig Vorteile im Hinblick auf das Wohlergehen der Tiere bieten, aber derzeit hinsichtlich der Einhaltung der Verordnungen (EU)

2018/848 und 2020/464 kritisch sind, sollten ausgewählt und vorgestellt werden, da die Kommission sich bereit erklärt hat, die derzeitigen Anforderungen der Verordnung (EU) 2020/464 im Hinblick auf Haltungssysteme zu überprüfen, die als innovativ und besonders tierfreundlich gelten. Für deren Bewertung sollten Tierschutzkriterien ausgearbeitet werden, während weitere Aspekte wie die Reduzierung von Emissionen nicht im Fokus dieses Berichts standen.

4 Ausführliche Darstellung der wichtigsten Ergebnisse

Nach einer Definition von Tierwohlkriterien und den verschiedenen Funktionsbereichen im Rinder- und Schweinestall, wurden die Bedürfnisse von Rindern und Schweinen hinsichtlich Verhalten und Gesundheit beschrieben und die grundlegenden Effekte der Haltungsbedingungen dargestellt. Basierend auf einer systematischen Literaturrecherche wurden darauf aufbauend spezifische Effekte von Funktionsbereichen und Ressourcen im Außenbereich auf Verhalten und Gesundheit der Tiere identifiziert. Von wissenschaftlich abgesicherten Erkenntnissen wurden jeweils spezifische Kriterien zur Beurteilung der Tiergerechtheit von offenen innovativen Systemen in der Rinder- und Schweinehaltung abgeleitet. Diese Haltungskriterien wurden auf ausgewählte Stallbeispiele angewendet. Auf dieser Grundlage wurde schließlich ein Vorschlag für eine Ausnahme von Kapitel II Teil I Abschnitt 1 Artikel 3 der Verordnung (EU) 2020/464 formuliert, der die Übernahme dieser innovativen tiergerechten Haltungssysteme auch im ökologischen Landbau ermöglichen würde.

Im Folgenden werden die in diesem Projekt erarbeiteten Haltungskriterien zur Bewertung von Haltungssystemen aufgeführt. Für eine detaillierte Übersicht über die beispielhaften Haltungsverfahren und deren Bewertung ist diesem Schlussbericht die aktuelle Version des Berichts „Report Indoor Outdoor - Innovative animal-friendly housing systems for organic pig and cattle farming in the context of the amended organic EU regulation - 28th of February 2023“ im Anhang beigefügt.

4.1 Bericht zu Rindern

4.1.1 Bewertung von Kriterien für innovative Haltungssysteme bei Rindern

Generell bringt die Bereitstellung von frei zugänglichen Außenbereichen, auch während der Stallhaltung (Indoor) im Winter, eine Reihe von Vorteilen für das Wohlergehen der Rinder mit sich und entspricht den Präferenzen der Tiere. Verschiedene Studien haben gezeigt, dass Rinder grundsätzlich den Zugang zu Außenbereichen, insbesondere zu Weideflächen, gegenüber der Stallhaltung vorziehen und motiviert sind, diese zu nutzen.

Wenn man den Tieren die freie Wahl zwischen verschiedenen Haltungsbedingungen lässt, haben sie bessere Möglichkeiten, sich an ihre Umgebung anzupassen. Daraus lässt sich ableiten, dass unabhängig davon, ob Zugang zur Weide besteht, der freie Zugang zu einem Außenbereich des Stalls verschiedene positive Auswirkungen auf das Wohlergehen der Rinder hat. Offene Stallsysteme mit Funktionsbereichen und Ressourcen im Freien bergen jedoch auch einige

Risiken, insbesondere im Hinblick auf die Herausforderungen der Thermoregulation und die negativen Auswirkungen von Niederschlägen, die jedoch durch eine angemessene Stallgestaltung wirksam kontrolliert werden können. Wenn diese Voraussetzungen erfüllt sind, können offenere Haltungssysteme als innovative, tiergerechte Systeme bewertet werden. Da die Unterscheidung zwischen Innen- und Außenbereich bei diesen Systemen weniger aussagekräftig ist, sollte die Einhaltung der Verordnung (EU) 2020/464 nur durch die Betrachtung der zur Verfügung gestellten Gesamtfläche erreicht werden. Die Kriterien für eine Bewertung als innovatives tiergerechtes System sind in Tabelle 3 aufgeführt. Sie wurden auf der Grundlage der dargestellten Bedürfnisse der Tiere und der im Report beschriebenen entsprechenden Haltungsanforderungen entwickelt. Im Folgenden werden sie kurz begründet, jeweils mit Verweis auf die Abschnitte im angehängten Dokument, die detailliertere Erläuterungen enthalten.

Rinder sind natürlicherweise daran angepasst, weite Strecken zurückzulegen, da die **Fortbewegung** mit dem Grasen unter naturnahen Bedingungen verbunden ist (siehe Anhang Report Abschnitt 3.4.2). Verschiedene Studien deuten auch darauf hin, dass die Fortbewegung zu einer besseren Klauen- und Gelenkgesundheit beiträgt, wenn die Bodenbedingungen geeignet sind (siehe Anhang Report Abschnitt 3.4.2), und die Fruchtbarkeit der Kühe fördert (siehe Anhang Report Abschnitt 3.4.3). Auch Kälber zeigen eine hohe Motivation zur Fortbewegung. Insbesondere im Zusammenhang mit dem Spielverhalten führen Kälber verschiedene Bewegungen aus, die auch den Bewegungsapparat stärken (siehe Anhang Report Abschnitt 3.4.2). Dementsprechend muss allen Rindern, unabhängig von der Altersgruppe, ausreichend Platz und Anreiz zur Bewegung geboten werden.

Rinder zeigen vermehrtes **Erkundungsverhalten**, wenn sie verschiedene Sinne nutzen können und ihnen verschiedene Reize wie Ressourcen im Freien angeboten werden. Eine abwechslungsreiche Umgebung wird von ausgewachsenen Rindern bevorzugt und trägt bei Kälbern und Jungtieren dazu bei, Verhaltensprobleme wie das gegenseitigen Besaugen zu verringern (siehe Anhang Report Abschnitt 3.3.9). Daher müssen Rinder aller Altersgruppen Zugang zu wechselnden Reizen erhalten.

Soziale Dominanzbeziehungen innerhalb von Herden entwickeln sich bei jungen Rindern ab einem Alter von etwa 4 bis 6 Monaten. In diesem Zusammenhang sind die Tiere bestrebt, ausreichende Individualdistanzen zueinander einzuhalten, um soziale Konflikte zu vermeiden oder zu reduzieren (siehe Anhang Report Abschnitt 3.3.3). Der Wechsel zwischen verschiedenen Funktionsbereichen oder der Zugang zu Ressourcen wie Tränken und Fressplätzen sollten daher keine Engpässe darstellen. Dementsprechend muss im Laufbereich ausreichend Platz für gegenseitiges Ausweichen vorhanden sein, auch für den Wechsel zwischen Innen- und Außenbereich. Außerdem muss den Tieren ein ungehinderter Zugang zu den Ressourcen ermöglicht werden.

Rinder bevorzugen trockene, weiche **Liegeflächen** und suchen bei Temperaturen im unteren und vor allem im oberen kritischen Bereich geschützte Liegeflächen auf. Länger andauernde widrige Bedingungen beeinträchtigen die Qualität der Liegeflächen und führen zu verkürzten

Liegezeiten und weiteren Beeinträchtigungen des Tierwohls: Verkürzte Liegezeiten können z.B. Klauenerkrankungen begünstigen (siehe Anhang Report Abschnitt 3.4.2); nasse und/oder verschmutzte Liegeflächen stellen ein zusätzliches Risiko hinsichtlich Eutererkrankungen dar (siehe Anhang Report Abschnitt 3.4.1). Stehen adäquate Ressourcen zudem in geringerer Anzahl zur Verfügung, kann dies die sozialen Konflikte in der Herde, insbesondere bei rangniedrigeren Tieren, aufgrund der Tendenz zu synchronem Verhalten erhöhen (siehe Anhang Report Abschnitt 3.3.3). Sind aufgrund regionaler klimatischer Bedingungen oder der Ausrichtung des Stalls mehr als nur kurzfristige Herausforderungen zu erwarten, sollten bauliche Maßnahmen zum Schutz der Tiere vor solchen aversiven Witterungsbedingungen umgesetzt werden, wie z.B. eine Verlängerung der Dächer. Grundsätzlich muss jedes Tier auch bei Niederschlag Zugang zu einem trockenen Liegeplatz und bei erhöhten Temperaturen zu einem sonnengeschützten Liegeplatz haben.

Junge Kälber verfügen noch nicht über ein ausreichend entwickeltes Immunsystem und beginnen zudem aufgrund ihres geringeren Verhältnisses von Körperoberfläche zu Körpermasse leichter zu frieren als ausgewachsene Rinder (siehe Anhang Report Abschnitt 3.3.8). Daher muss Kälbern in den ersten Lebensmonaten (≤ 200kg Lebendgewicht) ein vor Zugluft geschützter Liegebereich zur Verfügung gestellt werden.

Die **Futteraufnahme** ist im Tagesverlauf eine Haupttätigkeit von Rindern, die mehrere Stunden am Tag und vorzugsweise synchron in der Herde ausgeführt wird. Bei erhöhten Temperaturen und Sonneneinstrahlung passen sich die Rinder an, indem sie klimatisch günstigere Bereiche aufsuchen, die z.B. beschattet oder besser belüftet sind. Wenn die Möglichkeiten für ein solches thermoregulatorisches Verhalten nicht ausreichend gegeben sind, können sich die Fresszeiten der Tiere reduzieren (siehe Anhang Report Abschnitte 3.3.5 und 3.3.8). Dementsprechend müssen auch bei erhöhten Temperaturen Fressplätze in ausreichender Menge und Qualität vorhanden sein.

4.1.2 Kriterien für die Bewertung innovativer Rinderhaltungssysteme

Die Bewertung der innovativen, tiergerechten Haltungssysteme für Rinder (siehe Anhang Report Kapitel 4) kann anhand der Kriterien in der folgenden Tabelle 3 bewertet werden.

Tabelle 3: Kriterien für die Bewertung innovativer Rinderhaltungssysteme.

Bedürfnisse	Kategorie	Kriterien	Erfüllt z.B. durch
Fortbewegung	alle	Jedes Tier hat ausreichend Fläche und Anreiz zur Fortbewegung.	räumlich verteiltes Reizangebot einschließlich klimatischer Reize
Sozial-, Erkundungsverhalten	alle	Jedes Tier hat Zugang zu wechselnden Reizen.	Bereitstellung eines Außenbereichs, Möglichkeit, verschiedene klimatische Bedingungen zu erleben
	>2 00 kg	Jedes Tier hat ausreichend Platz zum gegenseitigen Ausweichen im Laufbereich, auch beim Wechsel zwischen Innen- und Außenbereich.	breiter Durchgang oder mehrere breite Durchgänge zwischen Funktionsbereichen im Außen- und Innenbereich, ausreichend Freifläche um Ressourcen, keine Platzierung an Engstellen
Liegend	alle	Jedem Tier steht grundsätzlich auch bei Niederschlag ein trockener und bei erhöhten Temperaturen ein sonnengeschützter Liegeplatz zur Verfügung.	überdachte Liegeplätze
	≤ 200 kg	Jedem Tier steht ein vor Zugluft geschützter Liegeplatz zur Verfügung.	dreiseitig geschlossene Liegefläche
Füttern / Trinken	alle	Fressplätze sind in ausreichender Anzahl und Qualität vorhanden, auch bei hohen Temperaturen.	Sonnennetze, Belüftung oder Beregnung im Fressbereich bei erhöhten Temperaturen

4.2 Bericht zu Schweinen

Schweine teilen natürlicherweise ihren Lebensraum in sogenannte "Funktionsbereiche" ein, d.h. sie weisen bestimmten Verhaltensweisen bestimmten Orten zu (Signoret et al., 1975; Stolba & Wood-Gush, 1989; Tillmanns, 2022). In dem Bestreben, Schweinen entsprechende Bedingungen zu bieten, wird in der modernen und tiergerechten Schweinehaltung versucht, die natürliche Aufteilung von Verhaltensweisen in Funktionsbereichen in Stallsystemen zu ermöglichen. Die Funktionsbereiche bestehen daher aus abgegrenzten Zonen im Innen- und Außenbereich der Haltungssysteme, und sind nach dem Hauptverhalten benannt, das an einem bestimmten Ort gezeigt werden soll. Bei geringem Platzangebot können die Tiere keine Funktionsbereiche anlegen und aufrechterhalten (Baldwin, 1969; Tillmanns, 2022). Daher ist es in der Schweinehaltung von zentraler Bedeutung, angemessenen Platz zur Verfügung zu stellen, damit die Schweine die Möglichkeit haben, ihre Funktionsbereiche in der Bucht anzulegen, und damit die Verhaltensweisen in dem ihnen zugedachten Funktionsbereich zu zeigen (z. B. Simonsen, 1990, EFSA, 2022).

In ökologischen Schweineställen ist für alle Altersstufen ein Auslauf vorgeschrieben (Verordnung (EU) 2018/848). In üblichen Bio-Schweineställen ist der Auslauf klar vom Innenbereich des Stalls abgegrenzt und wird definiert als: "der Außenbereich eines Haltungssystems, der (1) vom Innenbereich (Gebäude oder Unterstand, der an vier Seiten geschlossen ist) ständig zugänglich ist, (2) einen Betonboden (planbefestigt oder Teilspalten) hat und (3) teilweise überdacht sein kann" (Wimmler et al., 2022). In der ökologischen Schweinehaltung gibt es jedoch eine Vielzahl von Stallsystemen mit offener Bauweise, die meist als nicht isolierte Ställe konzipiert sind, bei denen Innen- und Außenbereich nicht klar voneinander zu unterscheiden sind. In nicht isolierten Ställen sind die Schweine unterschiedlichen klimatischen Bedingungen ausgesetzt (Botermans und Andersson, 1995).

Im Folgenden werden allgemeine Verhaltensweisen von Schweinen, die Auswirkungen der klimatischen Bedingungen auf diese Verhaltensweisen sowie die Nutzung spezifischer Funktionsbereiche, soweit einschlägige wissenschaftliche Literatur hierzu verfügbar war, beschrieben.

4.2.1 Bewertung von Kriterien für innovativer Schweinehaltungssysteme

Ein entscheidender Faktor für das Tierwohl von Schweinen in modernen Haltungsverfahren besteht darin, Schweinen die Möglichkeit zu geben, ihre natürlichen Verhaltensweisen auszuleben (Bracke und Hopster, 2006). Der Mangel an Möglichkeiten, natürliche Verhaltensweisen auszuleben, kann zur Entwicklung abnormaler Verhaltensweisen führen (Olczak et al., 2015). Zusätzlich zu den verschiedenen physiologischen Bedürfnissen (z. B. Bedarf an Nahrung, Wasser und thermaler Komfort) haben Tiere kognitiv-emotionale Fähigkeiten entwickelt, um mit einer variablen Umwelt umzugehen (Bracke und Hopster, 2006). In diesem Zusammenhang scheint es für Tiere, die sich natürlicherweise im Freien aufhalten, notwendig zu sein, wechselnden Umweltreizen ausgesetzt zu sein. Im Einklang mit dem Anreiz, das Wohlergehen in der (ökologischen) Schweineproduktion zu verbessern, scheint die Einrichtung von überdachten und nicht überdachten Außenbereichen (die sowohl die Exposition gegenüber wechselnden Umweltreizen als auch die Ausübung natürlicher Verhaltensweisen ermöglichen) daher für eine angemessene Zucht und Haltung von Hausschweinen erforderlich zu sein.

Im Folgenden fassen wir die wichtigsten Verhaltensbedürfnisse von Hausschweinen kurz zusammen. Auf diesem Hintergrundwissen aufbauend stellen wir eine Liste von Kriterien vor. Diese Kriterien sollen helfen zu beurteilen, inwieweit Haltungssysteme, die nicht vollständig

der aktuellen EU-Öko-Verordnung entsprechen (in Bezug auf Innen- und Außenbereiche), die Voraussetzungen für einen Mehrwert an Tierwohl für Schweine bieten. Diese Bewertung erfolgt mit besonderem Augenmerk auf die Unterscheidung zwischen Innen- und Außenbereich und ist nicht dazu gedacht, allgemeine Haltungsmerkmale außerhalb dieses Rahmens zu bewerten (wie z. B. die Bodenverhältnisse, Buchtenabmessungen usw.).

Fütterung: Wenn es heiß ist, bevorzugen es Schweine bei kühleren Temperaturen zu fressen. Schweine meiden bei der Fütterung starken Regen.

Liegen: Schweine ruhen natürlicherweise in einem Liegenest, in der Nähe ihrer Gruppenmitglieder. Sie bevorzugen dafür einen geschützten Bereich. Schweine zeigen eine Vielzahl von Liegepositionen. Unter kommerziellen Bedingungen sollte der Liegebereich Wärme- und Liegekomfort bieten. So sollte die Größe des Liegebereichs es den Schweinen ermöglichen, zumindest gleichzeitig in Halbseitenlage zu liegen, um bei kalten Temperaturen ein ausreichendes Mikroklima zu schaffen und relativ bequem zu liegen. Bei warmen Temperaturen nehmen Schweine die vollständige Seitenlage zur Thermoregulation ein, und es wird davon ausgegangen, dass während dieser Perioden auch die Außenbereiche zum Liegen genutzt werden.

Ausscheidung: Schweine trennen die Orte, an denen sie schlafen, koten und fressen, räumlich voneinander. Schweine bevorzugen Bereiche, die folgende Eigenschaften aufweisen: gut beleuchtet, zugig, feucht und ungestört.

Thermoregulation: Schweine passen sich durch ihr thermoregulatorisches Verhalten an variable klimatische Bedingungen an. Die Anforderungen an die Thermoregulation ändern sich stark mit dem Alter und den klimatischen Bedingungen. Vor allem jüngere Schweine haben einen höheren Wärmebedarf als ältere und schwerere Schweine. Bei hohen Temperaturen suchen die Schweine kühlere Bereiche auf. Unter solchen Bedingungen legen sie sich mit ausgestreckten Beinen auf die Seite, ohne Kontakt zu anderen Schweinen, um die Wärme an den Boden abzugeben.

Erkundung: Der ursprüngliche natürliche Lebensraum von Schweinen ist der Wald. Dort sind sie verschiedenen wechselnden klimatischen Reizen ausgesetzt und können Schutz vor ungünstigen Wetterbedingungen suchen. Dies ermöglicht ihnen, eine breite Palette von Verhaltensweisen zu zeigen. Ein allgemeiner Mangel an Reizen aus der Haltungsumwelt kann zu Verhaltensstörungen und Langeweile führen.

Mütterliches Verhalten: Die Sauen ferkeln isoliert von der Gruppe in Nestern. Die Abferkelnester bieten dem Nachwuchs unter anderem Schutz vor ungünstigen Witterungsverhältnissen. Während der Geburt und des Säugens liegt die Sau auf der Seite. Das Ferkelnest dient in erster Linie dem Säugen, Ruhen und der sozialen Interaktion mit den Ferkeln. Nach einer intensiven Zeit im Abferkelnest (ca. 10 Tage) kehrt die Mutter mit ihren Ferkeln in die Gruppe zurück.

Ob innovative Schweinehaltungssysteme, die derzeit nicht vollständig der EU-Öko-Verordnung entsprechen, als tiergerecht bewertet werden können, kann daher anhand der Kriterien in Tabelle 4 beurteilt werden.

4.2.2 Kriterien für die Bewertung innovativer Schweinehaltungssysteme

Die Bewertung der innovativen, tiergerechten Haltungssysteme für Schweine (Kapitel 5) kann anhand der Kriterien in der folgenden Tabelle 4 bewertet und erläutert werden.

Tabelle 4: Kriterien für die Bewertung innovativer Schweinehaltungssysteme.

Bedürfnis	Kriterien	Erfüllt z.B. durch
Fütterung	Die Schweine sollten bei der Fütterung nicht permanent ungünstigen Witterungsbedingungen (z. B. direkte Sonneneinstrahlung im Sommer, starker Regen) ausgesetzt sein.	Dach oder Beschattungsnetz über Futterbereich/dem Futtertrog
Liegen	Die Liegeflächen müssen dauerhaft vor ungünstigen Witterungseinflüssen (z.B. Regen, Zugluft und direkte Sonneneinstrahlung) geschützt werden.	Drei Wände und ein flexibel verstellbares Dach über dem Liegebereich; dicke Strohmatratze im Winter; Vorhänge etc..
	Schweine brauchen einen geschützten Platz, an dem sie in verschiedenen Liegepositionen zusammen mit ihren Gruppenmitgliedern ruhen können. Unter kommerziellen Bedingungen sollte der Liegebereich Wärme- und Liegekomfort bieten. So sollte die Größe des Liegebereichs Schweinen ermöglichen, zumindest gleichzeitig in Halbseitenlage zu liegen, um bei kalten Temperaturen ein ausreichendes Mikroklima zu schaffen und relativ bequem zu liegen. Bei warmen Temperaturen nehmen Schweine die vollständige Seitenlage zur Thermoregulation ein, und es wird davon ausgegangen, dass während dieser Perioden auch die Außenbereiche zum Liegen genutzt werden.	Ausreichend Platz im Liegebereich, so dass alle Schweine gleichzeitig mindestens in Halbseitenlage liegen können. Anpassung der Gruppengröße an den erforderlichen Platzbedarf des Liegebereichs für die jeweilige Altersgruppe
	Die Liegefläche sollte einen weichen und komfortablen Untergrund bieten.	Bereitstellung von ausreichend Stroh
	Der Liegebereich sollte ein angemessenes Mikroklima für die jeweilige Altersgruppe bieten. Der Liegebereich sollte klimatisch anpassungsfähig sein, um die Thermoregulation der Tiere bei dauerhaft ungünstigen	Anpassung der Einstreumenge je nach Jahreszeit; ein anpassungsfähiges Dach, das geöffnet oder geschlossen werden kann; Vorhänge

	Witterungsverhältnissen im Sommer und Winter zu erleichtern. Dies betrifft u.a. die Menge der Einstreu, die Luftgeschwindigkeit, die Luftfeuchtigkeit und die Temperatur.	
Ausscheidung	Der Ausscheidungsbereich sollte vom Liege- und Fressbereich getrennt sein, vorzugsweise im Freien.	Gewährleistung, dass sich Liegebereich, Fressbereich und Bereiche mit Spaltenboden nicht überlappen (wobei letztere das Ziel haben, die Ausscheidung zu fördern)
Thermo-regulation	Bei hohen Temperaturen sollten ausreichend schattige Bereiche und Kühlmöglichkeiten vorhanden sein. Insbesondere wenn keine anderen Kühlmöglichkeiten (Dusche, Suhle) vorhanden sind, sollten kühle Bodenoberflächen vorhanden sein, auf denen sich die Schweine durch Wärmeaustausch abkühlen können.	Ein nicht eingestreuter Betonboden im Sommer ist verfügbar; abnehmbare Schattennetze; Wassersprinkler/Duschen im Freien
Erkundung	Die Schweine sollten freien Zugang zu überdachten und nicht überdachten Außenbereichen haben.	Teilweise nicht überdachte Bereiche im Außenbereich
Mütterliches Verhalten	Die Umgebung, in der die Sauen ihre Nester bauen, muss Schutz vor ungünstigen Witterungsbedingungen (Regen, Wind, Zugluft usw.) bieten.	Umschlossene Bucht mit der Möglichkeit, ein Nest zu bauen
	Die Position des Nestes sollte dem Bedürfnis der Sau nach Isolation in den ersten Tagen nach der Geburt entgegenkommen und ihr die Möglichkeit geben, außerhalb des Nestes nach Nahrung zu suchen und abzukoten.	Umschlossener Abferkel- und Säugebereich
	Im Nest muss es den Sauen möglich sein, in Seitenlage zu gebären und zu säugen.	Jedes einzelne Nest bietet ausreichend Platz, damit die Sau (auf der Seite liegend) und die Ferkel ventral zu ihr in Bauchlage liegen können, während sie an den Zitzen der Sau saugen

5 Diskussion der Ergebnisse

Für eine detaillierte Übersicht über die beispielhaften Haltungsverfahren und deren Bewertung ist diesem Schlussbericht die aktuelle Version des Berichts „Report Indoor Outdoor - Innovative animal-friendly housing systems for organic pig and cattle farming in the context of the amended organic EU regulation - 28th of February 2023“ im Anhang beigefügt.

„Executive Summary“

In den letzten Jahrzehnten wurden vor allem im ökologischen Landbau zunehmend Stallsysteme mit offener Bauweise oder mit Verlagerung von Funktionsbereichen und Ressourcen aus dem geschlossenen Stallbereich ins Freie entwickelt und eingesetzt. Diese Stallsysteme können Vorteile für verschiedene Aspekte des Tierwohls bieten, darunter eine verbesserte Luftqualität durch offene Stallseiten (Außenklima), mehr Möglichkeiten, Klimareize und zusätzliche Reize (z. B. visuelle oder olfaktorische) zu erleben, und die Wahl zwischen verschiedenen Mikroklimabereichen. Die neuen Haltungssysteme lassen, aufgrund ihrer offenen Bauweise, oft keine klare Unterscheidung zwischen Innen- und Außenbereich zu. Trotz Einhaltung oder Überschreitung des in der Verordnung (EU) 2020/464 festgelegten Gesamtplatzbedarfs pro Tier können einige Haltungssysteme bzw. -verfahren (je nach Bauart) formal als nicht konform eingestuft werden, da sie hinsichtlich der Innen- oder Außenbereiche kritisch sind. Daher stellt sich die Frage, ob solche Systeme zugelassen werden sollten, um hohe Tierschutzstandards in der ökologischen Landwirtschaft zu fördern oder nicht.

Für Rinder- und Schweinehaltungssysteme wurden auf der Grundlage einer umfangreichen Literaturrecherche Tierschutzkriterien aus den jeweiligen Bedürfnissen der Tiere abgeleitet, wobei mögliche Herausforderungen, denen die Tiere in diesen Systemen ausgesetzt sind, z. B. im Hinblick auf die Thermoregulation und die Auswirkungen von Niederschlägen, berücksichtigt wurden. Die Kriterien wurden exemplarisch auf ausgewählte Beispiele angewandt, die hinsichtlich der Einhaltung der Verordnung (EU) 2020/464 derzeit kritisch sind, und mit Expert:innen diskutiert wurden.

Auf dieser Grundlage schlagen wir vor, dass für die neuen, offeneren Stall- bzw. Haltungssysteme die Unterscheidung zwischen Innen- und Außenbereichen weniger sinnvoll ist und stattdessen die in diesem Projekt entwickelten Kriterien, welche im Bericht aufgeführt sind, angewendet werden sollten, um zu bewerten, ob diese Systeme hohen Tierschutzstandards entsprechen und sie somit zu einem verbesserten Tierschutz beitragen können.

Sollte dies der Fall sein, sollte eine Abweichung von Kapitel II Abschnitt 1 Artikel 3 und Abschnitt 3 Artikel 10 der Verordnung (EU) 2020/464 möglich sein, so dass von den in Anhang I Teil I und III festgelegten und geforderten Mindestflächen für die Innen- und Außenbereiche abgewichen werden kann, sofern die innovativen tierschutzfreundlichen Systeme die erforderliche Mindestgesamtfläche (Innen- und Außenbereich) bieten.

Außerdem wird im Bericht erläutert, dass die Liegefläche für kleine Ferkel mit einem Lebendgewicht von bis zu 20 kg nicht zu groß sein sollte, um eine effiziente Thermoregulation bei kalten klimatischen Bedingungen zu ermöglichen und eine Verschmutzung der Liegefläche zu vermeiden. Daher wird vorgeschlagen, die Gewichtsklasse "bis 35 kg" in Anhang I Teil III

der Verordnung (EU) 2020/464 in die beiden Klassen "bis 20 kg" und "mehr als 20 kg, aber nicht mehr als 35 kg" zu unterteilen.

6 Angaben zum voraussichtlichen Nutzen und zur Verwertbarkeit der Ergebnisse.

Die Ergebnisse des Projekts werden für die Weiterentwicklung der Schweine- und Rinderhaltung im Rahmen der EU-Öko-Verordnung von maßgeblicher Bedeutung sein. Sie werden dem BMEL in Form eines englischsprachigen Berichts (siehe Report im Anhang) zur Verfügung gestellt, so dass sie auf europäischer Ebene genutzt werden können. Ein eigenes Kommunikationskonzept ist im Projekt nicht vorgesehen.

Die Ergebnisse sind auch auf andere Regionen und Strukturen im europäischen Raum übertragbar. Ansatzpunkte für weitere Forschungs- und Entwicklungsaufgaben werden deutlich werden.

Die Ergebnisse dieses Projektes dienen in erster Linie als Einschätzungshilfe und Vorschläge, welche der EU-Kommission in Form eines Reports zur Verfügung gestellt werden.

Die Ergebnisse des Projekts werden der Forschung, Beratung und Praxis der ökologischen Tierhaltung zur Verfügung gestellt. Eine mögliche Aufbereitung und Verbreitung der Projektergebnisse, den Wissensaustausch zwischen Wissenschaft und Praxis und die Übertragbarkeit der erwarteten Projektergebnisse auf andere Regionen oder Strukturen auch über die Projektlaufzeit hinaus können erst geleistet werden, wenn eine Entscheidung seitens der EU-Kommission vorliegt.

7 Gegenüberstellung der ursprünglich geplanten zu den tatsächlich erreichten Zielen; Hinweise auf ggf. weiterführende Fragestellungen

7.1 Überblick über die geplanten und erreichten Zwischenziele des Projekts

Ein Überblick über die geplanten und erreichten Termine zur Erreichung der Projektziele wird in Tabelle 5, ein Überblick über den tatsächlichen Ablauf des Projektes in Tabelle 6 gegeben.

Nach Übereinkunft mit dem BMEL und der zuständigen Referentin wurde übereinstimmend geklärt, dass der Fokus des Projektes und auch des Reports (siehe Anhang) zunehmend auf den im Projekt erarbeiteten Haltungskriterien, mit welchen sich Haltungssysteme im Hinblick auf die Tiergerechtheit bewerten lassen, liegen sollte. Im Report wurde der Schwerpunkt dementsprechend auf die Betrachtung beispielhafter Haltungssysteme für Schwein und Rind gelegt und andere Themen wie der Emissionsschutz wurden nicht näher einbezogen.

Gegenüberstellung der ursprünglich geplanten zu den tatsächlich erreichten Zielen; Hinweise auf ggf. weiterführende Fragestellungen

Tabelle 5: Erreichte Ziele und Meilensteine

Nächste Tätigkeiten	Geplanter Termin	Erreichter Termin
Fachgespräch Fulda	21.-22.09.20	21.-22.09.20
1. Workshop (online) - **M1** Aufgaben und Vorgehensweisen innerhalb des Projektes ist vereinbart	15.06.22	15.06.22
M2 Bedürfnisse der Tiere sind beschrieben	31.07.22	31.10.22
M3 Haltungsverfahren sind beschrieben	31.07.22	10.11.22 Schwein 13.12.22 Rind
2. Workshop – Abstimmung mit Beirat in Fulda	22.-23.08.22	22.-23.08.22
Austausch via Mail über derzeitigen Stand der Ausarbeitung Bedürfnisse der Tiere – bearbeitete Gliederung von Fr. Knierim Rind und Schwein	ab 05.09	12.10.22
Online Treffen AP2 (Wissenschaft) Ausarbeitung Bedürfnisse der Tiere	12.10.22	12.10.22
AP 3 Schwein Beispiele Haltungsverfahren Zeichnungen	14.10.22	08.11.22
Online Treffen Schwein - AP2 und AP3 Austausch im Hinblick auf die Darstellung der Beurteilung der Verfahren	17.10.22	17.10.22
AP 3 Rinder Beispiele Haltungsverfahren Zeichnungen	24.10.22	16.12.22
Online Treffen Rind - AP2 und AP3 Austausch im Hinblick auf die Darstellung der Beurteilung der Verfahren	24.10.22	24.10.22
Online Treffen AP2 (Wissenschaft) interne Absprache – Darstellung der Beurteilung/Evaluierung der einzelnen Haltungssysteme Schwein, Rind	16.11.22	16.11.22
Vorlage eines Beispiels für die Evaluierung der Haltungsbeispiele liegt vor – Rückmeldung und Austausch -AP2	23.12.22	23.12.22
Evaluierung der einzelnen Haltungssysteme Schwein und Rind abschließen – AP2	09.12.22	09.12.22
M4 Haltungsverfahren sind hinsichtlich Tiergerechtheit und ihrer zukünftigen Bedeutung bewertet - Evaluierung	31.08.22	10.11.22
Die fertigen Evaluierungen werden an die gesamte Gruppe via Mail geschickt – AP2	12.12.22	12.12.22
Darstellung der Beurteilung der Verfahren – Entwurf - Dossier	10.12.22	16.12.22
M5 Abgestimmte Darstellungsmöglichkeiten in der Durchführungsverordnung liegen vor	30.09.22	30.09.22
3. Workshop (online) - Abstimmung mit Beirat/Beiratssitzung	13.12.22	13.12.22
M6 Eine erste Version für den Bericht auf Englisch für EGTOP liegt vor	15.10.22	18.12.22
Rückmeldungen und Vorschläge zur ersten Version des Berichts liegen von den Projektbeteiligten vor	13.01.23	13.01.23
Kapitelweise Bearbeitung der Rückmeldungen, Anmerkungen, Korrekturen	08.-24.02.23	08.-24.02.23
M7 Endbericht ist form- und fristgerecht fertiggestellt und liegt dem BMEL vor	31.12.22	28.02.23

Gegenüberstellung der ursprünglich geplanten zu den tatsächlich erreichten Zielen; Hinweise auf ggf. weiterführende Fragestellungen

7.2 Tatsächlicher Ablauf des Projektes

Tabelle 6: Zeitlicher Ablauf des Projektes

Arbeitspakete	Mai 2022	Juni 2022	Juli 2022	August 2022	September 2022	Oktober 2022	November 2022	Dezember 2022	Januar 2023	Februar 2023
AP1: Projektkoordination										
Abstimmung der Aufgaben und Vorgehensweisen im Projekt										
Organisation der Abstimmungsworkshops										
Koordination der termingerechten Zwischenberichte										
Koordination der Rückmeldungen zu Zwischenberichten										
Endbericht auf Englisch										
AP2: Bedürfnisse der Tiere										
Bedürfnisse Schwein										
Bedürfnisse Rind										
Erstellung der Kapitel für den Bericht auf Englisch							M2			
AP3: Beschreibung innovativer tiergerechter Haltungsverfahren in der ökologischen Schweine- und Rinderhaltung und Einschätzung ihrer zukünftigen Bedeutung										
Auswahl der Haltungsverfahren										
Erstellungen von Zeichnungen und 3D-Modellen beispielhafter Haltungsverfahren							M3			
Bewertung der Haltungsverfahren hinsichtlich Tiergerechtheit										
Einschätzung der jeweiligen Bedeutung										
Erstellung der Kapitel im Bericht auf Englisch							M4			
AP4: Entwicklung von Darstellungsmöglichkeiten in der Durchführungsverordnung (EU) 2020/464 für die ökologischen Schweine- und Rinderhaltung										
Entwicklung von Definitionen für innen und außen in der ökologischen Schweine- und Rinderhaltung -stattdessen Formulierung der Haltungskriterien										
Prüfung der Kompatibilität dieser Definitionen z.B. zu Initiative Tierwohl oder in der TA Luft für tiergerechte Außenklimaställe										
Erstellung des Kapitels im Bericht auf Englisch					M5					
AP5: Aufbereitung der Ergebnisse zur Vorlage EGTOP										
Erarbeitung der Darstellung und Abstimmung										

8 Zusammenfassung

In der ökologischen Rinder- und Schweinehaltung ist der Auslauf charakteristisch und obligatorisch. Es gibt innovative, tierfreundliche Systeme, bei denen Innen- und Außenbereich nicht klar getrennt sind. Dies kann eine Herausforderung für die Einhaltung der EU-Öko-Verordnung sein. Die Außen- und Innenbereiche sollten nicht nur die von der EU vorgeschriebenen Mindestflächenanforderungen erfüllen, sondern den Tieren auch die Möglichkeit bieten, arteigene Verhaltensweisen auszuüben, um so ihr Wohlbefinden zu schützen. Es werden Beispiele und Lösungen diskutiert und vorgestellt.

Bei allen Nutztieren ist ein ausreichendes Platzangebot eine Voraussetzung für die Tiere das arteigene Verhalten auszuüben, was die Basis für ein hohes Tierwohl darstellt. Es ermöglicht den Tieren, die Breite der verschiedenen natürlichen Verhaltensweisen auszuleben, welche in sogenannte Funktionskreise eingeteilt werden können. Hierzu gehören die Fortbewegung, Liegen und Ruhen, Nahrungsaufnahme, Ausscheidungsverhalten, Thermoregulation, Körperpflege, Erkundungsverhalten, Sozialverhalten, Sexualverhalten, und Geburts- und Mutter-Kind-Verhalten.

In klassischen ökologischen Haltungsverfahren erfolgt der Zugang zum Außenbereich überwiegend durch eine Wandöffnung im Stallgebäude. In vielen innovativen, besonders tiergerechten Haltungssystemen der ökologischen Rinder- und Schweinehaltung sind jedoch der Stall- (indoor) und Außenbereich (outdoor) nicht mehr durch eine Wand klar voneinander getrennt, sodass Innen- und Außenbereich ineinander übergehen. Dabei werden häufig die für den überdachten Innenbereich typischen Funktionsbereiche der Tiere (wie beispielsweise die Fütterung) in den Außenbereich verlagert.

Diese Haltungsverfahren entsprechen teilweise nicht den in der EU-Öko-Verordnung definierten Vorgaben für die Stall- und Außenflächen, sondern nur hinsichtlich der Gesamtfläche. Für die Tiere ist neben einem ausreichenden Platzangebot auch wichtig, für verschiedene Verhaltensweisen unterschiedliche Funktionsbereiche zu nutzen, unterschiedliche Klimabereiche aufzusuchen, eine natürliche Sozialstruktur aufzubauen und ausreichend Zugang zu Beschäftigungsmaterial zu haben. Soweit die im Projekt erarbeiteten Kriterien erfüllt werden, sollten Möglichkeiten gefunden werden, auch entsprechende Verfahren in der ökologischen Schweine- und Rinderhaltung verordnungskonform nutzen zu können.

Im Bericht werden Beispiele entsprechender Haltungssysteme der ökologischen Schweine- und Rinderhaltung vorgestellt und mit Bezug auf ihre Tiergerechtheit mit Fokus auf die Wirkung von Außenklimabedingungen bewertet.

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10 Übersicht über alle im Berichtszeitraum vom Projektnehmer realisierten Veröffentlichungen zum Projekt (Printmedien, Newsletter usw.), bisherige und geplante Aktivitäten zur Verbreitung der Ergebnisse

Wita 2023, 16. Wissenschaftstagung Ökologischer Landbau im FiBL in Frick, Schweiz

Donnerstag 9. März - Vorstellung des Projektes „Indoor outdoor“ in einem Workshop

„W 02.5: Indoor Outdoor - Innovative tiergerechte Haltungsverfahren für die ökologische Schweine- und Rinderhaltung im Rahmen der geänderten EU-Öko-Verordnung“

Klöble Ulrike, Seibt Katharina D., Schubbert Antje, Holinger Mirjam, Ebinghaus Asja, Franz-Wippermann Rebecca & Knierim Ute

Keywords: organic housing systems, indoor, outdoor run, cattle, pigs

English abstract:

In organic cattle and pig husbandry, outdoor areas are characteristic and obligatory. Recently, innovative, animal-friendly systems have been developed in which indoor and outdoor areas cannot be clearly separated. This may pose challenges regarding compliance with the EU Organic Regulation. However, the outdoor and indoor areas should not only meet the EU-regulated minimum space requirements, but also allow the animals to perform most of their species-specific behaviour and protect them from harm and other welfare impairments. Examples and potential solutions are discussed.

German Abstract:

In der ökologischen Rinder- und Schweinehaltung ist der Auslauf charakteristisch und obligatorisch. Es gibt innovative, tierfreundliche Systeme, bei denen Innen- und Außenbereich nicht klar getrennt sind. Dies kann eine Herausforderung für die Einhaltung der EU-Öko-Verordnung sein. Die Außen- und Innenbereiche sollten nicht nur die von der EU vorgeschriebenen Mindestflächenanforderungen erfüllen, sondern den Tieren auch die Möglichkeit bieten, arteigene Verhaltensweisen auszuüben, um so ihr Wohlbefinden zu schützen. Es werden Beispiele und Lösungen diskutiert.

Anhang: Report

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BÖL BUNDESPROGRAMM ÖKOLOGISCHER LANDBAU

aufgrund eines Beschlusses des Deutschen Bundestages

Report

Innovative animal-friendly housing systems for organic pig and cattle farming in the context of the amended organic EU regulation

Acronym: Indoor-Outdoor

28th of February 2023

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Abbreviations

BHV	Bovine herpesvirus 1
BRSV	Bovine respiratory syncytial virus
BVDV	Bovine viral diarrhoea virus
cfu	Colony-forming unit
ESF	Electronic Sow Feeders
hz	hertz
kHz	kilohertz
log10	Decadic logarithm
n	sample size
NA	Not Applicable
NH3	Ammonia
PI	Parainfluenza virus
SCS	Somatic cell scores
THI	Temperature Humidity Index

Executive Summary

In recent decades, housing systems with open construction or in which functional areas and resources are relocated from a closed barn area to outdoor areas have been increasingly developed and used, particularly in organic farming. They may offer advantages in terms of various aspects of animal welfare, including improved air quality, greater opportunity to experience climate stimuli and additional stimuli (e.g. visual or olfactory) and choice between different microclimate areas. The new housing systems often do not allow a clear distinction between indoor and outdoor area due to their open construction. Some of these housing systems can (depending on the design) be formally classified as non-compliant with Regulation (EU) 2020/464 in terms of indoor space allowances, particularly, although they fulfil or exceed the total space requirements per animal. It is therefore the question whether or not such systems should be allowed in order to promote high animal welfare standards in organic husbandry. For cattle and pig housing systems, welfare criteria were derived from the relevant animal needs, based on an extensive literature search. Possible challenges animals are exposed to in these systems were taken account of, for instance regarding thermoregulation and effects of precipitation. The criteria were exemplarily applied to selected examples that are currently critical regarding compliance with Regulation (EU) 2020/464, involving discussions with a broad number of experts. On this basis we propose that for the new more open systems the differentiation between indoor and outdoor areas is less meaningful, and instead the developed criteria should be applied to evaluate whether these systems may contribute to high animal welfare standards. If that is the case, a derogation from Chapter II Section 1 Article 3 and Section 3 Article 10 of Regulation (EU) 2020/464 should be possible, allowing to deviate from the minimum indoor or outdoor areas required in Part I of Annex I under the condition that these innovative animal welfare-friendly systems provide the minimum total area (indoor plus outdoor area) required. Furthermore, it is explained that for small piglets of up to 20 kg liveweight the lying area should not be too large to allow efficient thermoregulation during cold climatic conditions and avoid soiling of the lying area. Therefore, it is proposed to divide the weight class of "not more than 35 kg" in Annex I Part III of Regulation (EU) 2020/464 into the two classes "not more than 20 kg" and "more than 20 kg but not more than 35 kg".

1. General Introduction

In recent decades, housing systems with open construction or in which functional areas and resources are relocated from a closed barn area to outdoor areas have been increasingly developed (for cattle: Barkema et al., 2015; Galama et al., 2020). While these alternative housing systems can be interesting from an economic point of view due to lower construction costs, in particular, they may offer advantages for various aspects of animal welfare. These include, for example, improved air quality, greater opportunity to experience climate stimuli and additional stimuli (e.g. visual or olfactory) and choice between different microclimate areas. These more open housing designs play an increasing role in alternative farming, e.g. in organic farming. In Annex I, Part I and III of Regulation (EU) 2020/464, minimum indoor areas (net area available to animals, in German: "Stallfläche") and outdoor areas (exercise area, excluding pasture, in German: "Außenfläche") are laid down (while in areas with appropriate climatic conditions housing is not mandatory when protection from adverse weather conditions is provided by shelters or shaded areas (Annex II, Part II, Point 1.6.2 in Regulation (EU) 2018/848)). The new housing systems described above, however, often do not allow a clear distinction between indoor and outdoor area. Some of these housing systems can (depending on the design) be formally classified as non-compliant with Regulation (EU) 2020/464 in terms of indoor space allowances, particularly, although they fulfil or exceed the total space requirements per animal. It is therefore the question whether or not allowance should be made for such systems in order to promote high animal welfare standards in organic husbandry.

It is the aim of this report to present examples of such innovative housing systems which clearly provide advantages in terms of animal welfare, but currently are critical regarding compliance with Regulations (EU) 2018/848 and 2020/464. The Commission agreed to review the current requirements of Regulation (EU) 2020/464 with regard to housing systems that are considered innovative and particularly animal-friendly. Welfare criteria are elaborated for their evaluation while further aspects such as the reduction of emissions are not in the focus of this report. The welfare criteria may also be used for a specific derogation from the minimum standards regarding indoor and outdoor area.

Therefore, after a brief definition of animal welfare criteria, separately for cattle and pigs, the relevant animal needs are presented based on a literature search, welfare criteria are derived and finally applied to selected examples. On this basis, a proposal for a derogation from Chapter II Section 1 Article 3 and Section 3 Article 10 of Regulation (EU) 2020/464 is formulated that would allow adoption of these innovative welfare-friendly housing systems also in organic farming.

2. Definition of animal welfare criteria

In the Terrestrial Animal Health Code, animal welfare is defined as ‘the physical and mental state of an animal in relation to the conditions in which it lives and dies’ (WOAH, 2022). If housing systems shall be evaluated regarding their likely consequences on animal welfare, in general it must be analysed to which degree they provide conditions to the animals that decrease the risk of negative welfare consequences and likely foster positive welfare consequences. These consequences largely depend on the animals’ possibility to fulfil the animals’ needs. The welfare criteria elaborated in the following therefore ask whether under the given conditions the animals are sufficiently able to perform natural behaviour they are motivated for or that enables them to maintain good health (following the operational welfare definition of e.g. Dawkins, 2017).

3. Cattle

Ebinghaus, A., Franz-Wippermann, R., Knierim, U.

3.1. Legal background

In organic cattle farming, certain minimum indoor areas must be complied with according to Annex II Part II point 1.6.4. of Regulation (EU) 2018/848 (in combination with Annex I Part I of Regulation (EU) 2020/464). Access to summer pasture is in principle mandatory for cattle. For male cattle from the age of 12 months, access to an outdoor loafing area (adjacent to the barn) is also permitted, provided it is accessible all year round. For all cattle housed in loose housing in winter and having access to pasture in summer, an outdoor exercise area is not compulsory (Annex II Part II points 1.7.3. and 1.9.1.1. of Regulation (EU) 2018/848). However, if certain conditions do not allow to provide access to pasture during the vegetation period for some groups of cattle, in addition to the minimum indoor area, a minimum outdoor area per animal specified for the various cattle categories must be provided which may be partially roofed (Annex II Part II point 1.6.4. of Regulation (EU) 2018/848 in combination with Annex I Part I of Regulation (EU) 2020/464). Cattle housing systems shall provide smooth, but not slippery floors (Annex II, Part II, point 1.9.1.2 of Regulation (EU) 2018/848). At least half of the minimum indoor surface shall consist of a solid construction, that is to say not of a slatted or grid construction (Chapter II, Section 1, Article 4 of Regulation (EU) 2020/464). Moreover, housing shall be provided with a comfortable, clean and dry lying area of sufficient size, littered with ample straw or other suitable natural material (Annex II, Part II, point 1.9.1.2 of Regulation (EU) 2018/848).

Material and Methods

For the description of the functional areas, for basic explanations of cattle needs with regard to behaviour and animal health as well as for main fundamental effects of husbandry conditions, the common professional literature in German and English language (listed in Appendix Table 1), dissertations (Menke, 1996; Plesch, 2011; Schneider, 2010) and scientific literature (review and research article) were consulted.

Additionally, a systematic literature search in the database ‘Web of Science’ was conducted to identify more specific studies on the effects of outdoor functional areas or resources on the behaviour and health of cattle. For this purpose, a general query ((cattle OR cow OR calves OR calf OR bull OR steer OR heifer OR "young stock") AND outdoor AND (welfare OR behav* OR locomot* OR comfort OR thermoreg* OR health OR disorder OR disease)) was supplemented by further keyword combinations based on reasonable assumptions (behaviour: Appendix Table 2, health: Appendix Table 3).

The different queries were used in a 'topic search' strategy (i.e. searching in abstract, title, author keywords, keywords plus). The search was not limited with regard to the date of publication. However, articles in a language other than English or German, articles from tropical countries, and articles published in research categories other than agricultural animal, veterinary, and behaviour sciences were excluded.

Search results were scanned by title and abstract for relevance using the inclusion criteria:

1. at least one of the populations studied was cattle (Bos taurus)
2. article refers to at least one of the cattle needs described above
3. article refers to influences by housing factors

Articles were excluded according to the following criteria

x1: species other than cattle (Bos taurus), or bucking bulls or hérens cows

x2: article refers exclusively to cattle needs not relevant for the present report (e.g. REM-sleep)

x3: article refers exclusively to influencing factors other than housing-related (e.g. farm size)

x4: opinion elicitations, attitude or consumer studies

x5: articles referring to the informal dairy sector (backyard farms that produce milk or milk products for own consumption or sale in the informal sector, e.g. in Romania or India)

x6: investigations of methods´ quality aspects only (e.g., reliability)

The general search resulted in 254 hits, from which a total of 38 articles were selected for abstraction (research articles: 30, review articles: 8). Specific searches resulted in a total of 25 additional articles (research articles: 24, review articles: 1). Number of hits and selected articles from specific searches are presented in detail in Appendix Tables 2 and 3.

Review articles were used for further snowball search and research articles were abstracted in a standardized way using the following data items:

- article characteristics (first author, year of publication)
- study characteristics (cattle category investigated, study type, country, sample size)
- housing system in which animals were kept
- welfare criteria investigated
- farm risk factors investigated
- effects found/not found.

All review articles used (previously available and identified via systematic or snowball search) are listed in Appendix Table 4 and are therefore not additionally marked as such in the text.

3.2. Definitions

3.2.1. Cattle categories

The Organic Regulation (EU) 2020/464 differentiates regarding cattle ("bovine animals") between dairy cows, breeding bulls and all other bovines, the latter in live weight classes of ≤ 100 kg, ≤ 200 kg, ≤ 350 kg and > 350 kg (Annex I Part I). We consider dairy cows as bovines used for milk production for human consumption and breeding bulls as bovines used for the collection of semen or mating with any cows, i.e. dairy cows or suckler cows. The remaining category of bovines thus includes rearing and veal calves, young rearing stock, beef bulls and heifers including young stock and suckler cows, calves, and heifers.

3.2.2. Functional areas

The species-specific behaviour can be categorized into locomotion, social behaviour, resting and lying, feeding and drinking, elimination behaviour, reproduction, comfort and exploratory behaviour (Albright and Arave, 1997; KTBL, 2006; Ofner-Schröck et al., 2017; Phillips et al., 2013; Sambraus et al., 1978; Winckler, 2009). Depending on the design of specific areas in the housing system, they predominantly serve the performance of certain behaviours. These so-called functional areas comprise a walking, lying, and feeding area for cattle. In contrast to pigs,

cattle do not perform elimination and comfort behaviour in defined areas (Albright and Arave, 1997; Sambraus et al., 1978; Winckler, 2009).

For dairy cows and winter-housed suckler cows additional separate barn areas, namely calving pens, and on some farms also pens for cows in heat are used (Hoy et al., 2016; Ofner-Schröck et al., 2017). However, as the animals are only temporarily housed in these areas for short periods of time, they are not considered further in this report. Additionally, in some cattle housing systems where cows and calves are kept together, there is an area only accessible to the calves, the so-called calf creep. These will also not be considered in this report, because they are usually placed only indoors. The same applies to pens for sick animals.

3.2.3. Walking area

The walking area connects the different barn areas and resources (e.g. feeding area, lying area, water troughs, cow brushes, lick stones, hay racks) and provides space for the following active behaviours: locomotion, social behaviour, exploration, reproductive behaviour (mounting), comfort (e.g. use of a cow brush), elimination and drinking behaviour. Sometimes parts of the feeding and walking area are not clearly separated from each other (e.g. there can be a hay rack in the loafing area). Depending on the size and design of the housing system, the walking area comprises one or more alleys (except the one at the feeding table), passages between cubicle rows, and an outdoor loafing area (Ofner-Schröck et al., 2017). In dairy farming, part of the walking area can be used as a waiting area in front of the milking parlour, or vice versa, an outdoor waiting area can be used as a loafing area outside milking times (Ofner-Schröck et al., 2017; Schneider, 2022).

Regarding the condition of the floor, the walking area may be of a solid or slatted construction. However, in organic cattle husbandry, at least half of the total minimum indoor area shall consist of a solid construction (Annex I Part I of Regulation (EU) 2020/464).

3.2.4. Lying area

The lying area in cattle loose housing can be designed either as individual free stalls (cubicles) that are primarily used for lying, or as an open-bedded area (straw yard, solid manure, or compost-bedded pack) that is used for lying and locomotion (Hoy et al., 2016; Ofner-Schröck et al., 2017). Cubicles define the lying area per individual animal by structural elements (neck rail, side partitions) and can be deep-bedded or raised. According to the Council of Europe Recommendation concerning Cattle, the number of housed animals must not exceed the number of cubicles available (Council of Europe, 1988).

Open lying areas are usually unstructured (Hoy et al., 2016; Margerison, 2011; Ofner-Schröck et al., 2017). Regardless of the system and cattle category, the lying area in organic husbandry must be littered with straw or other suitable natural material (Annex II Part II No. 1.9.1.2. of Regulation (EU) 2018/848).

3.2.5. Feeding area

Cubicle systems and two-room systems with an open-bedded lying area provide a separate feeding area. For roughage feeding (hay, silage, or total mixed ratio), cattle of all categories are provided with feeding places at the feeding table with (e.g., diagonal or palisade) or without division into individual places (neck rails). According to the Council of Europe Recommendation concerning Cattle, the number of housed animals must not exceed the number of individual feeding places, if roughage is not available ad-libitum (Council of Europe, 1988). In two-room loose housing systems, the feeding area at the feeding table also includes the barn side alley (solid or slatted feeding alley).

As an alternative to roughage feeding at a feeding table (young cattle, suckler cows) or in addition to such a main feeding axis (dairy cows, beef cattle), feeding racks can be placed in the barn or outdoor area. Self-feeding at the silo offers a limited number of feeding places and is only occasionally used in temporary winter housing systems for suckler cow herds (Ofner-Schröck et al., 2017; Schneider, 2022).

In dairy farming, some farms use concentrate feeders with transponder technology for individual animal feeding. Depending on the barn design, these stations are installed in the indoor or outdoor walking area.

In calf rearing, calves are fed with milk via (teat) buckets or an automated feeding system with transponder technology until weaning at the age of at least three months. Both the buckets and the automated feeders are usually placed along the feeding axis (Ofner-Schröck et al., 2017). Systems in which calves have the possibility to suckle their dams or nursing cows are of growing importance, particularly in organic dairy production (Eriksson et al., 2022, Placzek et al., 2021).

3.3. Needs of cattle and corresponding requirements concerning the housing environment

3.3.1. Behavioural aspects of animal welfare

The degree of freedom to perform most natural behaviour has important animal welfare consequences for three reasons: Firstly, impairment or prevention to perform behaviour for which the animal is motivated leads, depending on the strength of motivation, to varying degrees of frustration and in some cases to related negative consequences such as abnormal behaviour (Špinka, 2006). Secondly, it may also lead to impaired biological functioning, because of the ultimate function of evolved behaviour. For instance, the reduction of lying times may impair body recovery and increase risks for claw diseases and metabolic disorders (Tucker et al., 2021). Thirdly, the performance of certain behaviour, for instance related to body care or exploration, likely produces positive emotions in the performing animal (Boissy et al., 2007). Therefore, in the following the behavioural categories that may be affected by the design of husbandry systems with regard to indoor or outdoor areas are presented in more detail.

3.3.2. Locomotion behaviour

Under near-natural conditions, an important part of locomotion is linked to feed intake during grazing (Albright and Arave, 1997; Sambraus et al., 1978; Winckler, 2009). Accordingly, the predominant gait is slow walking while grazing. Trot and canter are also possible but are mainly shown in connection with play behaviour (especially in calves and young, but also adult animals) or escape behaviour (Winckler, 2009).

Cattle claws are adapted to travel long distances and to locomotion on soft ground. At pasture, cattle walk up to 13 km per day (Krohn et al., 1992) depending on area size, availability and quality of forage, and other environmental factors such as temperature or precipitation. However, also in loose housing, cattle cover certain distances every day, for example, to get from the lying place to milking (for dairy cows), to the feeding place or drinking trough. The daily distances covered in the barn range from 300 m to 4 km (Winckler, 2009). In studies comparing zero-grazing with overnight pasture (Crump et al. 2019) or all-day pasture (Black and Krawczel, 2016; Dohme-Meier et al., 2014), dairy cows showed significantly more locomotor activity on pasture compared to indoors.

In tie stall housing systems with temporary access to an outdoor loafing area, Loberg et al. (2004) found an increase in the mean percentage of walking and trotting (as well as exploratory behaviour) with decreasing frequency of exercise (once a week, twice a week, every day), which could indicate an internal motivation build up over time (rebound behaviour), but also that perception of a greater change in external factors might newly stimulate more locomotion (Loberg et al., 2004).

Under loose housing conditions, the freedom of movement depends largely on floor conditions and on space allowance including avoidance of bottlenecks that present social barriers, because intended inter-individual distances between conspecifics cannot be maintained. In a cubicle system, dairy cows walked greater daily distances in larger pens ($120m^2$ versus $60m^2$), regardless of stocking densities ranging from one to four cubicles per cow (Telezhenko et al., 2012). Adding space and complexity through an outdoor loafing area adjacent to the indoor system may also provide opportunity and incentive for increased locomotion (Shepley et al., 2020). When tethered cows were given temporary access to an exercise yard for just one hour per day, they walked on average of 0.22 km during this time (Krohn et al., 1992). Lutz et al. (2019) did not find differences in the locomotor activity of loose housed dairy cows during one-hour observations comparing outdoor loafing areas of 5 m^2, 8 m^2,12 m^2 and 15 m^2/cow, while Krötzl and Hauser (1997) noted a steady decrease of walked distance from 15.1 m^2 outdoor area/dairy cow over 9.2 m^2 to 3.6 m^2/cow, combined with a lower use of the smallest area over the year. Less clear-cut effects of expanded an exercise/loafing area compared to pasture are likely to be due to the smaller expansion in terms of area and the lack of the grazing possibility, but may also be influenced by floor conditions. Deformable and/or slip-resistant floor types such as pasture-like surfaces, sand, rubber mats, or mastic asphalt compared to concrete, were found to improve walking speed and stride length (Alsaaod et al., 2017; Franco-Gendron et al., 2016; Telezhenko and Bergsten, 2005). An experimental study by Platz et al. (2007) also showed that high-ranking dairy cows in contrast to low-ranking conspecifics were significantly more likely to spend time on limited walking areas equipped with rubber mats (45% of the total walking area; concrete slatted floor in the rest of the barn), which indicates a preference for softer flooring which in case of limited availability can be implemented depending on the animals´ social rank.

Also calves from an early age onwards have a high motivation for locomotion, which is especially shown with changing environmental stimuli (Albright and Arave, 1997). This may be reason for calves with access both to indoor and outdoor areas spending more activity time outdoors than indoors (Whalin et al., 2022). Locomotion behaviour in calves is often coupled with play behaviour and faster movements such as jumping, bucking, or galloping (Albright and Arave, 1997). Accordingly, adequate floor conditions also play an essential role in calf rearing, both for non-slip locomotion, but also for the development of healthy claws (Frankena et al., 1993). If given the choice, calves prefer to walk and stand on dry surfaces (Camiloti et al., 2012).

Climatic conditions have considerable effects on locomotor activity in cattle. At increased temperatures, particularly in combination with increased humidity (expressed as temperature-humidity index (THI)) pastured cattle reduce locomotion activities and move towards shaded or better ventilated areas if provided (Kendall et al., 2006; Palacio et al., 2015; K.E. Schütz et al., 2010; Schütz et al., 2014; Silva et al., 2021; Tucker et al., 2008; van laer et al., 2015).

3.3.3. Social behaviour

The behaviour of cattle in a herd is highly synchronised, i.e. the animals show their main activities, especially of feeding and lying, predominantly at the same time (Bouissou et al., 2001; Sambraus et al., 1978).

Within herds, a social hierarchy exists, with dominance relationships between individual animals remaining rather stable over longer periods of time (Foris et al., 2019; Wierenga, 1990) if conditions allow, but frequent changes of group composition (Foris et al., 2021; Talebi et al., 2014; von Keyserlingk et al., 2008) and large herd sizes (de Vries et al., 2015; Gieseke et al., 2018) may limit stability of relationships. Negotiation of dominance relationships begins in cattle at an age of about four to six months (Bouissou et al., 2001; Winckler, 2009), which corresponds to a live weight of over 200 kg, depending on the breed. In addition to age and physical factors such as body weight, body size, and health, the length of the stay in the herd also has an influence on the animals´ social rank. Therefore, social conflicts occur mainly within 24 to 72 hours after animals have been regrouped or newly integrated into the herd (Kondo and Hurnik, 1990; von Keyserlingk et al., 2008).

Depending on the individual dominance relationship and actual behaviour, cattle maintain different spatial distances from their conspecifics (inter-individual distances) and have different access to limited resources. When resources are restricted, lower-ranking cattle have subordinate access (Platz et al., 2007) and increased social conflicts between conspecifics may occur (Eriksson et al., 2021; Wierenga, 1990). An epidemiological study in horned dairy herds in Germany and Switzerland found that an increased space allowance per cow was associated with a lower risk of agonistic interactions and fewer skin lesions in the animals (Menke et al., 1999). Pointing into the same direction, in an experimental investigation in Swiss dairy herds (Lutz et al., 2019), the total number of agonistic interactions observed in the outdoor loafing area decreased with increasing space allowance (5, 8, 12, 15m^2/cow). Both in horned and hornless herds, the percentage of agonistic interactions without body contact (i.e. mere threats) was highest at 15 m^2 and lowest at 5 m^2 space allowance, indicating that the animals were better able to avoid injurious conflicts when more space was available (Lutz et al., 2019).

With regard to the structural design of the barn area, scientific literature indicates that a good overview for the animals and the avoidance of narrow passages or dead ends as well as a separation of functional areas contributes to avoiding social conflicts (Schneider, 2010). Accordingly, housing systems in which parts of the resources are shifted to outdoor areas may offer advantages particularly to lower-ranking animals in the form of better avoidance options, provided that sufficient space is available. On the other hand, certain weather conditions (high temperatures with high solar radiation, continuous or heavy rain with low temperatures) pose requirements for the design of outdoor (climate) functional areas. In particular, the motivation to feed and lie down synchronously (Bouissou et al., 2001) should be taken into account, and a sufficient number or size of appropriate lying and feeding places should be available.

Haskell et al. (2013) found low-ranking dairy cows to be more often in an outdoor loafing area during feeding times than high-ranking cows, suggesting that a loafing area can also serve to avoid dominant animals during times of high competition.

3.3.4. Lying behaviour

Cattle rest mainly while lying down. The predominant resting state is dozing, while sleep only covers a minor part of time. Periods of rest and activity alternate in cattle during the course of the day, with a high degree of synchrony in the herd (Bouissou et al., 2001; Winckler, 2009). In loose housing systems, mean daily lying times range between ten and 14 h (e.g., Charlton et al., 2014; Eckelkamp et al., 2014; Ito et al., 2014; Nielsen et al., 2011; Robles et al., 2021; Shepley et al., 2019). Lying is even prioritised over feeding after a period of deprivation of both behaviours (Tucker et al., 2021). The frequency and duration of individual lying bouts as well as the total daily lying times depend on the animal's age, level of milk production (in dairy cows), stage of pregnancy (in dairy and suckler cows) or social rank, but also on climate conditions, housing, and management factors (Tucker et al., 2021; Winckler, 2009). There is

some evidence in the literature that reduced lying times due to unfavourable conditions forcing the animals to stand can increase the risk of claw disorders. Lameness per se, though, can lead to longer lying times, while mastitis reduces lying times (Tucker et al., 2021).

If cattle have a free choice of lying place, they prefer to lie near familiar conspecifics (Gutmann et al., 2015) and conspecifics of comparable social rank (Friend and Polan, 1974). If lying space is limited, lower-ranking animals are often chased up by higher-ranking conspecifics (Wierenga, 1983). Since lying in cattle is strongly synchronised (Bouissou et al., 2001; Winckler, 2009), sufficient space of comparable quality should be available for each animal in the lying area.

For unrestricted lying down and standing up, as well as for comfortable lying, cattle prefer soft, deformable, and dry lying surfaces. A surface that is too hard or cubicles of inadequate dimensions can result in reduced lying durations (beef cattle: Absmanner et al., 2009; dairy cows: Gomez and Cook, 2010; Ito et al., 2014; King et al., 2016; Morabito et al., 2017; Solano et al., 2016) or in difficulties while lying down or rising up (beef cattle: Absmanner et al., 2009; dairy cows: Dirksen et al., 2020; Plesch, 2011), which again can lead to integument alterations, such as swellings or wounds on the tarsal and carpal joints (Brenninkmeyer et al., 2013; Haskell et al., 2006; Potterton et al., 2011). In dairy cows, reduced daily lying times were also found on moist and dirty lying surfaces (Chen et al., 2017; Reich et al., 2010; Robles et al., 2021; Schütz et al., 2019). An experimental study by Schütz et al. (2019) showed that animals had even significantly shorter daily lying times when the lying surface was wet as compared to dirty lying surfaces.

In the case of non-roofed lying places, persistent precipitation may lead to wet lying surfaces and is thus likely to be associated with reduced use by the animals. A Finnish study in fattening bulls pointed in this direction: Animals kept in outdoor paddocks with forest area and a roofed, deep-bedded lying area lay exclusively in the roofed area in winter and also predominantly in summer (Tuomisto et al., 2009), which may be explained by both the better deformability and the drier ground. Similarly, in an experiment by Langford et al. (2021), dairy cows preferentially lay down on a grassed paddock adjacent to a cubicle barn in dry conditions but preferred to use indoor cubicles when the ground was wet. In an earlier study in dairy cows, however, O'Driscoll et al. (2009) found no differences in average daily lying time between indoor cubicle housing (equipped with mattresses), roofed out-wintering paddocks or non-roofed out-wintering paddocks, the latter were both open-bedded with woodchips and a space allowance of 12 m^2/cow. The authors attributed this result to the relatively dry trial period with a maximum of 3.5 mm daily precipitation.

The preference of dairy cows and beef cattle for dry lying areas can also be transferred to calves: In an experimental study by Camiloti et al. (2012), two-week-old Holstein Friesian calves were offered the choice between dry sawdust lying surface (dry matter content (DM) of 90%) and different moist sawdust lying surfaces (DM of 74, 59, 41, and 29%). The lying time on the moist surfaces was reduced from 5.3 h/day at 74% to almost 0 h/day at 29% DM. In addition, the calves preferred to stand on the dry surfaces (2.6±0.1 h/day) compared to any level of moist surfaces (1.7 ± 0.1 h/day). Thermal insulation and protection from draughts on the lying surface can also be important for calves, especially in the first weeks of life, to protect the animals from heat loss at low temperatures (Roland et al., 2016). Particularly new-born calves prefer a warm lying place, e.g. at mean daily air temperature of 6.7° Celsius and independent of feeding level (daily milk allowance of 30% versus 8% of body weight) they were found to lie primarily in the area of the pen where a heat lamp was placed (Borderas et al., 2009).

Although in adult cattle thermal insulation plays a subordinate role (Phillips et al., 2013), cows in pasture-based systems in New Zealand showed shorter total lying times as well as shorter

and fewer lying bouts at lower temperatures in a range of -0.9-16.5° Celsius and higher precipitation (in a range of 0.0-52.6 mm/day), which might be explained by lower lying comfort on wet but also cold ground (Hendriks et al., 2019). A comparison by Hickey et al. (2002) of the lying behaviour of beef cattle in conventional indoor housing (3 m^2/animal, slatted floor) versus out-wintering paddocks with different space allowances (6, 12, 18 m^2/animal, wood ship bedding) and with or without windbreaks, however, showed a higher number of lying bouts and more synchronized lying in the outwintering paddocks regardless of space allowance and windbreaks than in indoor housing, even though the mean ambient air temperature indoors was slightly higher than outdoors (3.5° versus 5.0° Celsius) with a mean daily rainfall of 2.2 mm. The low space allowance and quality of the lying area indoors may have largely influenced the differences.

At elevated temperatures or THI, especially in combination with increased solar radiation, cattle increasingly seek shaded lying areas in order to reduce heat stress. This has been confirmed for dairy and beef cattle at pasture (Kendall et al., 2006; Palacio et al., 2015; K.E. Schütz et al., 2010; Schütz et al., 2014; Silva et al., 2021; Tucker et al., 2008; van laer et al., 2015), but is likely to be equally applicable to housing systems with outdoor lying areas.

Studies have also shown effects of heat stress on the lying behaviour in unweaned calves: Calves exposed to heat stress stood longer across the day, lay more often in a lateral and less often in a sternal-tucked posture compared to calves offered cooling (Dado-Senn et al., 2022). Moreover, heat stress increased the frequency of lying bouts and posture changes (Kovács et al., 2018). Accordingly, sufficient lying areas with roofing or other adequate sun protection should be offered for all cattle independent of age.

3.3.5. Feeding, ruminating, and drinking behaviour

Cattle are ruminants and therefore roughage feeders. Under near-natural conditions at pasture, cattle graze at a slow forward stride with head and shoulder lowered. When housed, this so-called grazing stride is compensated for by a raised feeding table (Winckler, 2009). Like lying behaviour, also feed intake in cattle is characterised by a high degree of herd synchrony, both on pasture and when fed indoors (Sambraus et al., 1978; Winckler, 2009). A low animal:feeding place ratio can result in increased agonistic interactions between the animals and impaired resting behaviour (Collings et al., 2011; Fujiwara et al., 2019; Krawczel et al., 2012; Schrader et al., 2002).

In loose housing systems, cattle spend on average four to seven hours a day feeding and at pasture up to 12 hours a day. Depending on quantity and quality of the feed, cattle spend four to nine hours a day ruminating, which is mainly done while lying (Albright and Arave, 1997; Sambraus et al., 1978; Winckler, 2009). At adverse climate conditions, cattle seek protected feeding areas. In an experimental study with Canadian dairy cows and all-day summer grazing, animals offered shaded areas (4.65 m^2/cow) grazed up to 1.5 times more than cows offered no shade during midday and afternoon hours at a THI above the thermal comfort threshold (≥72) (Palacio et al., 2015).

In general, the amount of drinking water needed increases with age, dry matter content of the feed, ambient air temperature, and with increasing milk yield in cows. Under housing conditions, cattle drink on average two to seven times a day. One drinking session at an open water trough takes one to eight minutes; during this time up to 30 litres can be drunk by adult cattle (Albright and Arave, 1997; Sambraus et al., 1978). Especially in lactating dairy cows, high frequencies and durations of water intake were observed. High-yielding dairy cows in a cubicle housed Canadian herd during summer months spent on average 25.6 ± 1.53 min/day

(range: 11.7–54.0 min/day) at the drinker, distributed over 19.0 ± 0.6 visits/day (range: 10–31 visits/day; McDonald et al., 2020).

The need for water intake can be increased by several causes: after feeding, in the case of dairy cows, after milking (Sambraus et al., 1978), and at increasing temperatures (Cook et al., 2007) or THI (McDonald et al., 2020) as well as higher temperatures in addition with solar radiation (Polsky and von Keyserlingk, 2017). In a study by Palacio et al. (2015) dairy cows with no shade available in the summer pasture in Canada visited water troughs 6.4 times more often than cows in pastures with shaded areas. In the study by McDonald et al. (2020) dairy cows in a passively ventilated indoor cubicle system drank more water, visited the open water trough more frequently and for longer periods as the 24-h maximum THI increased (mean = 70.9, range = 56.3–81.3). In housing systems with non-shaded areas, the water demand is likely to be additionally increased during solar radiation. Thus, a sufficient number of functioning and well-distributed water sources is important.

3.3.6. Comfort behaviour

The comfort behaviour of cattle includes allo- and self-grooming to remove dirt, and parasites from the skin and hair coat, as well as thermoregulatory behaviour when the environmental temperature, humidity, wind speed or precipitation poses a challenge to the animal's comfort (Broom and Fraser, 2015).

3.3.7. Allo- and self-grooming

Allogrooming, the mutual licking between conspecifics, is mostly carried out on body regions that are difficult to access for the recipient, such as the head or neck area. In addition to helping the animals to stay clean, allogrooming plays a major role in reinforcing social bonds and reducing social tension within the herd (Boissy et al., 2007). Both self- and allogrooming are usually considered indicators of good animal welfare (Albright and Arave, 1997). However, if particularly allogrooming is increased, it may also indicate an understimulation or a social conflict (Knierim and Winckler, 2009).

For self-grooming, cattle use their tongue, hind claws or horns. In order to reach various parts of the body, the animals sometimes adopt extreme postures (Albright and Arave, 1997; Sambraus et al., 1978) that may require sufficient space and non-slippery flooring. To groom body regions that are hardly approachable, cattle rub themselves on objects, such as trees at pasture (Broom and Fraser, 2015; Sambraus et al., 1978) and partition gates, drinkers or walls under housing conditions. However, self-grooming can be supported by offering cow brushes (DeVries et al., 2007), which were valued by the animals as important as access to fresh feed in a motivation test by McConnachie et al. (2018). Providing a cow brush can also enrich adjacent outdoor areas of the barn: in an experimental study in the UK, Haskell et al. (2010a) found that a higher proportion of dairy cows used a roofed outdoor loafing area after feeding when it was furnished with a cow brush compared to when it was not furnished or furnished only with tractor tires.

3.3.8. Thermoregulation

Thermoregulatory behaviour is performed when the temperature is either in the lower critical range and the animal needs to maintain body heat, or when the temperature is in the upper critical range and heat stress occurs. Cattle have a wide tolerance range with regard to the ambient temperature, though they cope better with lower temperatures than with heat. Adaptability depends on the breed and performance of the animals (Broom and Fraser, 2015).

The lower critical temperature range (maintenance conditions) for adult cattle starts below -17° Celsius, and for calves in the first weeks of life at 9° Celsius in dry and still air

(Broom and Fraser, 2015; van laer et al., 2014). Thermoregulatory behaviour in the lower critical range includes close social contact, muscle trembling, and changes in feeding and lying times depending on the resources available, i.e. protected versus unprotected feeding and lying areas. Investigations in Ireland showed a higher climatic energy demand in dairy heifers (Boyle et al., 2008) and in beef cattle (Hickey et al., 2002) when housed in out-wintering paddocks compared to control animals in indoor housing systems. Depending on air velocity and precipitation, cattle may already show behavioural changes at temperatures above 0° Celsius, indicating impairment of thermal comfort. In an experimental study in New Zealand in winter (mean ambient air temperature: 4.9° Celsius), Tucker et al. (2007) compared the behaviour and physiological stress response of dairy cows when kept in an outdoor pen with artificially induced precipitation (water sprinkler) and air velocity (fans) with when kept in an indoor pen, both bedded with wood chips: when cows were kept outdoors, they spent less time lying and feeding, adopted more protective standing and lying positions and had higher cortisol levels compared to when kept indoors. Similar results were found by Webster et al. (2008), dairy cows kept under cool (mean air temperature: 3.4° Celsius, continual air movement: 7.1 kph) and wet (water sprinkling for 15 min/h) outdoor conditions showed increased behavioural (less time feeding and lying) and physiological (increased cortisol level) stress responses compared to cows kept indoors. The results of another experimental study by Schütz et al. (2010) pointed in the same direction: cows exposed to artificial precipitation (water sprinklers) or precipitation in combination with wind (fans) in an indoor experimental pen (mean air temperature: 10° Celsius) had shorter lying times and ate less than control animals without adverse treatment. Thus, in the lower critical temperature range, cattle should be provided with sufficient feed and, especially in the case of open housing, thermally insulated lying areas and protection from wind and rain (Gregory, 1995; van laer et al., 2014).

Due to their low body surface:body mass-ratio and poor insulation (i.e. thin skin and subcutaneous fat; Gonzalez-Jimenez and Blaxter, 1962) calves, especially new born calves, have an increased risk of heat loss under cold and/or wet conditions. In addition to the temperature, air humidity influences the calves' possibilities to thermoregulate (Schäffer and Von Borell, 2008). Healthy calves are physically active, which again increases heat production and cold resistance (Vermorel et al., 1989). Calves are tolerant to cold and wet weather conditions only if their hair coat and the bedding material provided are dry, and the lying area is protected from draft (Schäffer and Von Borell, 2008).

The upper critical temperature range for cattle can start at below 20° Celsius (particularly for lactating dairy cows) and also depends on the humidity. Accordingly, the risk of heat stress in livestock is commonly assessed using the THI, which represents climatic conditions based on air temperature and relative humidity. Usually, a THI of >72 is assumed as the upper threshold (Higashiyama et al., 2013), although, particularly for dairy cows, lower critical values are discussed in the literature (Herbut et al., 2019; Polsky and von Keyserlingk, 2017; van laer et al., 2014; West, 2003).

In the upper critical temperature range the animals move to better ventilated or shaded areas (dairy cows: Kendall et al., 2006; beef cattle: Mitlöhner et al., 2002; Mitlöhner et al., 2001). An experimental study in New Zealand even showed that dairy cows deprived of lying for 12 h increased their times standing in the shaded area of the test arena (where lying was made impossible) instead of lying down in the non-shaded lying areas when air temperatures increased from < 25° to > 30° Celsius (Schütz et al., 2008). Sufficient shaded space plays a major role for cattle to adapt to heat stress: In a subsequent experimental study of dairy cows in a pasture-based system in New Zealand, Schütz et al. (2010) found that animals with no or little shade per cow (2.4 m^2) had significantly higher respiration rates and engaged in more agonistic interactions in shade than those with more generous shade provided (9.6 m^2/cow). In

addition, time spent in shade, aggressive interactions in the shade, mean body temperature, and respiration rate increased with environmental heat load (at temperatures ranging from 5 to 30° Celsius and THI ranging from 42 to 78). Pointing into the same direction, in feedlot beef heifers in Texas, US, misting and providing shaded areas during summer (mean daily temperatures: 14.5 – 27.0° Celsius) significantly reduced rectal temperatures and respiration rates compared to control animals without any possibility to reduce heat stress (Mitlöhner et al., 2002; Mitlöhner et al., 2001).

In addition to shade-seeking behaviour, cattle are more likely to stay near the water troughs, spend longer times standing and shorter times lying as ambient heat load increases (Cook et al., 2007; Lovarelli et al., 2020; McDonald et al., 2020; Schütz et al., 2010; Tucker et al., 2008; van laer et al., 2015). In an observational study of a Canadian dairy herd housed in a passively ventilated indoor cubicle system, cows drank more water, visited open water troughs more frequently and for longer periods, and were more frequently engaged in competitive interactions at the drinker as the 24-h maximum THI increased (mean = 70.9, range = 56.3–81.3). Time spent at the drinker and the number of competitive interactions at the drinker began to increase at a THI of 65; frequency of visits to the drinker began to increase at a THI of 64 (McDonald et al., 2020), indicating that heat stress in dairy cows already starts below the usual threshold of 72. Although calves and young stock may be comparatively heat resistant due to less production of metabolic heat and higher heat dissipation efficiency, they still suffer from heat stress when the ambient temperature exceeds their thermoneutral range (Wang et al., 2020). The upper critical range in terms of THI thresholds for calves and young cattle has not been defined, as little scientific research is available so far. For the thermoneutral range, however, temperatures of up to 25° Celsius are given for calves and up to 15° Celsius for young cattle (Hahn, 1997). However, calves born at a THI above 72 had lower weights until weaning than calves born during lower temperature periods. They also consumed more water and less starter feed, indicating negative effects of heat stress (Broucek et al., 2008).

3.3.9. Exploration behaviour

Exploration of the environment as well as social communication depend on sensory usage. Cattle are capable of colour vision and have a total angle of vision of approximately 320°, but only a 1/22 to 1/12 the visual acuity of humans (Bouissou et al., 2001). Cattle have a very distinct sense of smell, which is particularly important for close communication in connection with their sexual behaviour and the individual recognition of conspecifics (Albright and Arave, 1997). Cattle are able to hear a frequency spectrum from 23 Hz to 35 kHz, which includes part of the ultrasonic range from 20–35 kHz (Heffner and Heffner, 1992, 1983; Kruger et al., 2021). In comparison to cattle, humans can commonly perceive only up to 20 kHz (Purves et al., 2019). However, frequency resolution and directional hearing are poorer in cattle than in humans (Heffner and Heffner, 1983). Mechano-, thermo- and pain- receptors in the skin are most densely distributed in cattle on the lips, tongue, muzzle, udder and vulva (Schrader and Mayer, 2005).

Outdoor areas adjacent to indoor housing areas may increase opportunities to express exploration behaviour, e.g., by access to changing weather conditions, to additional olfactory stimuli, and by visual enrichment due to a view on the surrounding areas. Dairy cows kept in a tie stall system performed increased exploratory behaviour when provided with temporary access to an exercise yard, particularly when the access was limited to once a week (Loberg et al., 2004). However, research on exploration behaviour and, more specifically, on the importance of visual stimuli for cattle is limited. Only one study in Scotland has been conducted so far, but found no effect: Visual stimuli through a free view on the surrounding area compared to no view through erected screens made of finely knitted cloths did not affect the time dairy

cows spend in the outdoor loafing area adjacent to the cubicle loose housing system (Haskell et al., 2013).

Research on the behavioural problem of intersucking in calves or heifers suggests that a stimulus-enriched environment during rearing can contribute to a reduction in occurrence (Keil et al., 2002, 2000): In an epidemiological study on Swiss dairy farms, heifers on farms where calves did not have access to a yard or pasture and where calves were reared in pens in enclosed buildings were more likely to perform intersucking in comparison to heifers on farms that offered calves outdoor (climate) access (Keil et al., 2000). In a subsequent comparative study of farms housing calves under enriched conditions (group igloos with outdoor area, n=5) and farms housing calves under low-stimulus conditions (one-room group pens in enclosed barns without outdoor area, n=6), Keil et al. (2002) found a tendency of less frequent and significantly shorter durations of inter-sucking under enriched conditions. Although many factors might have played a role, the possibility to explore changing stimuli could be part of it.

3.3.10. Motivation to use outdoor areas

In a motivation test, animals can be asked for their preferences or priorities in relation to certain resources. Von Keyserlingk et al. (2017) found that dairy cows work just as hard for access to pasture as for access to fresh feed after 1.5 hours of feed deprivation. However, research also indicates that preference for outdoor areas depends on various factors, such as the animals´ previous experience, time of the day, or environmental condition, with night-time access increasing, and rainfall or higher temperatures decreasing the preference (Charlton et al., 2013, 2011b; Falk et al., 2012; Legrand et al., 2009). When offering outdoor experienced cows' free choice between daytime pasture and cubicle housing (during summer in Canada, with provision of comparable feed options), the animals went to and remained at pasture for the majority of time (Shepley et al., 2017).

Characteristics of the indoor environment, such as stocking density, may also influence the animals´ motivation to access outdoor areas. In an experimental study by Falk et al. (2012), however, the preference of dairy cows for pasture over indoor housing was not influenced by cow:cubicle ratio (24, 16, 8, or 0 cubicles per group of 24 cows): during night-time, animals of all groups preferred pasture and spent on average 78.5% of the time outside. During the day, however, they spent an average of 58.5% of the time indoors, even when overstocked, which could be due to the additional solar radiation at higher temperatures (of up to 29.6° Celsius) on the one hand, and the lack of habituation to the experimental changes in stocking density on the other (Falk et al., 2012).

Alternative to pasture, an outdoor loafing area adjacent to the barn can provide access to the outside. Although experimental studies have shown that dairy cows have a preference for pasture or grassed paddocks over concrete or sand outdoor loafing areas, the latter are used for large parts of the day depending on climatic conditions, design and space allowance if no pasture is available (e.g., Langford et al., 2021; Smid et al., 2020, 2019, 2018). Shepley et al. (2016) found that even in winter (with outdoor temperatures of -4.4 to 8.7°Celsius), when given a free choice between indoor housing and outdoor area (either pasture or outdoor yard) in the afternoon hours, dairy cows similarly spent a large proportion of their time outside (up to 89% during the first hour of observation). Earlier investigations by Haskell et al. (2013, 2010b) in a Scottish dairy herd showed that weather conditions, time related to feeding routine, and time related to feeding in interaction with environmental enrichment and social rank had an influence on the use the outdoor loafing area: Usage was reduced in rainy compared to sunny or overcast weather and slightly positively correlated with the THI inside the barn ($r = 0.23$, $p<0.001$), suggesting that the outdoor access fulfilled some thermoregulatory function for the cows (Haskell et al., 2013). A significantly higher percentage of cows used the outdoor loafing area

after feeding in the barn (29%) compared to before (9%) or during feeding (7%), which was again more pronounced when the area was enriched by a cow brush (Haskell et al., 2010b) and when considering the cows´ social rank: Low-ranking animals were more often outside during feeding times than high-ranking cows, suggesting that they may be using the loafing area to avoid dominant animals (Haskell et al., 2013).

3.4. Health aspects of animal welfare

The health state is another important part of animal welfare (Broom, 2007). Major health challenges for the different cattle categories are therefore presented in the following, discussing the extent to which husbandry factors can play a role as health hazard.

3.4.1. Udder diseases

Udder diseases, which belong to the most common causes of early, involuntary culling in dairy farming (Compton et al., 2017; Dallago et al., 2021) are mostly caused by a range of factors including management, housing, and animal-related aspects. In general, the risk of infection with environmentally associated pathogens can be reduced by avoiding high levels of udder contamination (Firth et al., 2019; Ward et al., 2002), e.g. by higher frequencies of cleaning the lying area (Hohmann et al., 2020). Comparisons between housing systems indicated advantages of cubicle systems over systems with open-bedded lying areas with regard to udder cleanliness (Fernández et al., 2020; Moreno et al., 2020) and udder health (De Visscher et al., 2017; Detilleux et al., 2012; Emanuelson et al., 2022; Ivemeyer et al., 2018; Richert et al., 2013). Additionally, dimensions and the quality of lying places play an important role (Plesch and Knierim, 2012), also for the risk of teat injuries which may lead to udder infections (Ruud et al., 2010).

Increased moisture on bedded lying surface, e.g., due to persistent precipitation in non-roofed outdoor lying areas, could be assumed to increase the risk for reduced udder hygiene and health. However, the few studies available do not support this assumption: A case study in combination with an experimental study by O'Driscoll et al. (2008) in roofed and non-roofed outwintering paddocks (open-bedded with woodchips) indicated that udder hygiene and udder health (somatic cell scores (SCS) and mastitis incidences) depended more on the space allowance than on roofing: in roofed paddocks with a space of 6 m^2/cow, dirtiness scores and somatic cell scores were significantly higher than in non-roofed paddocks with 12 m^2/cow. With identical space allowance (12 m^2/cow) in the subsequently conducted experiment, SCS, and mastitis incidences did not differ. Nevertheless, dirtiness scores in roofed paddocks were significantly lower than in uncovered paddocks (O'Driscoll et al., 2008). In addition, experimental studies in an organic dairy herd during winter in Minnesota found no difference in average SCS between an open-front compost-bedded pack barn (9.5 m^2/cow, SCS = 2.57) and a non-roofed straw yard (12 m^2/cow, SCS = 2.63; Heins et al., 2019), but higher mastitis treatment incidences indoors compared to outdoors (27% versus 15%; Sjostrom et al., 2019). Moreover, the total bacteria count from bedding samples tended to be lower in the outdoor (13.0 log10 cfu/mL) compared with the indoor system (14.9 log10 cfu/mL; Heins et al., 2019), and cows had significantly lower udder, abdomen, and leg dirtiness scores outdoors compared to indoors (Sjostrom et al., 2019).

3.4.2. Locomotory disorders

Locomotory disorders are less prevalent in open-bedded systems compared to cubicle systems with hard floor surfaces (Burgstaller et al., 2016; Griffiths et al., 2018; Häggman and Juga, 2015; Lobeck et al., 2011; Sjöström et al., 2018; Somers et al., 2005b). Slatted compared to solid floor (Dippel et al., 2009a) and increased contact with faeces and moisture, e.g. in the case of insufficient manure removal, were identified as risk factors for claw diseases (Leach et al.,

2005; Somers et al., 2003). In this context, O'Driscoll et al. (2008) found higher heel horn erosion scores in cows kept in non-roofed outwintering paddocks ensiled with grass compared to indoor-housed cows and cows in roofed outwintering paddocks with concrete feeding areas. The authors attributed this to the wetter floor in the non-roofed grass paddocks; in the other two systems, on the one hand the amount of moisture was reduced due to the roofing, and on the other hand manure was regularly scraped off the solid walking and feeding areas.

In tie stall systems, access to an outdoor loafing area was found to reduce lameness and claw disorders in dairy cows (Keil et al., 2006; Loberg et al., 2004; Popescu et al., 2013), especially when exercise was offered regularly throughout the year (Regula et al., 2004). This can be explained by strengthening of the locomotor system and improvement of claw condition (Keil et al., 2006). In loose housing systems, increased space allowance in the feeding alley was associated with lower lameness prevalences in dairy herds (Sarjokari et al., 2013; Westin et al., 2016), which may also be explained by better claw condition due to increased freedom of movement and less standing in the alley, but also by a lower risk of traumatic claw injuries in social conflicts in the feeding area.

Metabolic disorders, for example rumen acidosis, increase the risk of non-infectious claw diseases, such as sole ulcers (Shearer et al., 2015). In addition, some studies indicate that infectious diseases of other organs (e.g. mastitis) are associated with infectious processes in the claws (O'Connor et al., 2020; Refaai et al., 2017; Sato et al., 2008; Slawuta et al., 2005).

A study by Cook et al. (2007) also indicated an association between heat stress and impaired claw health, which was attributed to longer standing times and shorter lying times at increasing temperature-humidity index.

In bulls kept for breeding purposes, locomotory disorders may also result from insufficient claw wear, especially when the bull is kept in a separate pen providing limited space for locomotion (Haugstätter et al., 2007). Otherwise, specific scientific research on breeding bulls could not be identified in the present literature review and is likely very limited. However, results on locomotory disorders and other disease complexes such as metabolic disorders (section 3.4.3) or integument alterations (section 3.4.4) may be transferable from the other cattle categories to breeding bulls.

3.4.3. Metabolic and reproductive disorders

Major metabolic disorders like ketosis, acidosis, abomasal distortion, are particularly prevalent in dairy and beef cattle as well as reproductive disorders in cows (e.g., cyst formation, anoesteria, parturient paresis). These disorders are mainly influenced by management factors such as feeding including the frequency of fresh feed provision (Berge and Vertenten, 2014; Oetting-Neumann et al., 2018). However, reproductive disorders occur considerably less in loose housing systems than in tethered housing (Richert et al., 2013; Schenkenfelder and Winckler, 2022), which indicates a positive influence of locomotion. In organic beef farming, metabolic disorders due to low roughage content in the ration play a lesser role than in conventional fattening, although metabolic disorders can occur due to variations in feed quality, especially when grazing in summer (Nielsen and Thamsborg, 2005).

3.4.4. Integument alterations

Integument alterations (wounds and swellings) can be caused by inappropriate housing facilities (Andreasen and Forkman, 2012; Armbrecht et al., 2019; Barrientos et al., 2013; Brenninkmeyer et al., 2013; Burow et al., 2013; Cook et al., 2016; Ekman et al., 2018) or result from agonistic interactions between animals (Menke et al., 1999). In the latter case, Menke (1996) found for horned cows on five farms with loose housing with outdoor yards that providing day and night

access to the outdoor yard contributed to less agonistic behaviour which again was correlated with horn related injuries.

Alterations at the neck, carpal or tarsal joints typically indicate causes related to inadequate housing conditions. Effects of inappropriate cubicle dimensions and obstructed lunge space on the occurrence of hock alterations have been shown in various studies (e.g., Busato et al., 2000; Dippel et al., 2009a, 2009b; Haskell et al., 2006; Keil et al., 2006; Somers et al., 2005a). These findings are related to impaired lying behaviour, i.e., difficulty in lying down and rising up, and collisions with the cubicle fittings (Bouffard et al., 2017; Cook et al., 2004; Dippel et al., 2009b; Fregonesi et al., 2009; Olmos et al. 2009; Ostojić Andrić et al., 2011; Popescu et al., 2014). Adaptations to the cubicle dimension (e.g., longer lying area, less restricted neck rails) improve cow comfort around resting and enhance limb health but can be at the expense of cow cleanliness and udder health (Bernardi et al., 2009; Fregonesi et al., 2009; Plesch and Knierim 2012). With regard to the effects of different lying surfaces, the results generally show that deep-bedding, soft and deformable surfaces offer advantages compared to raised cubicles in terms of pain-free locomotion and healthy leg joints. Mats or mattresses installed on the stall base are more deformable than plain concrete, but can – depending on the design – also be more abrasive and associated with increased prevalence of hock alterations (Potterton et al., 2011).

3.4.5. Respiratory diseases

Regarding respiratory diseases – particularly in calf rearing - especially enzootic bronchopneumonia, viruses (BHV, BVDV, PI viruses, BRSV) play a major role, although bacterial infections (Mannheimia haemolytica and Pasteurella multocida) may be involved as well (Fulton et al., 2002). The risk of respiratory diseases increases with insufficient colostrum supply and when calves of different origins are housed together, but it is also dependent on the general housing conditions: high stocking densities and inadequate ventilation favour respiratory diseases in calves (Barrington et al., 2002; Gorden and Plummer, 2010; Smith, 2020; Stokka, 2010). The risk for respiratory diseases in calves is strongly associated with the number of pen bacterial counts and by the amount of insulation material (mostly straw; Lago et al., 2006). Thus, adequate ventilation with fresh air, but without draft is essential to reduce respiratory diseases (Roland et al., 2016).

3.4.6. Diarrhoea

In calf rearing, diarrhoea is one of the most common health problems. Important pathogens of diarrhoea are rotavirus, corona virus, coli bacteria, cryptosporidia, and salmonella. In addition to a late or low supply of colostrum and generally inadequate feed management, risk factors also include inadequate barn hygiene (Barrington et al., 2002; Cho and Yoon, 2014; Foster and Smith, 2009).

3.4.7. Endoparasitosis

Depending on the pasture biotope and management, endoparasitoses can occur more frequently during grazing compared to winter housing (Arnott et al., 2017), leading to deteriorations in body condition and increased mortality in calves (Hawkins, 1993). Particularly, when keeping calves and young animals at pasture, the risk of parasitic infestation must be taken into account (Blanco-Penedo et al., 2012; Dimander et al., 2000; Höglund et al., 2001). During winter housing, access to an outdoor loafing area can reduce endoparasite infestations: Jäger et al. (2005) found lower prevalences of infestation with cryptosporidia in German Angus calves in suckler herds when the animals had access to an outdoor loafing area during winter housing compared to indoor confinement.

3.5. Conclusions and welfare assessment criteria for innovative cattle housing systems

In general, the provision of freely accessible outdoor areas, even during winter indoor housing, carries a number of advantages for cattle welfare and corresponds to the animals´ preferences. Various studies have shown that cattle in principle express motivation and preference to access outdoor areas, particularly pasture, over indoor confinement.

Giving the animals free choice of different housing conditions improves the animals' opportunities to adapt to their environment. It can be concluded that regardless of access to pasture, free access to an outdoor barn area has various positive effects for cattle welfare. However, open housing systems with outdoor functional areas and resources also pose some risks, particularly with regard to the challenges of thermoregulation and negative effects of precipitation, which can, nevertheless, be effectively controlled by an adequate housing design. Given that these preconditions are fulfilled, more open housing systems can be evaluated as innovative animal welfare-friendly systems. Because differentiation between indoor and outdoor areas is less meaningful in these systems, compliance with the Organic Regulation (EU) 2020/464 should be obtained by considering only the total area provided. The criteria for an evaluation as innovative animal welfare-friendly system are presented in Table 1. They have been developed based on the animals' needs and corresponding housing requirements presented above (section 3.3 and 3.4). In the following, they are justified in brief, each with reference to the sections providing more details.

Cattle are adapted to travel long distances, since **locomotion** is linked to grazing under near-natural conditions (see section 3.4.2). Various studies also indicate that locomotion contributes to improved claw and joint health when the floor conditions are suitable (see section 3.4.2) and promote fertility in cows (see section 3.4.3). Calves also show a high motivation for locomotion. Especially in connection with play behaviour, calves perform various movements that also serve to strengthen the musculoskeletal system (see section 3.3.2). *Accordingly, all cattle, regardless of age group, must be given sufficient space and incentive to move around.*

Cattle show increased **exploration behaviour** using different senses when offered different stimuli such as outdoor resources. Enriched environments are preferred by adult cattle and contribute to a reduction of the behavioural problem of inter-sucking in calves and young stock (see section 3.3.9). *Accordingly, cattle of all age groups must be given access to changing stimuli.*

Social dominance relationships within herds develop in young cattle from about 4 to 6 months of age. In this context the animals aim to maintain sufficient inter-individual distances to avoid or reduce social conflicts (see section 3.3.3). Passage between different functional areas or access to resources, such as drinkers and feeding places, should therefore not present any bottlenecks. *Accordingly, sufficient space for mutual avoidance must be given in the walking area, including for change between indoor and outdoor areas. Moreover, animals must be given unhindered access to resources.*

Cattle prefer dry, soft lying areas and seek sheltered **lying** areas when the temperature is in the lower and especially in the upper critical range. Longer lasting aversive conditions impair the quality of the lying areas and result in reduced lying times and further impairments of animal welfare: shortened lying times can, for example, exacerbate claw diseases (see section 3.3.2); wet and/or dirty lying areas pose an additional risk with regard to udder diseases (see section 3.4.1). In addition, if a reduced number of adequate resources is available, this may increase social conflict in the herd, and especially for lower-ranking animals, because of the tendency towards synchronous behaviour (see section 3.3.3). If more than short-term challenges are to be expected due to regional climatic conditions or the orientation of the barn, constructional

measures, such as extended roofs, should be applied to protect the animals from such aversive weather conditions. *Accordingly, each animal must in principle have access to a dry lying place, even in case of precipitation, and to a sun-protected lying place in case of increased temperatures.*

Young calves do not yet have a sufficiently developed immune system and moreover begin to freeze more easily than adult cattle due to their lower body surface:body mass ratio (see section 3.3.8). *Accordingly, calves in the first months of life (≤200kg live weight) must be provided with a lying area protected from draughts.*

Feeding is a main activity of cattle, which is performed several hours a day and preferentially synchronously in the herd. At elevated temperatures and solar radiation, cattle adapt by using climatically more favourable areas that are e.g. shaded or better ventilated. When opportunities for such thermoregulatory behaviour are not sufficiently given, the animals' feeding times may be reduced (see sections 3.3.5 and 3.3.8). *Accordingly, feeding places must be provided in adequate quantity and quality, even at elevated temperatures.*

Table 1: Criteria for the animal welfare evaluation of innovative cattle housing systems.

Needs	Category	Criteria	Fulfilled e.g. by
Locomotion	all	Each animal has sufficient space and incentive to move around.	well distributed different stimuli, including climatic stimuli
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	provision of an outdoor area, possibility to experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas	wide passage or several wide passages between functional areas in the outdoor and indoor areas and sufficient free space around resources, no placement in confined areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	roofed lying places
	≤200 kg	Each animal is provided with a lying area protected from draughts.	three-sided closed lying area
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	sun nets, ventilation or sprinkling/misting in the feeding area at elevated temperatures

3.6 References - Cattle

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4. Pigs

Schubbert, A., Holinger, M., Garcia, M.

4.1. Background

Pigs naturally divide their living environment into so-called 'functional areas', i.e., they allocate specific spaces for specific behaviours (Signoret et al., 1975; Stolba & Wood-Gush, 1989; Tillmanns, 2022). In an attempt to provide corresponding conditions to farmed pigs, modern and welfare-oriented pig production seeks to reproduce this natural space management in housing systems. Functional areas therefore consist in delimited zones in the indoor/outdoor housing systems which are named after the main behaviour aimed at being displayed in a specific location. In overcrowded conditions, no functional areas can be created and maintained by the animals (Baldwin, 1969; Tillmanns, 2022). Thus, a key issue in pig management is to provide appropriate space, so that pigs get the opportunity to separate functional areas in the pen and that behaviours are displayed in their intended functional area (e.g., Simonsen, 1990, EFSA, 2022).

In organic pig housing systems, an outdoor run is required for all pig categories (Regulation (EU) 2018/848). In usual organic pig housings, the outdoor run is clearly distinguished from the indoor barn area and is defined as: "the outdoor part of a housing system which (1) is permanently accessible from the indoor area (building or shelter, which is closed on four sides), (2) has a concrete floor (solid or partially slatted), and (3) may be partially roofed" (Wimmler et al., 2022). However, there exists a variety of housing systems with open constructions in organic pig husbandry, which are mostly designed as non-insulating housing, where indoor and outdoor area cannot be distinguished clearly from each other. In non-insulated housings, pigs are exposed to various climatic conditions (Botermans and Andersson, 1995).

In the following, general pig behaviours, the impact of climatic conditions on these behaviours as well as the use of specific functional areas, as far as relevant scientific literature was available, will be addressed.

4.2. Definition of the different categories of livestock

The minimum indoor and outdoor areas required for pigs are stated in the Commission Implementing Regulation (EU) 2020/464. In this regulation pigs are categorised depending on (re)production status and weight in Part III as followed:

- Farrowing sows with piglets until weaning
- Fattening porcine animals, weaners, rearing pigs, gilts, rearing boars
- Not more than 35 kg
- More than 35 kg, but less than 50 kg
- More than 50 kg, but less than 85 kg
- More than 85 kg, but less than 110 kg
- More than 110 kg
- Female brood porcine animal pigs, dry pregnant sows
- Male brood porcine animals, boar

4.3. Behavioural needs of pigs

4.3.1. Resting / lying behaviour

Adult pigs, like outdoor sows, spend approximately 80 % of their daytime resting (Buckner et al., 1998). One third of this time they get into a deep sleep, the rest of the time consisting of light sleep (Ruckebusch, 1972; Zepelin, 1989). Pigs rest in sternal, half-recumbent and full lateral recumbent position. In sternal position, pigs lie on their belly with at least two legs folded under the body, in half-recumbent position pigs lie on the side and half on the belly. In full lateral recumbency, pigs lie on their side with all four legs stretched out (Ekkel et al., 2003).

Pigs in general are seeking for a dry and clean lying area, which they separate from their elimination and feeding area (EFSA, 2022). In a semi natural environment, they build a communal nest within 30 m distance to the feeding place at least (Stolba and Woodgush, 1989). The communal nest has a circumference of 3 m (Stolba and Woodgush, 1989). In nature, they cushion their lying area with bedding material such as straw if available (Gunnarsson, 2018). During the night, animals rest together in a common area, while they rest outside the shelter in smaller subgroups during daytime (Stolba and Wood-Gush, 1989; Rodríguez-Estévez et al., 2010; reviewed by Wimmler et al., 2022). Under semi-natural conditions, pigs choose sheltered lying areas, protecting them from wind and rain (Stolba and Wood-Gush, 1989). Under commercial conditions, pigs prefer to lie in places that are protected from draught, for example next to solid pen partitions (Jackson et al., 2020). Under organic conditions, pigs with access to an outdoor run lie outdoors during daytime, even though they have access to an indoor area with straw bedding (Olsen et al., 2001).

Pigs also prefer to lie within their thermoneutral zone (Stolba and Woodgush, 1989; EFSA, 2022). During hot dry days wild boars seek the moist forest for cooling down, while during cold days they choose a resting place exposed to the sun (Allwin and Swaminathan, 2016).

4.3.2. Locomotion

Pigs living in a semi-natural environment devote a significant amount of their time to exploration and moving between different parts of their habitat (Stolba and Wood-Gush, 1989). This can be traced back to their wild relatives, who are known to spend over 50% of their time moving each day (Erdtmann and Keuling, 2020; Morelle et al., 2015), covering an average of 7.2 km/day (Podgórski et al., 2013) and up to 12 km/day (Morelle et al, 2015). While the motivations to do so are multiple in wild pigs (foraging exploration, traveling between foraging patches, running away from predators, dispersal (Allwin and Swaminathan, 2016; Cahill et al., 2003; Keuling et al., 2008; Morelle et al., 2015)), it is hardly applicable to domestic pigs living in housing systems. Indeed, the artificial conditions in which they live often deprive pigs from experiencing such natural stimuli. Yet, pigs raised under conventional conditions also show a strong motivation to move, with animals walking on average between 2316 m and 3605 m per day (Kalbe et al., 2018), however with a reduction of locomotor behaviour on slippery floors (Thorup et al., 2007).

The captivity experienced by domestic animals seems to lead to more adapted ankle bone anatomy to resist the loads (from increased body mass) induced by reduced locomotion (Harbers et al., 2020). Furthermore, as a result of multiple generations of selective breeding, osteochondrosis – but not lameness – can be more commonly found in free-ranging pigs (Etterlin et al., 2015). However, despite adaptive processes observed at the molecular level, the muscular phenotype (skeletal muscles) is not modified at the tissue level by locomotor behaviour, likely because pig movements are too reduced (Kalbe et al., 2018). Specific breed requirements are therefore to be expected in terms of locomotor behaviour needs.

Finally, pigs have advanced path integration abilities, allowing efficient orientation during locomotor behaviour (Broom et al., 2009; Morelle et al., 2015) and showing the importance of locomotion in pig ecology. This built-in behaviour is relevant to multiple other contexts, as pigs' locomotion can occur simultaneously with various other activities such as foraging and social interactions (Erdtmann and Keuling, 2020; Morelle et al., 2015). Note that this description is limited to terrestrial locomotion and does not include swimming, which is a locomotion mode that (wild) pigs are very capable of (Morelle et al, 2015; Allwin & Swaminathan, 2016).

4.3.3. Social behaviour

Pigs live naturally in small groups, with the exception of adult boars, who live a solitary life (Gonyou, 2001). Each group consists of two to four sows with their offspring and juveniles (Graves, 1984; Mauget, 1981). The sows live in long-term social relationships and mature sows are dominant over sub-adults and juveniles (Marchant-Forde, 2009; Mauget, 1981). Within a social group, aggression is rare. In nature, pigs only compete for limited resources such as for instance food (Jensen & Wood-Gush, 1984; Marchant-Forde, 2009). Juvenile boars leave the social group at approximately 7-8 months of age and live in non-breeding times in groups of two or three pigs. An adult boar joins the group during the mating season. He assumes dominance over all members of the group at this time (Fradrich, 1974; Gonyou, 2001; Graves, 1984). Each social group has its own home range and groups do not interact and avoid open confrontation, unless when food resources become rare (Gabor et al., 1999; Gonyou, 2001; Marchant-Forde, 2009).

4.3.4. Feeding and drinking behaviour

Pigs are omnivorous animals with a high level of flexibility and adaptability with respect to feed composition. The composition of wild boars' diet varies across regions and seasons. However, under natural conditions the main share consists of above-ground plant material (Ditchkoff and Mayer, 2009; Ballari and Barrios-Garcia, 2014). The behavioural complex related to feed intake includes grazing, rooting, foraging, nosing, sniffing and chewing. Domesticated pigs released into a semi-natural habitat spent 31 % of the daylight period "grazing", 21 % "rooting" and another 5 % "manipulating" or "nosing" objects (Stolba and Wood-Gush, 1989). In commercial housing systems, especially when fed restrictively, "feeding" is estimated to account for 1 % to maximum 10 % of total time budget (Gonyou et al., 1992; Li et al., 2012; Broom and Fraser, 2015), depending on feeding technique, availability and feeding space to animal ratio.

Pigs show a diurnal rhythm for feed intake: the times with highest feed intake typically occur early in the morning and in the afternoon (de Haer and Merks, 1992). Pigs prefer to eat during cooler periods of the day (Feddes et al., 1989). Feeding also occurs at night, but less frequently so (Morgan et al., 2000; Bigelow and Houpt, 1988). Around 64 % of daily food intake and 68 % of water intake were found to occur during the 12-hour light period, as described in Bigelow and Houpt (1988). When growing-finishing pigs grow older, the frequency of eating bouts decreases (Bigelow and Houpt, 1988). Pigs show a high level of behavioural synchronicity for feeding. This begins already after birth with all piglets within one litter suckling at the same time. Under natural conditions pigs prefer to forage synchronously but with an average distance to the other group members of around 4 m (Stolba and Wood-Gush, 1989). Larger distances between feed sources reduce aggressive interactions (Thomsen et al., 2010).

Drinking only accounts for about 1 % of the daily active time in a semi-natural environment (Stolba and Wood-Gush, 1989). For young pigs in a commercial housing system with nipple drinkers it was found to be even a bit less, while drinkers were visited around 44 times per day

(Andersen et al., 2014). Temporally, drinking is closely linked to feed intake. 75% of the water intake is associated with the pigs' feed intake and thus also mirrors feeding behaviour (Bigelow and Houpt, 1988). Feed-deprived pigs consume more water, probably to reduce the hunger sensation (Yang et al., 1981). Pigs drink from water surfaces by sucking the water in, without dipping the snout completely into the water.

4.3.5. Exploration behaviour

Most feed-related behaviours that have been described above can also be motivated by curiosity and serve the purpose of gathering information about the environment and reducing uncertainty, especially with respect to feed sources (Wood-Gush and Vestergaard, 1989; Studnitz et al., 2007). Additionally, exploratory behaviour may serve the goal of finding an appropriate place to lie down. Exploratory behaviour which is not directly linked to feed intake has been called "inspective exploration" (Wood-Gush and Vestergaard, 1989), while exploratory behaviour related to feeding is called foraging.

Rooting, sniffing, biting and chewing on food items or indigestible objects are part of the exploratory behavioural complex. These behaviours can be divided into an appetitive complex (= exploratory behaviour) and a consummatory complex (= feed intake behaviour). While commercial pig feed satisfies the consummatory part and provides nutrients and energy, the appetitive part is more difficult to satisfy. In many commercial systems there is no appropriate material to display these behaviours.

Exploratory behaviour is best stimulated by materials that are complex, changeable, destructible, manipulable, and contain sparsely distributed edible parts (Studnitz et al., 2007). A comparison of several preference tests with pigs showed that pigs prefer materials for exploration in the following order: edible materials (e.g. carrots, maize silage), earth-like materials (peat, compost, mushroom compost), wooden materials (sawdust, bark chips), straw, sand, ropes, paper, chains (Studnitz et al., 2007). Exploratory behaviour is closely linked to locomotion as pigs are usually moving while exploring.

Pigs have a very high motivation to perform rooting behaviour, even when they are fed *ad libitum*. The time spent rooting increases when feed is restricted (Day et al., 1995). Rooting is also stimulated by novelty (Studnitz et al., 2007). If pigs are prevented from rooting (e.g. with nose rings) they increase the duration of other exploratory behaviours (Studnitz et al., 2003). A lack of opportunities to perform exploratory behaviour in general is known to be one of the main causes of abnormal behaviour such as tail biting. Tail biting can indeed be regarded as redirected exploratory behaviour towards pen mates (Schröder and Simmonsen, 2001; Studnitz et al., 2007).

4.3.6. Thermoregulatory and comfort behaviour

Thermal comfort zones in pigs differ depending on their age class (itself correlated with body weight). While temperatures of around 34°C are appropriate for new-borns, they range 25–30 °C for 4–6 kg piglets, 25 °C for piglets aged 8–14 weeks (SVC, 1997; Bracke, 2011) to around 16–20°C for pigs of 30–60 kg and 14–20°C for finishing pigs and adult females (Kyriazakis and Whittemore, 2006). Despite these requirements, pigs are highly limited in their ability to sweat in order to regulate their body temperature (Montagna and Yun, 1963). In general, they rely on mechanisms such as radiation, convection, conduction and evaporative cooling (Bruce and Clark 1979; Ingram, 1965; Nannoni et al., 2020). Some of the behaviours they display accordingly include huddling together and lying sternally on the floor when cold, spreading away from one another and lying on the side when hot (Olsen et al., 2001). They also exhibit preferences for cool surfaces, as indicated by a shift in their preferred lying area from

the straw-bedded area to concrete floor with increasing temperature (Olsen et al., 2001; Wimmler et al., 2022).

Besides being directly influenced by external temperature, humidity and air velocity (Collier, 2012), pigs' internal temperature is affected by their metabolic activity, in turn dependent on feed intake, feed composition and stocking density (Mount, 1979; Yousef, 1985; Nannoni et al., 2020). To compensate the little flexibility that pigs have to physiologically accommodate to extreme temperatures, both wild boars and domestic pigs kept in semi-natural conditions employ a strategy known as wallowing, defined as the covering of the body in mud or a mud-like substance (Erdtmann and Keuling, 2020; Bracke, 2011). Wallowing appears to be innate, as domestic pigs with no prior wallowing experience display this behaviour when given the opportunity (Fraser, 1970; Bracke et al., 2011). Pigs also naturally prefer shaded areas (Olsen et al., 2001), also during wallowing when temperatures are very high (> 35.5°C under arid [dry] conditions; > 27°C in humid conditions) (Bracke et al., 2011). It is to be noted that pigs make little use of an unshaded wallow after the water temperature reaches 35°C (Garrett et al., 1960; Bracke et al., 2011). In line with the fact that water in mud on the skin of a pig took 2 h to evaporate (compared to 15 min when only water was used), a preference has been shown for wallowing in mud over wallowing in water (Jensen, 2002; Bracke et al., 2011) and over wallowing/soiling in faeces (Huynh et al, 2005), which pigs do when faced with no other option to cool down (Bracke, 2011; Kyriazakis and Whittemore, 2006). However, cooling with water only, e.g. through the use of showers, is a viable alternative (Huynh et al., 2006; Jeppsson et al., 2021; Wimmler et al., 2022).

Wallowing also takes on additional functions to that of thermoregulation, as it enables pigs to coat with a mud layer that can be protective from insect bites (Ratnakaran et al., 2017; Nalin, 1996) and sunburns (Gegner, 2001; Bracke, 2011). Combined with (or rather, followed by) rubbing and scratching on surfaces like tree bark (once the mud has dried), wallowing in mud pools also helps pigs remove ectoparasites from their skin, which they could not reach otherwise (Campbell and Long, 2009; Bracke, 2011). Wallowing also seems to have a social dimension, as pigs often wallow in groups and social dominance interactions have been observed at wallows (Bracke, 2011). Finally, wallowing has been suggested to enhance well-being simply by generating pleasure/positive feeling in pigs (Bracke, 2011), since this behaviour can be observed yearlong (Allwin and Swaminathan, 2016).

Other pig comfort behaviours include stretching, shaking, rubbing, nibbling, scratching, rolling (Erdtmann and Keuling, 2020). Social grooming has also been documented in feral pigs (Stolba & Wood-Gush, 1989) as well as in pigs kept indoors (Camerlink et al., 2022), calling for more investigation into this behaviour.

4.3.7. Elimination behaviour

Elimination behaviour includes both urination and defecation. Pigs are naturally motivated to separate the elimination area from other areas such as those dedicated to resting and feeding (Olsen et al., 2001; Nannoni et al., 2020). In semi-natural conditions, there is indeed a minimum distance of 5 m separating the elimination and the resting areas, while elimination also occurs while pigs move between foraging patches (Stolba & Wood-Gush, 1989). This behaviour develops very early in piglets, who move to the edge of the nest to eliminate within 5 days after birth, and the distance between resting and elimination area then increases with age (Andersen et al., 2020). Hygiene maintenance thus seems paramount in pigs, and soiling with faeces and urine is only found for thermoregulation purposes when animals face extreme weather conditions (see section 4.3.6 'Thermoregulatory and comfort behaviour').

Pigs also seem to prefer eliminating in well-lit, draughty, wet and safe (in the sense of away from conspecifics) places (Olsen et al., 2001; Taylor et al., 2006; Nannoni et al., 2020). In particular, elimination appears to be facilitated by water, as it is often observed in wet areas and/or maybe through the close temporal association between drinking and elimination (Hacker et al., 1994; Vermeer et al., 2015; Olsen et al., 2001; Nannoni et al., 2020).

Although there is no clear scientific consensus as to whether pigs are territorial or not (Andersen et al., 2020), they often eliminate near pen walls (with open partitions) delimiting adjacent pens (Nannoni et al., 2020). Furthermore, although olfaction does seem to play a role in eliciting elimination behaviour (Erdtmann and Keuling, 2002; Yu et al., 2016), among others in areas of close contact between different groups (Watson et al., 2003: Andersen et al., 2020), this function is yet to be properly investigated.

4.3.8. Sexual behaviour

Sexual behaviour represents maturity, which is accompanied by certain physiological and behavioural changes at its beginning. Females usually become mature at the age of around five to six months (Reiland, 1978) ranging from the 4th to the 7th month of life (Comberg et al., 1978; Hoy, 2009). Male pigs become mature with 3 to 6 months (Comberg et al., 1978; Hoy, 2009).

In gilts, the time of first oestrus depends on body weight and body composition, as well as management factors (e.g. nutrition) or environmental factors (e.g. heat stress) (Evans & O'Doherty, 2001; Knox, 2019). In sows, endocrinal changes after weaning provoke the onset of oestrus. Oestrus in sows typically occurs 4 to 7 days after weaning (Bates et al., 2000) and lasts between 1 to 4 days (reviewed by Soede and Kemp, 1997). In alternative housings with prolonged suckling periods or with intermittent suckling regimes, lactational oestrus may also occur and can be used to induce pregnancy during lactation (Wechsler, 1996; Soede et al. 2012).

In general, sows in oestrus are increasingly active, restless and show a strong internally-driven motivation for social interaction (Pedersen, 2007). In addition, sows' vulva become reddish and swells (reviewed by Soede and Kemp, 1997) and expression of sexual behaviour in sows is characterized by ano-genital sniffing, flank nosing and mounting (reviewed by Pedersen, 2007). The presence of a mature boar or of other sows in oestrus can stimulate oestrus onset (reviewed by Pedersen, 2007). The main characteristic of sows' oestrus is the standing response in presence of a boar (or a human when any contact is applied to the sow, typically pressure on the back) (Soede and Kemp, 1997). The standing response is an expression of sexual receptivity and is used in practice to predict insemination time (Soede et al., 2011).

Entire male fattening pigs show typical signs of sexual behaviour such as mounting (Holinger et al., 2015). Mounting behaviour, in combination with more prevalent agonistic behaviours, have been found to slightly increase the risk for injuries such as skin lesions and lameness in some studies (Rydhmer et al., 2006: Holinger et al., 2015), but not in others (Lange et al., 2021). However, the level of chronic stress does not seem to be increased due to aggressive and sexual behaviours in groups of entire male pigs (Holinger et al., 2018a & 2018b).

4.3.9. Maternal behaviour

Wild and feral sows give birth to their piglets separately from their social group in farrowing nests. They build the nest at a sheltered place around 24 h before farrowing (Jensen, 1986). Under commercial conditions, sows choose to build the farrowing nest inside or against a solid wall (Hunt and Petchey, 1987), but never outside in the open (Baxter et al., 2011). This matches with observations of sows in semi-natural environments, who chose nest sites with 40% total enclosure and 89% partial enclosure (Stolba and Wood-Gush, 1984 in Baxter et al., 2011). The

fully or partly enclosed nest sites provide isolation or protection for potential threats, e.g. inclement weather conditions or predators (Baxter et al., 2011).

Minutes after birth, piglets are able to stand and reach the sow's udder. In order to reach the udder, they orient themselves by olfactory, acoustic, tactile and thermal stimuli (Alonso-Spilsbury et al., 2007; McBride, 1963; Welch and Baxter, 1996). Furthermore, piglets start to establish a teat-order from the first hours after birth (McBride, 1963; Newberry and Wood-Gush, 1985). Finally, teat-order becomes stable between the 7th and 10th day after birth (De Pastille, 1988). During the first week after parturition, a sow nurses her piglets almost 30 times a day (Weary et al., 2008), whereby sows and piglets follow a unique nursing-suckling pattern (Drake et al., 2008).

The sow remains the first days after farrowing together with her offspring in the nest, but steadily increases the time spent eating, eliminating and for social contact with other sows outside the nest (Stolba and Wood-Gush, 1989). During the nest bound period, sows are highly attentive to their piglets, and frequent nose-nose contacts occur between sow and piglets (Drake et al., 2008). Further, during the nesting phase sow and her offspring learn to appropriately react to each other in dangerous situations. For instances, sows learn to respond quickly to their piglets' distress call (Illmann et al. 2015). In addition, sows perform pre-lying behaviour giving piglets the signal that their mother is about to lie down (Drake et al., 2008). Around 10 days after parturition, the sow and offspring leave the farrowing nest and join the social group. The piglets start to socialize with piglets from other litters and their own strong mother-offspring bond gradually breaks up (reviewed by Marchant-Forde et al., 2020). In parallel the nursing frequency initiated by the sow decreases (Jensen & Recén, 1989). Furthermore, piglets start to forage and feed on their own. With the full intake of solid food, weaning is achieved. In nature, weaning is a slow and gradual process and will take about 2 to 5 months (Jensen & Recén, 1989; Newberry & Wood-Gush, 1985).

4.3.10. Play behaviour

Play behaviour is shown most frequently between the age of 2 to 6 weeks and declines thereafter (Newberry et al., 1988). Frequency of play behaviour is regarded as an "iceberg" indicator for animal welfare as it is often reduced in situations that preclude individual fitness (Held and Spinka, 2011). Play behaviour of pigs can be categorized into locomotor, object-directed and social play (Blackshaw et al., 1997; Martin et al., 2015), and is socially contagious (Held and Spinka, 2011). Locomotor play includes behaviours termed as "scamper", "pivot", "toss head", "flop", "hop", "rolling", and "gambolling". Social play consists of "pushing", "nudging", "chasing", "push-overs", "sow climbing" and "sow nudging". Object play includes "shake object" and "carry object" (Martin et al., 2015). While frequency of play behaviour has been investigated, the movement patterns including the covered distances while showing play behaviour are not known.

4.4. Requirements for the functional areas

4.4.1. Activity area

The activity area, if large enough, is the section in which pigs can perform multiple species-specific behaviours, e.g. social, sexual, locomotive, explorative, play, thermoregulatory and comfort behaviours. The activity area of the farrowing pen is the place, where farrowing and suckling occurs or sows and piglets socially interact (see section 4.4.1.3 'Suckling'). The activity area should therefore be designed so that it minimizes spaces that can be deemed appropriate by pigs for elimination behaviours.

For most of the behaviours described in the following subchapters (with exception to farrowing and suckling) it can be assumed that there is no adverse effect when performed outdoors instead of indoors. However, the scientific knowledge about climatic conditions and the impact on the activity behaviour of pigs is very scarce. Sheepens et al. (1991a) reported that pigs exposed to draught are more active than non-exposed pigs. They showed more redirected explorative behaviour on pen mates and exhibited agonistic interactions. Further, on wet days and when temperature falls, pigs spend more time inside (Ingram and Legge, 1970). When pigs are exposed to rain, most of them seek shelter. In contrast, on days of continuous drizzle, pigs spend long periods outside (Ingram and Legge, 1970). Thus, despite the strong potential of an outdoor activity area for enhanced animal welfare, the activity area should also provide shelter against harsh weather conditions.

4.4.1.1. Locomotion and social behaviour

The available space in the activity area should account for the naturally developed locomotion behaviour of pigs, which are animals that typically cover several thousand meters per day (Kalbe et al., 2018). In addition, the activity area should provide enough space in times of mixing and regrouping, because unfamiliar pigs show agonistic interactions (Mount and Seabrook, 1993). For instance, in sows, spatial limitations during mixing can prolong agonistic interactions and can provoke severe skin lesions (Spoolder et al., 2009). Similarly, in pens with insufficient space pigs cannot express nor recognize submissive behaviour (Camerlink et al., 2016, Hemsworth et al., 2013). In addition, sufficiently large activity areas, can provide extra space for escape behaviour. The exact space two pigs need for a fight can be calculated with the following formular from Baxter (1985): $0.11 * W^{0.667}$, whereby W is the bodyweight of the pigs. Furthermore, sexually active pigs show a high level of activity and mount other pigs (Pedersen, 2007), therefore extra space has to be considered in the design of the activity area for dry sows after weaning.

The activity area also provides extra space for play behaviour. The opportunity to display play behaviour is most relevant for young pigs (including growing-finishing pigs). In particular, the play behaviours that are considered as locomotor and social play need adequate space to be properly displayed. Due to the socially contagious nature of play, the required space can be substantial.

In any case, appropriate floor characteristics are a prerequisite to allow locomotion (also for play behaviour) and a solid foothold during agonistic interactions without risking injuries (Wimmler et al., 2022). Relevant floor characteristics to injuries are slipperiness, abrasiveness, hardness, surface profile and thermal properties (Webb and Nilsson, 1983). The regulation (EU) 2018/848 states that organic livestock housings shall have smooth, but non-slippery floors. Although the impact of climate conditions of floorings in outdoor housing has not been evaluated scientifically to date, it can be assumed that climatic conditions such as rain or frost can negatively impact floor characteristic in outdoor housings.

4.4.1.2. Exploration

Additionally, the activity area is the place best suited to provide access to enrichment material to keep pigs active and stimulated. Besides tokens aimed at entertaining pigs (Godyń et al., 2019), enrichment material has to be investigable, manipulatable, chewable and edible (Studnitz et al., 2007). Object play can be stimulated by hanging and attached objects, and by substrates such as straw or roughage (Bracke et al., 2006; Godyń et al., 2019; Guy et al., 2013). In any case, it has to be ensured that access to enrichment material is provided sufficiently, because pigs prefer to be active simultaneously (Wimmler et al., 2022) and limited access to a high valued resource can provoke agonistic interactions (Turner et al., 2000). Specifically focusing

on entire male pigs and their more active and aggressive behavioural expressions, it has been found that an enriched environment (i.e. straw, outdoor run and more space) compared with a barren environment did not necessarily reduce aggressive interactions (Tallet et al., 2013) but significantly reduced the prevalence of skin lesions (Prunier et al., 2013). It can therefore be concluded that entire male pigs are also especially in need of an appropriate environment in terms of space and structure in order to safely display their natural behaviours.

4.4.1.3. Suckling

In the free farrowing pen, the activity area often functions as farrowing and suckling area and is used both by the sow and piglets. However, an overlap with the excretory area, the nest or feeding area should be prevented, due to impaired hygiene and the risk of negative health consequences during (the consecutive) lactation (Baxter, 2011). When given the opportunity, the sow will clearly divide the farrowing pen in a nesting and elimination area (Pedersen et al., 2013). In any case, the suckling area provides space for nest building, farrowing, suckling, lying, locomotion and social interactions.

In organic pig husbandry, bedding is normally provided in the suckling area, and will be used by the sow as nest building material (Baxter et al., 2011). Additionally, sows often choose the suckling area as nesting area, because this area is traditionally located inside in an organic farrowing housing and sows prefer to farrow in places where they are protected from inclement weather or any other disturbances (Baxter et al., 2011, Pedersen et al., 2013). When the sow builds the farrowing nest, she is normally circling around, thus she also needs enough space to turn around (Baxter et al., 2011; EFSA, 2022). For parturition Baxter et al. (2011) recommended a minimum floor space of at least 2.79 m² for a 350 kg sow, who bears in lateral position piglets with a live weight of 1.6 kg. In addition to the physical dimensions of the sow, space needed for sow's postural changes has to be provided (Pedersen et al., 2013). The risk of crushing piglets often occurs when the sow changes her posture from standing to lying or when rolling (Damm et al., 2006, Weary et al., 1998).

After birth, the size of the pen has an effect on suckling behaviour. There exists scientific evidence, that piglets in larger pens spend more time at the udder and perform more suckling behaviour compared to piglets in smaller pens (Cronin et al., 1998, Lohmeier et al., 2019). Furthermore, sows and piglets use extra space for locomotion and social interactions (Lohmeier et al., 2019, Zhang et al., 2020). When the sow suckles her piglets, she lies laterally with all four legs stretched out. Furthermore, piglets need enough space to suckle, because the lack of space might prevent them from gaining access to their preferred teat, which can in turn provoke teat fighting and unstable teat-order especially in large litters. For conventional housings, Moustsen and Poulsen (2004, cited in Baxter et al., 2011) recommend a width of a minimum of 0.50 to 0.60 m between the sow's udder and any solid surface to allow 4 – 5-week-old piglets to all suckle comfortably. For organic housings, more space must be considered due to the prolonged suckling period of at least 6 weeks. Newborn piglets are vulnerable to lower temperature in comparison to their mother. The piglets' lower critical ambient temperature is above 34 °C right after birth (Berton et al., 2003). Thus, piglets need an external heat source to ensure thermal comfort, which is even more important in non-insulated housings. EFSA (2022) pointed 1.2 m² to be reserved in general for the creep area in the farrowing pen.

Due to the fact that, in semi-natural environments, parturition and nesting phases occur predominantly in protected areas, the suckling area should be located inside. This would also account for piglets' sensitivity to low temperatures.

4.4.1.4. Thermoregulatory and comfort behaviour

Each pen should provide areas for thermoregulation and comfort behaviour. In pigs, at high temperatures, almost all thermoregulation processes rely on skin contact with cool surfaces (Olczak 2015). High temperatures lead to changes with respect to where pigs eliminate. They will use an existing elimination area for resting if no efficient means of cooling down is provided to them (Bracke, 2011; Huynh et al, 2005; Kyriazakis and Whittemore, 2006). Wallowing is a key mechanism through which pigs adjust their body temperature, and they use it accordingly with increase in the environment temperature (Bracke, 2011). Late pregnancy sows were even observed using wallows in winter (Buckner et al., 1998). Due to the nature of wallowing (water or mud), the weather-dependent use of wallows made by the animals, and the fact that it helps with other comfort behaviour (e.g., parasite removal when combined with scratching), wallowing should be preferably located outdoor and with the possibility to be shaded in case of extreme high temperatures. Regardless of the behavioural context, pigs exhibit a strong preference for shade when temperatures are high (Blackshaw & Blackshaw, 1994), and pigs living in outdoor systems actively seek shade or shelter (Olczak et al., 2015), even when temperatures are relatively low (starting above 5 degrees – Ingram & Legge, 1970). As opposed to indoor conditions where temperature can remain relatively controlled, outdoor areas should therefore necessarily include additional means for pigs to thermoregulate efficiently, such as wallows and/or showers (Bracke, 2011; Jeppsson et al., 2021; Wimmler 2022), shaded areas (Olczak et al., 2015), as well as e.g., cool surfaces (Shi et al., 2006). This will not only benefit the animals' comfort but also prevent increased workload and poorer hygiene conditions due to repurposing of the functional areas by pigs finding their own ways (e.g. soiling) to adjust their body temperature.

Other comfort behaviours such as scratching and rubbing are associated with wallowing. Although pigs can rub against trees right after wallowing, they also use other structures for this purpose much later, once the mud on their skin has dried (Bracke, 2011; Bracke et al., 2011; Campbell and Long, 2009). Appropriate rubbing surfaces or brushes should therefore be available mainly outdoor (e.g., near wallows) but may also be present indoor.

4.4.1.5. Rooting behaviour

Within the activity area, a special rooting area can be implemented which is ideally filled with earth-like materials such as compost (see section 4.3.5 'Exploration behaviour'). The presence of a structurally separated rooting area increases the use of outdoor runs (Vermeer et al., 2015; Knoll et al., 2021) and reduces the soiled surface in the outdoor run (Vermeer et al., 2015; Olsson et al., 2016). However, rooting areas can get massively soiled, especially when the weather is cold and wet (Vermeer et al., 2015; Knoll et al., 2021). Rooting areas are very attractive for the pigs and are intensively used. They are not only used for exploratory behaviour but also for resting behaviour, if the climatic conditions are favourable (Knoll et al., 2021). The design and size of the rooting area does not seem to influence rooting behaviour (Olsson et al., 2016). However, Olsson et al. (2016) found that, in terms of ammonia emissions, a large rooting area (approx. 0.5 m2 per pig) with one high wall was a better design (i.e. showed reduced ammonia emissions) than smaller areas or areas with lower walls.

4.4.2. Lying area

The lying area for pigs should provide thermal and lying comfort at both very warm and cold periods (Botermans and Andersson, 1995). In organic farming, a bedded lying area is required (Regulation (EU) 2018/848), whereby straw is mostly chosen as bedding material, which provides lying comfort, but also functions as thermal insulation (Correa et al., 2009; Hötzel et al., 2009). Straw should be provided in great amount at low temperatures to provide thermal comfort (Hillmann et al., 2004; Tillmanns, 2022), but at high temperatures pigs favour cold

floor (e.g., concrete – Fraser, 1985, Olsen et al., 2001, Shi et al., 2006), and great amounts of straw may lead to thermal discomfort. In this case, pigs will engage in soiling in excrements and urine if no cooling systems has been implemented in the housing design (Bracke, 2011) (see section 4.4.1.4 'Thermoregulatory and comfort behaviour').

Furthermore, the lying area should allow pigs to establish a microclimate and to rest and lie within their thermoneutral zone. At insufficient thermal conditions pigs adapt their lying behaviour to cope with climatic discomfort (Botermans and Andersson, 1995) (see section 4.4.1.4 'Thermoregulatory and comfort behaviour'). Relevant thermal parameters that influence thermal comfort in the lying area are temperature, relative humidity and air velocity (Costa et al., 2013, Sällvik and Walberg, 1984). In non-insulated housings, the exposition at moderate and low temperature to air draught (with velocity and temperature as key characterizing parameters) represents a climatic stressor and provokes animal health and animal welfare problems (Sheepens et al., 1991a and b, Sällvik et al., 1984). Pigs exposed to draught might huddle already at moderate temperatures (Botermans and Andersson, 1995). On the contrary, at high ambient temperatures pigs feel comfortable when there is some fresh wind (Botermans and Andersson, 1995). Jeppson et al. (2021) found that pigs spent significantly more time lying in the lying area with the highest air velocity during periods with high ambient temperatures. In addition, pigs' intention to lie without body contact is affected by the amount of wind (Olsen et al., 2001). Furthermore, the level of humidity affects total duration of lying, duration of lying without body contact and total duration of lying on the belly (Olsen et al., 2001). Thus, outdoor systems should offer wind-sheltered areas for pigs at moderate and low temperatures (Olczak et al., 2015) and enough space to do so for lying to lose body heat at high temperatures (Huynh et al., 2005).

As pigs adapt for different lying positions with regard to thermoregulation and their need for comfortable lying, the lying area in commercial housings has to provide sufficient space. The minimum space allowance required for different lying postures can be calculated using a formula developed for finishing pigs by Petherick (1983) and by Ekkel et al. (2003). For, instance, the minimum space allowance required for a pig lying in full lateral recumbency can be estimated as: Area = $0.047 \times W^{0.667}$, whereby W = live bodyweight of the pig. However, regarding the fact that the lying area has to provide thermal and lying comfort, the lying area should at least allow all pigs to lie simultaneously in half-recumbent position. Indeed, in half-recumbent position pigs can lie relatively comfortably and it still enables them to establish an appropriate microclimate during cold conditions. Besides, during hot weather periods, pigs prefer to lie in full recumbency to dissipate body heat (Wimmler et al., 2023), but prefer cool floors outside of the littered lying area for this purpose. The minimum space allowance for lying in half-recumbent position can be estimated as: Area = $0{,}033 \times W^{0.667,}$ whereby W = live weight.

4.4.3. Elimination area

Elimination areas need to be implemented away from resting/lying and feeding areas, as pigs do not naturally eliminate in or near these (Stolba and Wood-Gush, 1989; Olsen et al., 2001). The pen design should also account for the fact that pigs seek isolation/minimal disturbance by conspecifics when eliminating (Baxter, 1982; Nannoni et al., 2020). In addition, elimination behaviour is associated with wet conditions that can for instance exist close to drinkers and wallows. Finally, elimination areas require a proper design to be cleaned up and they are responsible for NH_3 emissions (resulting from the mixing of manure and urine) (Philippe et al., 2011; Olsson et al., 2014; Wimmler et al., 2022). These emissions however can be reduced thanks to dilution by rain and/or showers, and by better draining surfaces such as metal & plastic (as compared with concrete floor, although this may be conflicting with the need for non-slippery floor surfaces) (Jeppsson et al., 2021; Philippe et al., 2011; Wimmler et al., 2022). For all these reasons, the elimination area largely appears to be best suited when integrated within

the outdoor (as opposed to indoor) section of organic housing systems. The main drawback with placing the elimination area outdoor is the fact that the soiled surface is usually bigger as compared with indoor housing (Olsson et al., 2014). Yet, this is often due to poorly arranged functional areas and various suggestions have been made to optimize the appropriate use of elimination areas by animals (both by reinforcing the use of the elimination area for elimination and by reducing the use of other functional areas for elimination – Nannoni et al., 2020).

The need to keep the elimination area well delimited is also determinant for the successful implementation of other welfare improvements. For instance, pigs rapidly lose interest in enrichment materials that are soiled with dung (Bracke, 2007 – but see Beaudoin et al., 2019) and choose to lie in the elimination area when other areas do not provide opportunities to cool down at high temperatures (Nannoni et al., 2020). Finally, the floor surfaces should not be slippery (since this can prevent pigs from adopting their typical posture during excretion – Randall et al., 1983), and should be selected to reduce splashing, as this has been suggested as a potential source of discomfort for pigs (Nannoni, 2020).

4.4.4. Feeding area

In semi-natural environments, pigs spend a lot of time with feed-related behaviour and feed intake (see section 4.3.4 ‘Feeding and drinking behaviour’ and section 4.3.5 ‘Exploration behaviour’). Thus, from an animal point of view, *ad libitum* feeding is advantageous because pigs can spend more time feeding. Moreover, stressful situations shortly before feed provision are avoided. Nevertheless, simultaneously feeding is only partially possible if fed *ad libitum* with feeders that accommodate limited feeding places. In most pig production units, especially in pregnant sows, restrictive feeding is common. In cases where pigs are fed restrictively, enough space at the feeding trough has to be provided, so that pigs can feed simultaneously and for subordinate pigs to also get access to food. The required minimal feeding space can be deducted from the age-dependent body size. Feeding places should be protected from adverse weather conditions, independently from feeding *ad libitum* or restrictively, in order to prevent moulding of the feed and to give optimal access to the feeding places for all pigs throughout the day. Feeding places should not be permanently exposed to direct sunlight in summer or rain.

Restrictive feeding of pregnant sows shall prevent excess of body weight gain and fat deposition, which can cause farrowing and locomotion problems and subsequently reduce reproductive performance (Meunier-Salaün et al., 2001). Pregnant sows can be fed individually (e.g. in feeding stalls or Electronic Sow Feeders (ESF)) or collectively (e.g. in floor feeding). In group-housed sows the common feeding system is individual (lockable) feeding stalls. These stalls ensure simultaneous feeding and protect subordinate sows from entrance of dominant sows (Andersen et al., 1999). A second common feeding system is the ESF. The system allows greater control over individual feed intake of a sow, but sows cannot feed simultaneously. The ESF is commonly used for large dynamic groups and a single feeder is used for 40-60 sows.

Restrictively fed pigs are often not satiated and hunger provokes a lot of abnormal behaviours, such as for instance stereotypies in sows (Meunier-Salaün et al., 2001). Racks filled with *ad libitum* roughage can help increase satiety in all pig categories but especially in pregnant sows (Verdon et al., 2015) and reduce competitive behaviour around feeding (Gjein and Larssen, 1995). Additionally, roughage provision has been shown to significantly reduce the prevalence of gastric ulceration in finishing pigs (Holinger et al., 2018a and 2018b).

In the observations by Stolba and Wood-Gush (1989) most pig groups in a semi-natural environment installed their nests at least 30 m away from the place where they were fed. Thus, feeding places should be separated from elimination and lying areas.

Presence of a drinker in the outdoor run (additionally to the one indoors) may increase indoor pen fouling (Vermeer et al., 2015). This is due to the observation that the outdoor drinker area remains relatively clean and becomes the main drinking source, and the indoor drinker area becomes more attractive as secluded location for elimination (Vermeer et al., 2015). However, this does shows that pigs prefer to have the drinker outdoor.

4.5 Conclusions and Animal welfare criteria for the evaluation of innovative pig housing systems

A key determinant with regards to animal welfare consists in providing pigs with the opportunity to display a range of natural behaviours, i.e. behaviours that pigs tend to show under natural conditions (Bracke and Hopster, 2006). The lack of possibilities to express such behaviours can lead to the development of abnormal behaviours (Olczak et al., 2015). In addition to various physiological needs (for instance the need for food, water, and thermal comfort) animals have evolved cognitive-emotional systems to deal with a variable environment (Bracke and Hopster, 2006). In this context, exposure to changing environmental stimuli seems necessary for animals that naturally occupy outdoor habitats. In line with the incentive to improve welfare in (organic) pig production, implementing both covered and uncovered outdoor areas (allowing both the exposure to changing environmental stimuli and the display of natural behaviours) thus appears necessary for appropriate breeding & housing of domestic pigs.

Below we briefly summarize the main behavioural needs of domestic pigs. We build up on this background knowledge to present a list of criteria. These criteria should help evaluate the extent to which housing systems that do not fully comply with the current EU organic regulation (in terms of indoor and outdoor areas) provide the preconditions for improved pig welfare. This evaluation is made with a particular focus on the distinction between indoor and outdoor spaces and is not intended to assess general housing characteristics outside of this scope (such as floor conditions, general pen dimensions, etc...).

Feeding: Pigs prefer to feed in cool conditions when it is hot. Pigs avoid heavy rain when foraging.

Lying: Pigs naturally rest in a nest, close to their group members. They prefer a sheltered area for this purpose. Pigs show a variety of lying positions. Under commercial conditions, the lying area should provide thermal and lying comfort. Thus, the size of the lying area should allow pigs at least to lie simultaneously in half-lateral recumbency, in order to establish a sufficient microclimate at cold temperatures and to lie relatively comfortably. Pigs adopt a full recumbency position over warm periods, and during such periods outdoor areas are also assumed to be used for lying.

Elimination: Pigs spatially separate the places where they sleep, eliminate and eat. Pigs prefer to defecate and urinate in areas with the following characteristics: well-lit, draughty, wet, and safe.

Thermoregulation: Pigs adapt to variable climatic conditions through thermoregulatory behaviour. Thermoregulatory requirements change greatly with age and climatic conditions. In particular, younger pigs have higher requirements with respect to heat than older and heavier pigs. Pigs search for cooler areas when temperatures are high. Under such conditions they lie on their side with all legs stretched out, without contact to other pigs, in order to dissipate heat to the ground.

Exploration: The natural habitat of pigs is the forest. There they are exposed to various changing outdoor climatic stimuli and can seek shelter from adverse weather conditions. This allows them to exhibit a wide range of behaviours. A general lack of environmental stimuli can lead to behavioural disorders and boredom.

Maternal behaviour: Sows farrow isolated from the group in nests. The nests offer the offspring protection from adverse weather conditions, among other things. During birth and suckling, the sow lies on her side. The piglet nest is primarily used for suckling, resting and social interaction with the piglets. After an intensive nesting phase (approx. 10 days), the mother returns to the group with her piglets.

Whether innovative pig housing systems that currently do not fully comply with the EU organic regulation can be evaluated as animal welfare-friendly can therefore be assessed using the criteria in Table 2.

Table 2: Criteria for the animal welfare evaluation of innovative pig housing systems.

Behavioural need	Criteria	Fulfilled e.g. by
Feeding	Pigs should not be permanently exposed to adverse weather conditions (e.g. direct sunlight in summer, heavy rain) when feeding.	Roof or shading net above feeder / feeding trough
Lying	The lying areas has to be permanently protected from adverse weather conditions (e.g. rain, draught and direct sunlight,).	Three walls and an adjustable roof above the lying area; thick mattress of straw in winter; curtains etc.
	Pigs need a sheltered place, where they can rest in different lying positions together with their group members. Under commercial conditions, the lying area should provide thermal and lying comfort. Thus, the size of the lying area should allow pigs at least to lie simultaneously in half-lateral recumbency, in order to establish a sufficient microclimate at cold temperatures and to lie relatively comfortably. Pigs adopt a full recumbency position over warm periods, and during such periods outdoor areas are also assumed to be used for lying.	Sufficient space in the lying area, to enable all pigs to lie simultaneously in half-lateral recumbency at least. Adapting group size based on the required space allowance for the lying area and for the specific age group
	The lying area should provide a soft and comfortable underground.	Provision of enough straw
	The lying area should provide an appropriate microclimate for the specific age group. The lying area should be climatically adaptable to facilitate thermoregulation of the animals during permanently adverse weather conditions in summer and winter. This concerns, among other things, the amount of bedding, air speed, humidity and temperature.	Adjustment of the bedding quantity depending on the season; an adaptable roof cover that can be opened or closed; curtains

Elimination	The elimination area should be separated from the lying area and feeding area, preferably outside.	Ensuring a non-overlap of lying area, feeding area and slatted floor areas (the latter being aimed at eliciting elimination)
Thermo-regulation	At high temperatures, sufficient shaded areas and cooling facilities should be available. Especially in the absence of other cooling facilities (shower, wallow), cool surfaces should be available on which the pigs can cool down via heat exchange.	Bare concrete floor available during summer; removable shade covers; water sprinkler/showers placed outdoors
Exploration	Pigs should have free access to both covered and uncovered outdoor areas.	Partially uncovered areas in the outdoor run
Maternal behaviour	The environment in which sows build their nests must provide protection from adverse weather conditions (rain, wind, draught, etc.).	Enclosed pen with the possibility to build a nest
	The position of the nest should take into account the sow's need for isolation in the first days after birth with the possibility to search for food and elimination outside the nest.	Enclosed farrowing and suckling area
	In the nest, it must be possible for sows to give birth and suckle in a lateral position.	Each single nest is large enough to accommodate the sow (lying on her side) and her piglets lying ventrally while suckling from the sow's udder

4.6 References - Pigs

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5. Animal welfare evaluation of exemplary cattle housing systems

Franz-Wippermann, R., Seibt, K. D., Ebinghaus, A., Knierim, U.

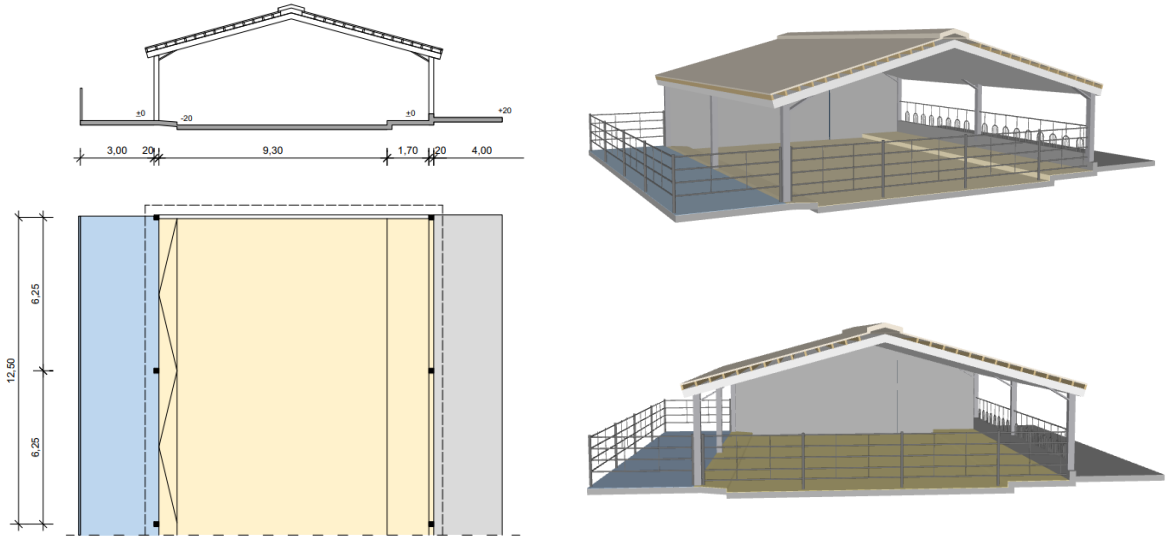
Using the animal welfare assessment criteria developed above and on the basis of expert group discussions, examples of general housing concepts for organic cattle farming which are regarded as relevant in commercial practice (in Germany), innovative and critical in terms of compliance with minimum indoor or outdoor areas set out in Annex I, Part I of EU Regulation 2020/464, because indoor and outdoor areas cannot clearly be distinguished, are presented and evaluated in the following.

Colour key for the following figures

	Indoor climate area
	Roofed area with outdoor climate
	Non-roofed area with outdoor climate
	Feeding table

5.1. Example 1A Open-sided bedded barn with adjacent outdoor loafing area

Suitable for youngstock > 200 kg, beef cattle, suckler cows (in this case with additional calf creep) and dairy cows



Short description:

- loose housing system
- roofed, open bedded lying area (e.g. straw yard)
- roofed, elevated feeding places
- adjacent outdoor walking area with solid concrete floor
- open passage for the animals between indoor lying area and outdoor loafing area

Table 3: Actual versus minimum space allowance (Regulation (EU) 2020/464) for dairy cows in a group without pasture access.

	Indoor area	**Outdoor area**	**Total area**
	m^2/animal	m^2/animal	m^2/animal*
Example 1A	8,25 (roofed)	**2,25 (non-roofed)**	10,5
Regulation (EU) 2020/464 for dairy cows	6,0	4,5	10,5

*Area calculated based on feeding place width of 0,75 m/animal, here 16,66 i.e. 17 animals

Evaluation (1A)

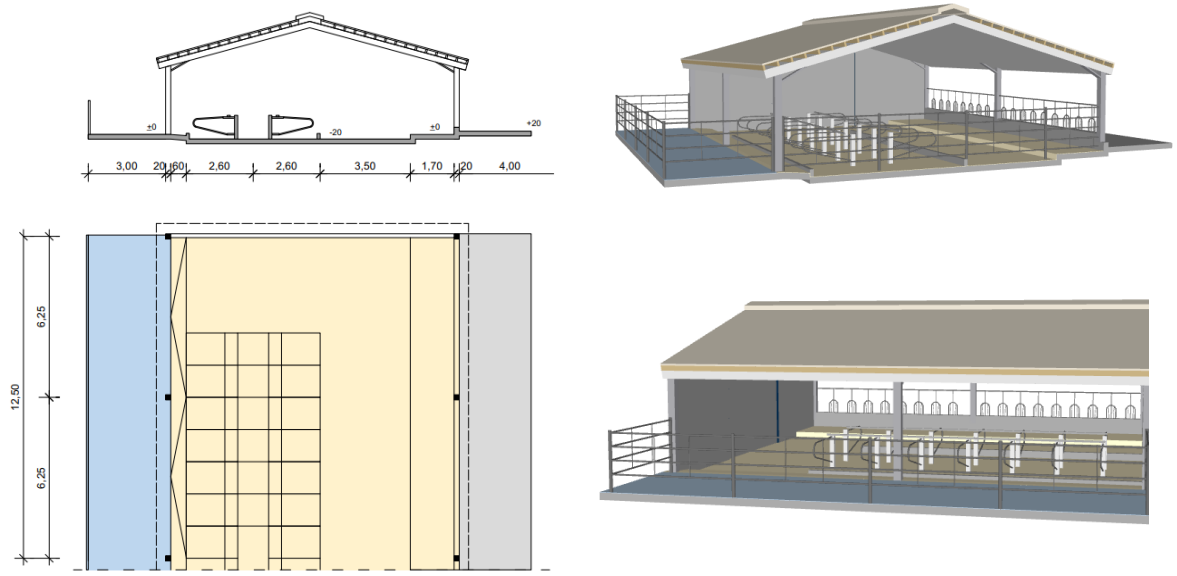
This is an innovative, animal-welfare friendly housing system, because it fulfils all applicable criteria as explained in Table 4.

Table 4: Animal welfare evaluation of open-sided bedded barn with adjacent outdoor loafing area

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by unhindered passage between feeding, lying and exercise (=walking) areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**Fulfilled** by the open front, allowing unhindered passage between indoor and outdoor
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**not applicable**
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled** by sufficient number of roofed feeding places

5.2. Example 1B Open-sided cubicle barn with adjacent outdoor loafing area

Suitable for youngstock > 200 kg, beef cattle, suckler cows (in this case with additional calf creep) and dairy cows



Short description:

- loose housing system
- roofed cubicles
- roofed, elevated feeding places
- adjacent outdoor walking area with solid concrete floor
- wide passages between indoor lying area and outdoor loafing area every 10-12 cubicles

Table 5: Actual versus minimum space allowance (Regulation (EU) 2020/464) for dairy cows in a group without pasture access

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 1B	9,82 (roofed)	**2,67 (non-roofed)**	12,49
Regulation (EU) 2020/464 for dairy cows	6,0	4,5	10,5

*Area calculated based on cubicle places, 1 cubicle/animal, here 14 cubicles

Evaluation (1B)

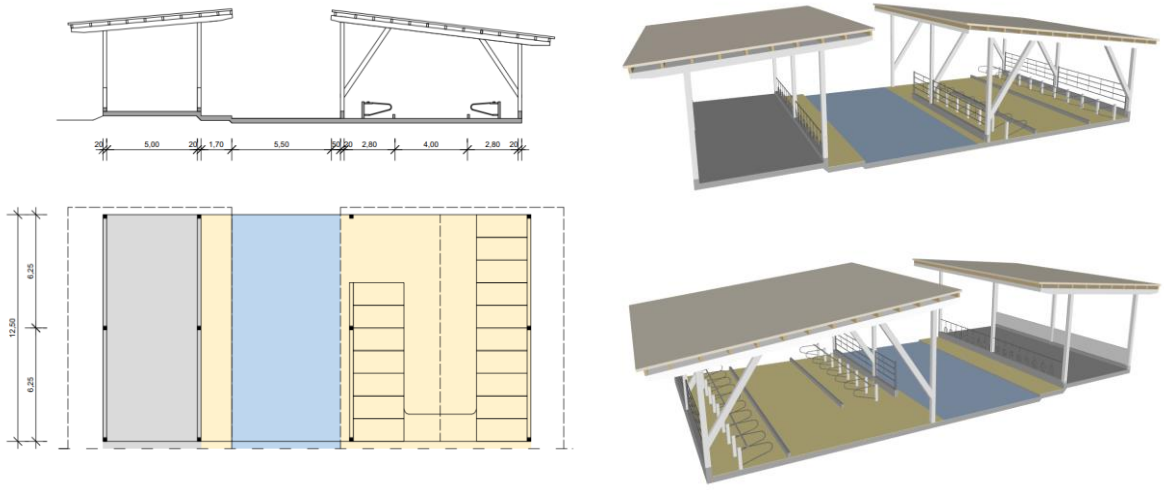
This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 6.

Table 6: Animal welfare evaluation of open-sided cubicle barn with adjacent outdoor loafing area

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by sufficient number of wide alleys between lying and exercise (=walking) areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**Fulfilled** by wide alleys in sufficient number between indoor and outdoor areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**not applicable**
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled** by sufficient number of roofed feeding places

5.3. Example 2A Multi-house open-sided cubicle barn with integrated outdoor loafing area

Suitable for youngstock > 200 kg, beef cattle, suckler cows (in this case with additional calf creep) and dairy cows



Short description:

- loose housing system
- roofed cubicles
- roofed, elevated feeding places
- outdoor walking area with solid concrete floor
- outdoor walking area integrated between lying area and feeding places
- wide passages every 10-12 cubicles between indoor lying area and outdoor loafing area and feeding places

Table 7: Actual versus minimum space allowance (Regulation (EU) 2020/464) for dairy cows in a group without pasture access

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 2A	8,68	**4,04**	12,72
Regulation (EU) 2020/464 for dairy cows	6,0	4,5	10,5

*Area calculated based on cubicle places, 1 cubicle/animal, here 17 cubicles

Evaluation (2A)

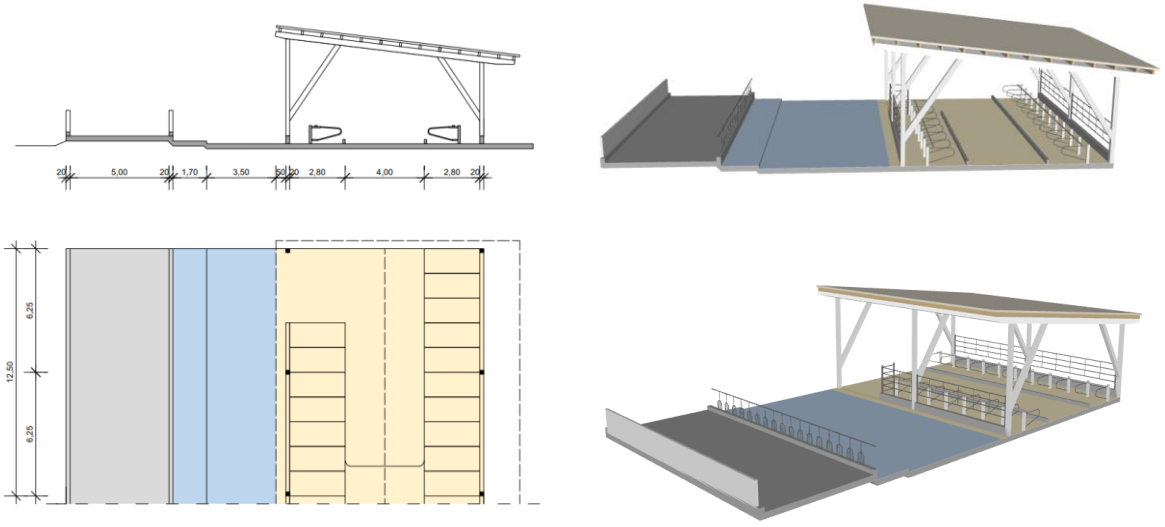
This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 8.

Table 8: Animal welfare evaluation of multi-house open-sided cubicle barn with integrated outdoor loafing area

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by sufficient number of wide alleys between lying and exercise (=walking) areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**Fulfilled** by wide alleys in sufficient number between indoor and outdoor areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation,and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**not applicable**
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled** by sufficient number of roofed feeding places

5.4. Example 2B Multi-house open-sided cubicle barn with unroofed feeding area and integrated outdoor loafing area

Suitable for youngstock > 200 kg, beef cattle, suckler cows (in this case with additional calf creep) and dairy cows



Short description:

- loose housing system
- roofed cubicles
- elevated unroofed feeding places
- outdoor walking area with solid concrete floor
- outdoor walking area integrated between lying area and feeding places
- wide passages every 10-12 cubicles between indoor lying area and outdoor loafing area and feeding places

Table 9: Actual versus minimum space allowance (Regulation (EU) 2020/464) for dairy cows in a group without pasture access

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 2B	7,43	**3,82**	11,25
Regulation (EU) 2020/464 for dairy cows	6,0	4,5	10,5

*Area calculated based on cubicle places, 1 cubicle/animal, here 17 cubicles

Evaluation (2B)

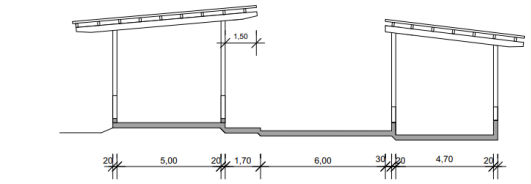
This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 10.

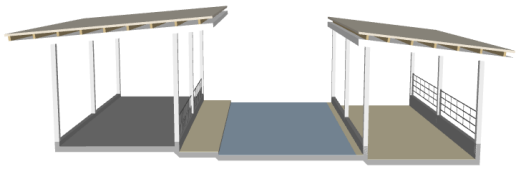
Table 10: Animal welfare evaluation of multi-house open-sided cubicle barn with unroofed feeding area and integrated outdoor loafing area

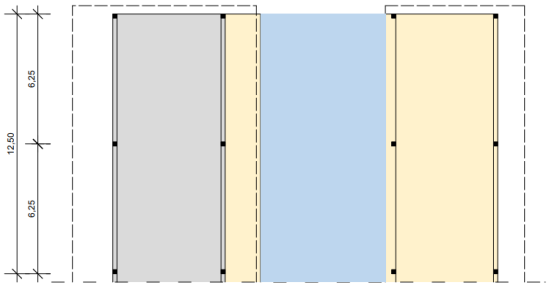
Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by sufficient number of wide alleys between lying and exercise (=walking) areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**Fulfilled** by wide alleys, and in sufficient number between indoor and outdoor areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**not applicable**
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled if** the feeding places can be protected or cooled in case of elevated temperatures, e.g., using water sprinklers, fans, or sun nets

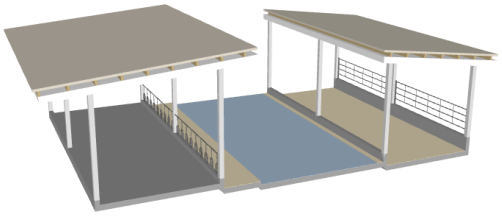
5.5. Example 2C Multi-house open-sided bedded barn with integrated outdoor loafing area

Suitable for youngstock > 200 kg and beef cattle









Short description:

- loose housing system
- roofed open bedded lying area (e.g. straw yard)
- roofed, elevated feeding places
- outdoor walking area with solid concrete floor
- outdoor walking area integrated between lying area and feeding places
- open front between indoor lying area and outdoor loafing area and feeding places

Table 11: Actual versus minimum space allowance (Regulation (EU) 2020/464) for beef cattle or young stock of 400 kg live weight

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 2C	**4,78**	4,56	9,34
Regulation (EU) 2020/464 for youngstock /beef cattle > 350 kg	5,0	3,7	8,7

*Area calculated based on feeding place width of 0,75 m/animal, here 12,5 m length : 0,75 m/animal = 16,66 animals, i.e. **17** animals

Evaluation (2C)

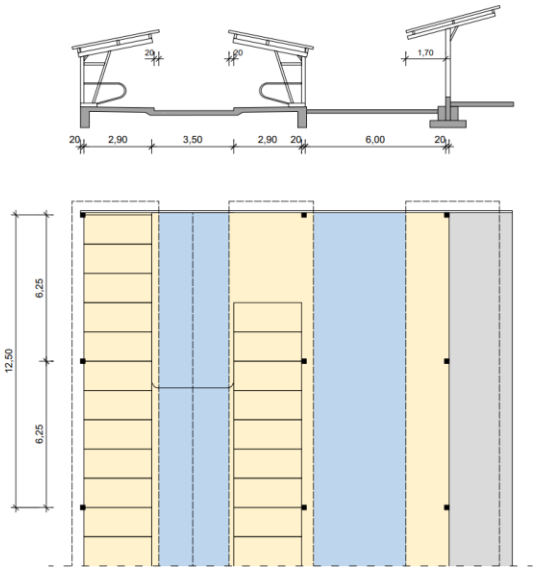
This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 12.

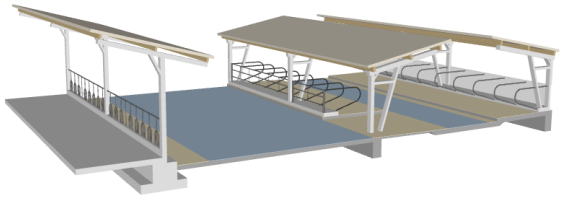
Table 12: Animal welfare evaluation of multi-house open-sided bedded barn with integrated outdoor loafing area

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by unhindered passage between lying, exercise (=walking) and feeding areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**Fulfilled** by the open front, allowing unhindered passage between indoor and outdoor and all functional areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**not applicable**
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled** by sufficient number of roofed feeding places

5.6. Example 3 'Cuccette' barn

Suitable for youngstock > 200 kg, beef cattle, suckler cows (in this case with additional calf creep) and dairy cows





Short description:

- loose housing system
- roofed cubicles
- roofed feeding places
- outdoor walking area with solid concrete floor
- outdoor walking area integrated between lying area and feeding places
- additional outdoor walking area between the cubicle rows
- wide passages every 10-12 cubicles between indoor lying area and outdoor loafing area and feeding places

Table 13: Actual versus minimum space allowance (Regulation (EU) 2020/464) for dairy cows

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 3	**5,36**	5,57	10,93
Regulation (EU) 2020/464 for dairy cows	6,0	4,5	10,5

*Area calculated based on cubicle places, 1 cubicle/animal, here 21 cubicles

Evaluation (3)

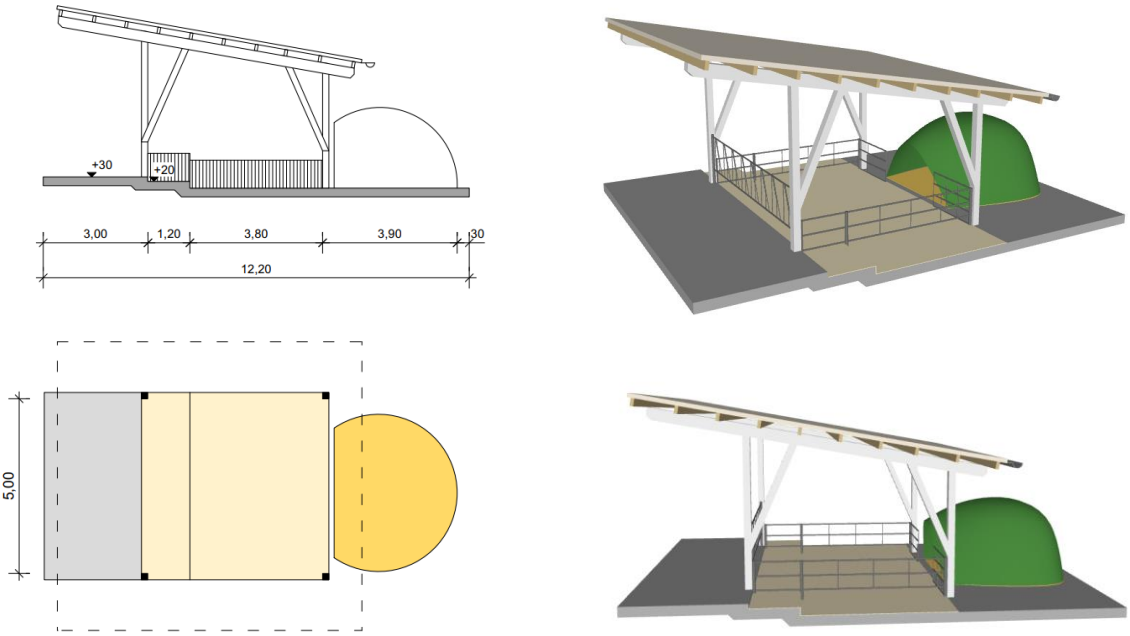
This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 14.

Table 14: Animal welfare evaluation of 'Cuccette' barn

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	Fulfilled by sufficient number of wide alleys between lying and exercise (=walking) areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	Fulfilled by outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	Fulfilled by wide alleys in sufficient number between indoor and outdoor areas
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.	Fulfilled by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	not applicable
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	Fulfilled by sufficient number of roofed feeding places

5.7. Example 4 Igloo with roofed exercise area for groups of calves

Suitable for groups of milk-fed calves (≤ 200 kg)



Short description:

- loose housing system
- roofed open bedded lying area, closed on three sides
- roofed feeding places
- roofed, bedded walking area between lying area and feeding places
- open passage between indoor lying area, walking area and feeding places

Table 15: Actual versus minimum space allowance (Regulation (EU) 2020/464) for calves during the milk feeding period (with up to 200 kg liveweight) in a group without pasture access

	Indoor area	**Outdoor area**	**Total**
	m^2/animal	m^2/animal	m^2/animal*
Example 4	2,8 (roofed with indoor climate/igloo) + 5,0 (roofed area with outdoor climate) = 7,8	**0,0 (unroofed)**	7,8
Regulation (EU) 2020/464 for cattle ≤ 200 kg	2,5	1,9	4,4

*Area calculated for 5 calves of up to 200 kg, roofed area with indoor climate 14 m^2/5 calves.

Evaluation (4)

This is an innovative, animal welfare-friendly housing system, because it fulfils all applicable criteria as explained in Table 16.

Table16: Animal welfare evaluation of igloo with roofed exercise area for groups of calves

Needs	Category	Criteria	Evaluation
Loco-motion	all	Each animal has sufficient space and incentive to move around.	**Fulfilled** by unhindered passage between lying, exercise (=walking) and feeding areas and by distribution of the different functional areas so as to stimulate movement
Social-, exploration behaviour	all	Each animal has access to changing stimuli.	**Fulfilled** by roofed outdoor area where the animals can experience different climatic conditions
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.	**not applicable**
Lying	all	Each animal in principle has access to a dry lying place even in case of precipitation and a sun-protected lying place in case of increased temperatures.	**Fulfilled** by completely roofed lying area
	≤200 kg	Each animal is provided with a lying area protected from draughts.	**Fulfilled** by closed walls around lying area to three sides
Feeding / drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.	**Fulfilled** by sufficient number of roofed feeding places

6. Animal welfare evaluation of exemplary pig housing systems

Schubbert, A., Holinger, M., Seibt, K. D., Garcia, M.

Using the animal welfare assessment criteria developed above and on the basis of expert group discussions, examples of general housing concepts for organic pig farming are presented and evaluated below. These housing systems are regarded as relevant in commercial practice (in Germany), innovative, but critical in terms of compliance with minimum indoor or outdoor areas set out in Annex III, Part I of EU Regulation 2020/464, because indoor and outdoor areas cannot be clearly distinguished.

The evaluation was based on basic drawings of housing systems. The drawings do not provide further details of housing elements, e.g. flooring materials or dimensions of racks for roughage supply etc. The evaluation is made with a particular focus on the distinction between indoor and outdoor spaces and is not intended to assess general housing characteristics outside of this scope (such as floor conditions, general pen dimensions, etc...). The provided pen dimensions might not be applicable for all EU member states, as requirements in specific national animal welfare legislations can exceed these dimensions.

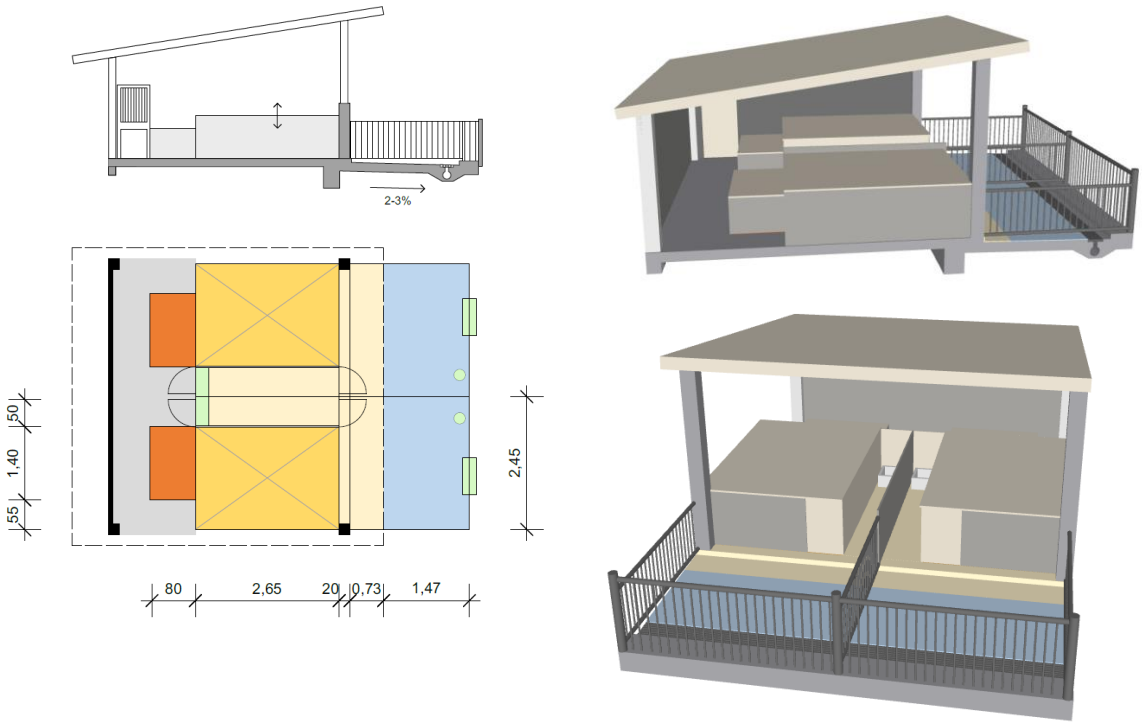
The measures that are suggested in the following tables to fulfil the animal welfare criteria ("Fulfilled under the assumption that") are not exhaustive, other similar measures might be appropriate as well to fulfil the criteria.

Colour key for the following figures

	Creep area
	Indoor climate area
	Roofed area with outdoor climate
	Non-roofed area with outdoor climate
	Feeding and drinking area
	Service alley

6.1. Example 1.1 Open fronted system – Lactating sows

Suitable for lactating sows with their piglets



Short description:
This system provides the animals with three different conditions: an indoor climate area, a small roofed area with outdoor climate and a non-roofed area with outdoor climate. No access to natural floor or pasture is provided. The sows have access to an extra feeding area which is protected by the roof. For the piglets an extra creep area is provided.

Table 17: Actual versus minimum space allowance (Regulation (EU) 2020/464) for lactating sows with their piglets

Area for pigs	**Example 1.1** m^2/sow with piglets	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for sows with piglets until weaning** m^2/sow
Creep area	1,12 (8,6 %)	Indoor area	7,5 (75 %)
Indoor climate area	5,17 (39,8 %)		
Roofed area with outdoor climate	3,11 (23,9 %)	Outdoor area	2,5 (25 %)
Non-roofed area with outdoor climate	3,60 (27,7 %)		
Total area m^2/sow with piglets	13,00 (100 %)	Total area m^2/sow with piglets	10 (100 %)

Evaluation (1.1)

As explained in Table 18, the system has the potential to enhance animal welfare, as long as some requirements are met, namely 1) enough straw is provided in the indoor climate area in winter with a lesser extent in summer, 2) curtains are installed between the 'Indoor climate area' and the 'Roofed area with outdoor climate' in every season to prevent draught, 3) the indoor climate area provides sufficient sow and piglet space (among other things for birth and suckling), 4) the indoor climate area for sow and the creep area for the piglets provides an appropriate microclimate, and 5) adjustable sun-shade is implemented depending on the hours of the day to prevent full sun-exposure when lying in the outdoor area, as well as showers or sprinklers for temperatures reaching above thermoneutral zone.

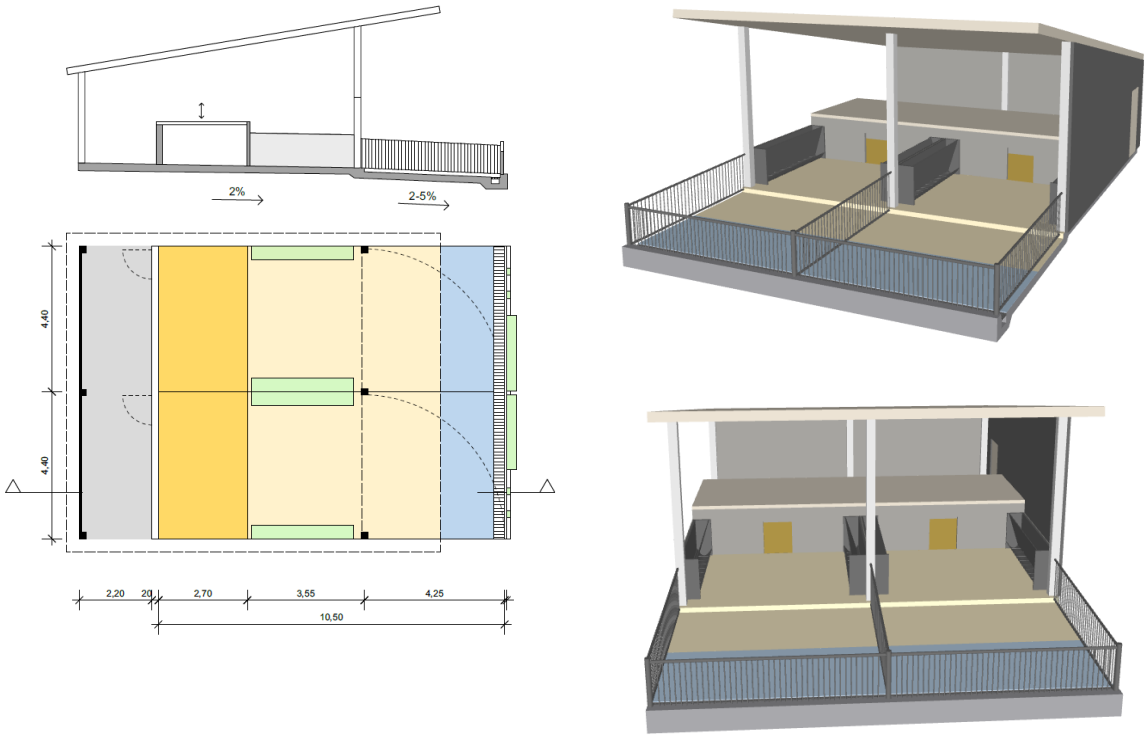
Table 18: Animal welfare evaluation of open fronted system for lactating sows

Criteria	**Evaluation**	**Fulfilled, under the assumption that (comment)**
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	Curtains are installed in every season at the entrance of the indoor climate area.
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	In addition to the sow space, the piglet creep area provides sufficient space for all piglets to lie simultaneously.
A comfortable lying area is available at all times.	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	1) During hot weather, the lid above the lying area is opened to increase air circulation. 2) During cold weather, additional straw is provided; curtains are installed. 3) Heating for piglets is provided in each season.
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.

The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas, cooling facilities (shower, wallow), cool surfaces).	Fulfilled	1) Additional sun-shades are deployable upon sun exposure, during hot seasons, because the shade provided by the roof will vary at different times of the day. 2) Further cooling possibilities for the sow are provided during hot seasons.
Pigs have access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	Fulfilled	
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	Fulfilled	
In the nest, it is possible for sows to give birth and suckle in a lateral position.	Fulfilled	

6.2. Example 1.2 Open fronted system - Weaners

Suitable for weaning piglets



Short description:
This system provides the animals with three different conditions: an indoor climate area, a roofed area with outdoor climate and a non-roofed area with outdoor climate. No access to natural floor or pasture is provided.

***Table 19**: Actual versus minimum space allowance (Regulation (EU) 2020/464) for weaners not more than 35 kg*

Area for pigs	**Example 1.2**	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for fattening porcine animals / weaners ≤ 35 kg**
	m^2/ animal *		m^2/animal
Indoor climate area	0,35 (25,7 %)	Indoor area	0,6 (60 %)
Roofed area with outdoor climate	0,73 (53,7 %)	Outdoor area	0,4 (40 %)
Non-roofed area with outdoor climate	0,28 (20,6 %)		
Total area m^2/animal	1,36 (100 %)	Total area m^2/animal	1 (100 %)

*Area calculated based on 34 weaning piglets weighing ≤ 35 kg

Evaluation 1.2

As explained in Table 20, the system has the potential to enhance animal welfare, as long as some requirements are met, namely 1) enough straw is provided in the indoor climate area in winter with a lesser extent in summer, 2) curtains are installed between the 'Indoor climate area' and the 'Roofed area with outdoor climate' in every season to prevent draught 3) the implementation of adjustable sun-shade over the 'Non-roofed area with outdoor climate' depending on the hours of the day to prevent full sun-exposure when lying outdoor, 4) showers or sprinklers are provided for temperatures reaching 25°C and above in the outdoor area, 5) enough space is provided in the indoor climate area for all individuals to lie at least in half-recumbent position.

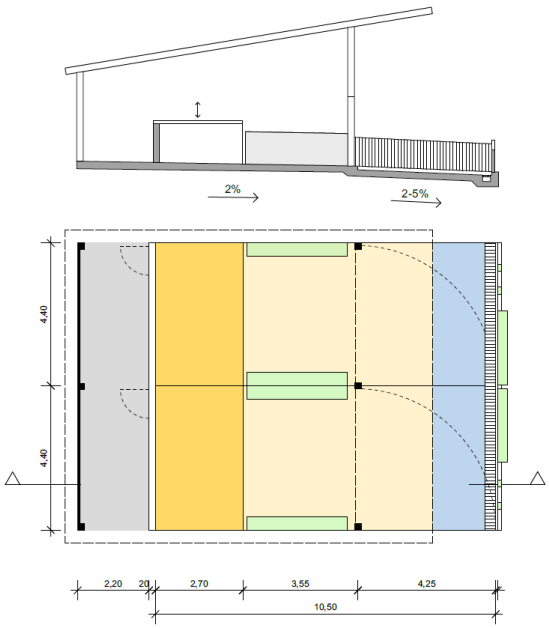
Table 20: Animal welfare evaluation of open fronted system for weaning piglets

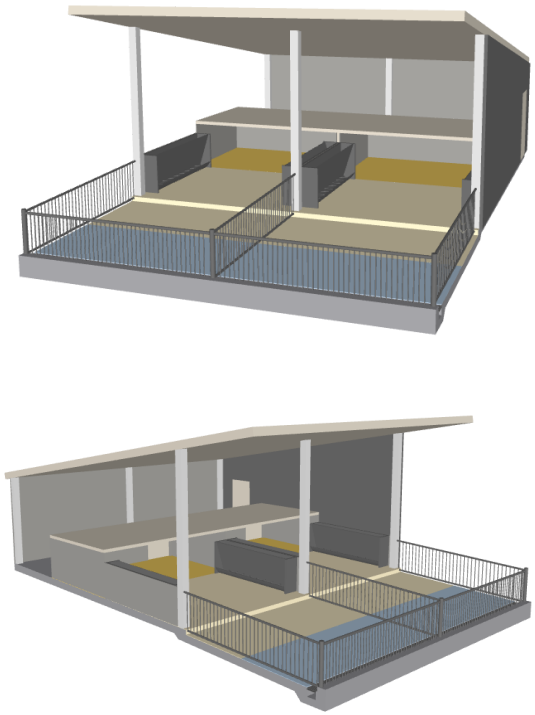
Criteria	Evaluation	Fulfilled, under the assumption that (comment)
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	Curtains are installed between the 'Indoor climate area' and the 'Roofed area with outdoor climate'.
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	The number of pigs per pen is adjusted so that all pigs can lie simultaneously in the indoor climate area in half-recumbent position (either changing the group size or adjusting the pen size using movable elements). Based on Ekkel et al. (2003) this is 0.35 m^2 for 35 kg pigs.
A comfortable lying area is available at all times.	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	1) During hot weather, the roof of the lying area is opened to increase air circulation 2) During cold weather, enough straw is provided, and curtains are installed when applicable.
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.
The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas, cooling facilities (shower, wallow), cool surfaces).	Fulfilled	1) Additional sun-shades can be deployed upon sun exposure because the shade provided by the roof will vary at different times of the day and depending on orientation of the barn. 2) Access to showers is possible (depending on the pigs' weight) whenever temperatures

		reach 25°C, but only in a specific area of the outdoor run allowing pigs to choose between microclimates.
Pigs have access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	NA	NA
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	NA	NA
In the nest, it is possible for sows to give birth and suckle in a lateral position.	NA	NA

6.3. Example 1.3 Open fronted system - Fatteners

Suitable for fatteners





Short description:
This system provides the animals with three different conditions: an indoor climate area, a roofed area with outdoor climate and a non-roofed area with outdoor climate. No access to natural floor or pasture is provided.

Table 21: Actual versus minimum space allowance (Regulation (EU) 2020/464) for fattening porcine animals more than 110 kg

Area for pigs	**Example 1.3**	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for fattening porcine animals > 110 kg**
	m^2/ animal *		m^2/animal
Indoor climate area	0,74 (25,7 %)	Indoor area	1,5 (55,6 %)
Roofed area with outdoor climate	1,56 (54,2 %)	Outdoor area	1,2 (44,4 %)
Non-roofed area with outdoor climate	0,58 (20,1 %)		
Total area m^2/animal	2,88 (100 %)	Total area m^2/animal	2,7 (100 %)

*Area calculated based on 16 fattening pigs weighing > **110 kg**

Evaluation 1.3

As explained in Table 22, the system has the potential to enhance animal welfare, as long as some requirements are met, namely 1) enough straw is provided in the indoor climate area in winter with a lesser extent in summer, 2) curtains are installed between the 'Indoor climate area' and the 'Roofed area with outdoor climate' in winter to prevent draught 3) the implementation of adjustable sun-shade depending on the hours of the day to prevent full sun-exposure when lying outdoor, 4) showers or sprinklers are provided for temperatures reaching 25°C and above, and 5) enough space is provided in the indoor climate area for all individuals to lie at least in half-recumbent position.

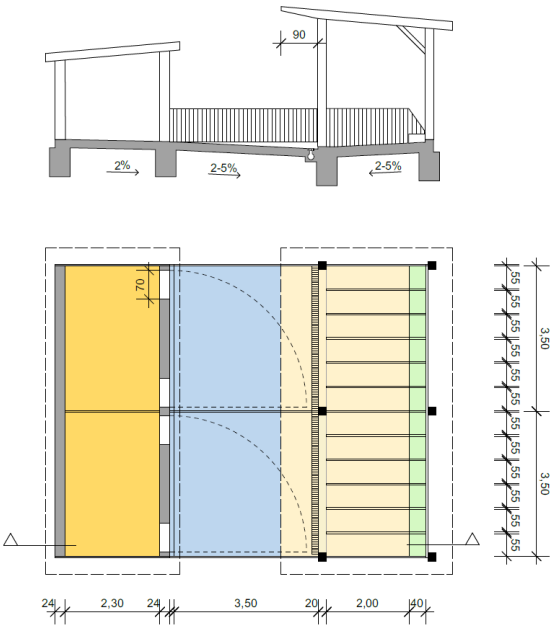
Table 22: Animal welfare evaluation of open fronted system for fatteners

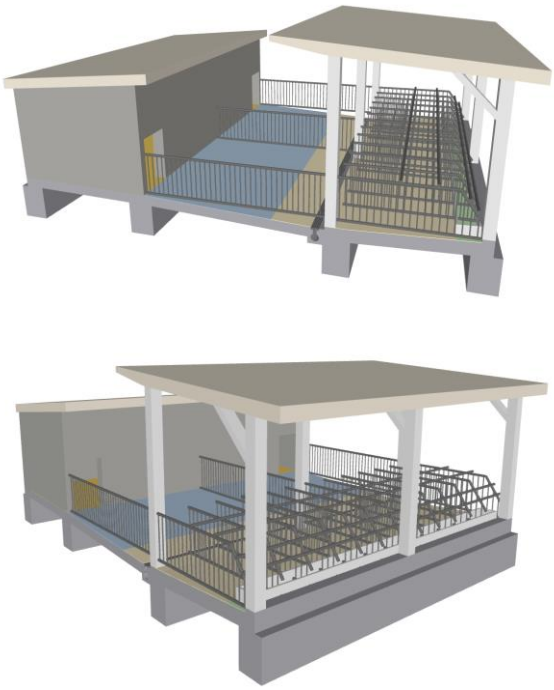
Criteria	**Evaluation**	**Fulfilled, under the assumption that (comment)**
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	Curtains (between the 'Indoor climate area' and the 'Roofed area with outdoor climate') are installed in winter.
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	The number of pigs per pen is adjusted so that all pigs can lie simultaneously in the indoor climate area in half-recumbent position (either changing the group size or adjusting the pen size using movable elements). Based on Ekkel et al. (2003) this is 0.74 m^2 for 110 kg pigs.
A comfortable lying area is available at all times	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	1) During hot weather, the roof of the lying area is opened to increase air circulation 2) During cold weather, additional straw is provided.
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.
The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas, cooling facilities (shower, wallow), cool surfaces).	Fulfilled	1) Additional sun-shades can be deployed upon sun exposure because the shade provided by the roof will vary at different times of the day and depending on orientation of the barn.

		2) Access to showers is possible whenever temperatures reach 25°C.
The pig has access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	NA	NA
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	NA	NA
In the nest, it is possible for sows to give birth and suckle in a lateral position.	NA	NA

6.4. Example 2.1 Pens with separated functional areas ("Dreiflächenbucht") - Non-lactating sows

Suitable for non-lactating sows





Short description:
This system provides the animals with three different conditions: an indoor climate area, a roofed area with outdoor climate with the feeding stalls and a non-roofed area with outdoor climate. Sows can be individually locked inside the feeding stalls during feeding.

Table 23: Actual versus minimum space allowance (Regulation (EU) 2020/464) for female breeding animals

Area for pigs	**Example 2.1**	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for female breed porcine animal / pregnant sows**
	m^2/ animal *		m^2/animal
Indoor climate area	1,34 (29,5 %)	Indoor area	2,5 (56,8 %)
Roofed area with outdoor climate	1,69 (37,1 %)	Outdoor area	1,9 (43,2 %)
Non-roofed area with outdoor climate	1,52 (33,4 %)		
Total area m^2/animal	4,55 (100 %)	Total area m^2/animal	4,4 (100 %)

*Area calculated based on 6 female breeding animals, 1 individual feeding stall/ animal

Evaluation 2.1

As explained in Table 24, the system has the potential to enhance animal welfare, as long as some requirements are met: 1) Enough straw is provided in winter in the indoor climate area and with a less extent of straw in summer, 2) cooling possibilities like showers are provided and 3) air circulation in the hut is increased (during hot periods), 4) enough space is provided in the indoor climate area for all individuals to lie at least in half-recumbent position. Additionally, shading nets are advisable if sows lie in the outdoor area in summer to prevent sunburn.

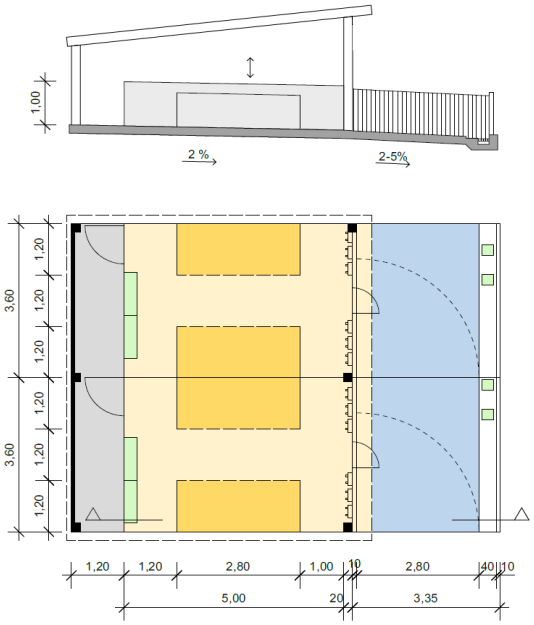
Table 24: Animal welfare evaluation of pens with separated functional areas ("Dreiflächenbucht") for non-lactating sows

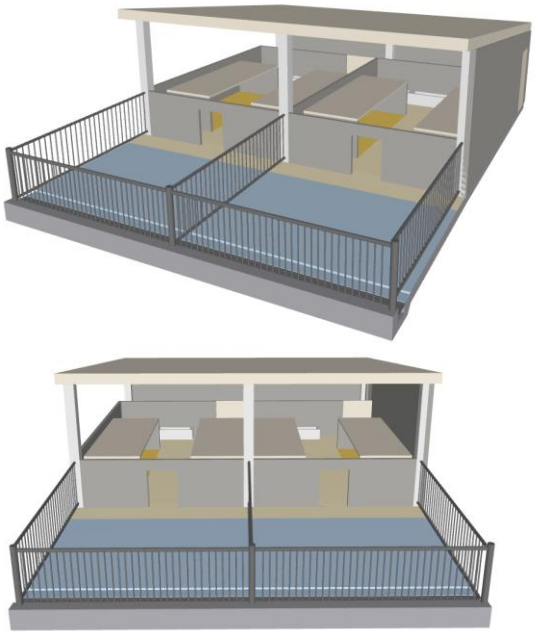
Criteria	**Evaluation**	**Fulfilled, under the assumption that (comment)**
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	The number of pigs per pen is adjusted so that all pigs can lie simultaneously in the indoor climate area in half-recumbent position (either changing the group size or adjusting the pen size using movable elements). Based on Ekkel et al. (2003) this is 1.27 m^2 per 250 kg sow.
A comfortable lying area is available at all times	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	1) During hot weather, the roof of the lying area is opened to increase air circulation 2) During cold weather, enough straw is provided.
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.
The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas, cooling facilities (shower, wallow), cool surfaces).	Fulfilled	1) Additional sun-shades can be deployed upon sun exposure (the shade provided by the roof will vary at different times of the day). 2) Further cooling possibilities for the sows are provided.

The pig has access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	NA	
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	NA	
In the nest, it is possible for sows to give birth and suckle in a lateral position.	NA	

6.5. Example 2.2 Pens with separated functional areas (“Dreiflächenbucht”) - Growing pigs

Suitable for growing / fattening pigs





Short description:
This system provides the animals with three different conditions: an indoor climate area, a roofed area with outdoor climate and a non-roofed area with outdoor climate.

Table 25: Actual versus minimum space allowance (Regulation (EU) 2020/464) for fattening porcine animals more than 35 kg but not more than 50 kg

Area for pigs	**Example 2.2**	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for fattening porcine animals 35 kg < X ≤ 50 kg**
	m^2/ animal *		m^2/animal
Indoor climate area	0,45 (24,1 %)	Indoor area	0,8 (57,14 %)
Roofed area with outdoor climate	0,75 (40,1 %)	Outdoor area	0,6 (42,86 %)
Non-roofed area with outdoor climate	0,67 (35,8 %)		
Total area m^2/animal	1,87 (100 %)	Total area m^2/animal	1,4 (100 %)

*Area calculated based on 15 growing pigs weighing **35 kg < X < 50 kg**

Evaluation 2.2

As described in Table 26, the system has the potential to enhance animal welfare standards, as long as some requirements are met, namely 1) enough straw is provided in the indoor climate area in winter with a lesser extent in summer, 2) the installation of curtains during cold and draughty weather to protect the roofed area with outdoor climate and the indoor climate are 3) provision of shade in the summer with i.e. shading nets, 5) enough space is provided in the indoor climate area for all individuals to lie at least in half-recumbent position. Curtains in front of the indoor climate area might be advisable the whole year round. An external heating source (floor heating or in the lid of the lying box) is recommended for young animals in winter.

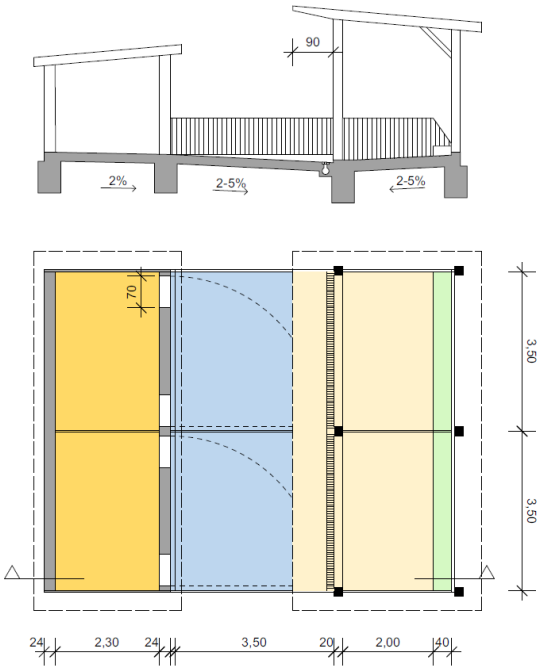
Table 26: Animal welfare evaluation of pens with separated functional areas ("Dreiflächenbucht") for growing pigs

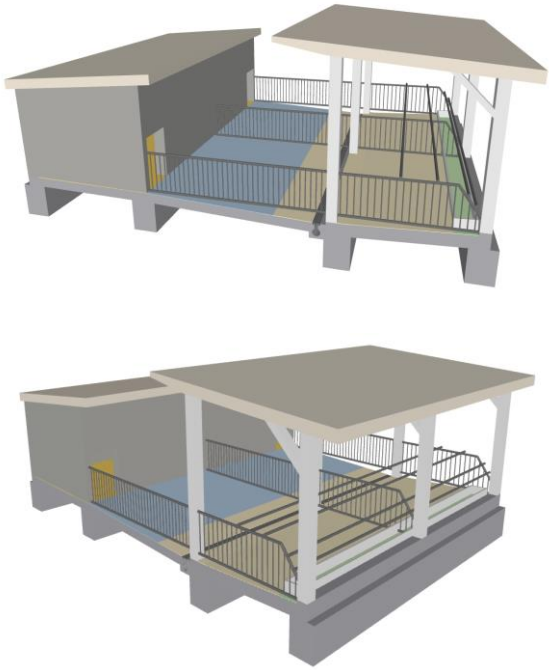
Criteria	**Evaluation**	**Fulfilled, under the assumption that (comment)**
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	Curtains might be needed during draughty periods to protect the feeding area.
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	Curtains are installed, especially during cold and draughty weather.
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	The number of pigs per pen is adjusted so that all pigs can lie simultaneously in the indoor climate area in half-recumbent position (either changing the group size or adjusting the pen size using movable elements). Based on Ekkel et al. (2003) this is 0.35 m^2 for 35 kg pigs and 0.44 m^2 for 50 kg pigs.
A comfortable lying area is available at all times	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	Curtains are installed in front of the indoor climate area to prevent draught. Heating is recommended for young animals in winter. (Heating in the floor or in the lid of the lying area).
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.
The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas,	Fulfilled	1) Additional sun-shades are deployable upon sun exposure. 2) Access to showers is possible (depending on the pigs' weight) whenever

cooling facilities (shower, wallow), cool surfaces).		temperatures reach 25°C, but only in a specific area of the outdoor run allowing pigs to choose between microclimates.
The pig has access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	NA	
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	NA	
In the nest, it is possible for sows to give birth and suckle in a lateral position.	NA	

6.6. Example 2.3 Pens with separated functional areas (“Dreiflächenbucht”) - Finishing pigs

Suitable for finishing pigs





Short description:
This system provides the animals with three different conditions: an indoor climate area, a roofed area with outdoor climate where feeding takes place and a non-roofed area with outdoor climate.

Table 27: Actual versus minimum space allowance (Regulation (EU) 2020/464) for fattening porcine animals more than 110 kg

Area for pigs	**Example 2.3**	**EU Regulation (EU) 2020/464 Definition of areas**	**EU Regulation (EU) 2020/464 for fattening porcine animals > 110 kg**
	m^2/ animal *		m^2/animal
Indoor climate area (box)	0,81 (29,6 %)	Indoor area	1,5 (55,6 %)
Roofed area with outdoor climate	1,02 (37,2 %)	Outdoor area	1,2 (44, 4 %)
Non-roofed area with outdoor climate	0,91 (33,2 %)		
Total area m^2/animal	2,74 (100 %)	Total area m^2/animal	2,7 (100 %)

*Area calculated based on 10 finishing pigs weighing > 110 kg

Evaluation 2.3

As described in Table 28, the system has potential to enhance animal welfare, as long as some requirements are met, namely 1) enough straw is provided in winter in the indoor climate area and with a lesser extent in summer, 2) installation of curtains to protect the feeding area, 3) installation of showers or other cooling possibilities when temperatures reach 25°C, and 4) enough space is provided in the indoor climate area for all individuals to lie at least in half-recumbent position.

Table 28: Animal welfare evaluation of pens with separated functional areas ("Dreiflächenbucht") for finishing pigs

Criteria	**Evaluation**	**Fulfilled, under the assumption that (comment)**
No permanent exposition to adverse weather conditions when feeding.	Fulfilled	Curtains could be installed during draughty periods to protect the feeding area.
Lying areas with permanent protection from adverse weather conditions (rain, draught).	Fulfilled	
All animals must be able to rest at the same time, at least in half recumbent position in the indoor area.	Fulfilled	The number of pigs per pen is adjusted so that all pigs can lie simultaneously in the indoor climate area in half-recumbent position (either changing the group size or adjusting the pen size using movable elements). Based on Ekkel et al. (2003) this is 0.74 m^2 for 110 kg pigs.
A comfortable lying area is available at all times	Fulfilled	Enough straw is provided.
The lying area provides an appropriate microclimate and conditions for climatic adaptations for each specific age group.	Fulfilled	1) Air circulation inside the hut is enabled during hot periods. 2) Enough straw is provided during cold periods.
The elimination area is outside and separate from the lying and feeding area.	Fulfilled	Roughage racks should ideally be placed away from the elimination area.
The system provides cooling possibilities at high temperatures (e.g. sufficient shaded areas, cooling facilities (shower, wallow), cool surfaces).	Fulfilled	Cooling possibilities are provided (shower)

The pig has access to both covered and uncovered outdoor environments.	Fulfilled	
Sows can build their nests providing offspring protection from adverse weather conditions.	NA	
Sows can isolate themselves in the first days after birth with the possibility to search for food and elimination outside the nest.	NA	
In the nest, it is possible for sows to give birth and suckle in a lateral position.	NA	

7. Conclusions

Giving the animals free choice of different housing conditions improves the animals' opportunities to adapt to their environment. It can be concluded that regardless of access to pasture (for cattle), increased free access to outdoor areas has various positive effects for animal welfare. However, open housing systems with outdoor functional areas and resources also pose some risks, particularly with regard to the challenges of thermoregulation and negative effects of precipitation, which can, nevertheless, be effectively controlled by an adequate housing design. Given that these preconditions are fulfilled, housing systems of more open design can be evaluated as innovative animal welfare-friendly systems. Criteria for their evaluation have been developed based on the animals' needs and corresponding housing requirements. Because differentiation between indoor and outdoor areas is less meaningful in these systems, compliance with the Organic Regulation (EU) 2020/464 should be obtained by considering only the total area provided.

We therefore propose to amend Regulation (EU) 2020/464 as follows:

By way of derogation from Chapter II Section 1 Article 3 and Section 3 Article 10 of Regulation (EU) 2020/464, innovative animal welfare-friendly housing systems fulfilling the criteria of Table A or B may deviate from the minimum indoor or outdoor areas set out in Part I of Annex I under the condition that they provide the minimum total area (indoor plus outdoor area) required.

Table A: Criteria for the animal welfare evaluation of innovative cattle housing systems

Needs	Category	Criteria
Loco-motion	all	Each animal has sufficient space and incentive to move around.
Social, exploration behaviour	all	Each animal has access to changing stimuli.
	>200 kg	Each animal has sufficient space for mutual avoidance in the walking area, including for change between indoor and outdoor areas.
Lying	all	Each animal in principle has access to a dry lying place, even in case of precipitation, and a sun-protected lying place in case of increased temperatures.
	≤200 kg	Each animal is provided with a lying area protected from draughts.
Feeding/ drinking	all	Feeding places are available in adequate quantity and quality, even at elevated temperatures.

Table B: Criteria for the animal welfare evaluation of innovative pig housing systems

Behavioural need	Criteria
Feeding	Pigs should not be permanently exposed to adverse weather conditions (e.g. direct sunlight in summer, heavy rain) when feeding.
Lying	The lying areas has to be permanently protected from adverse weather conditions (e.g. rain, draught and direct sunlight).
	Pigs need a sheltered place, where they can rest in different lying positions together with their group members. Under commercial conditions, the lying area should provide thermal and lying comfort. Thus, the size of the lying area should allow pigs at least to lie simultaneously in half-lateral recumbency, in order to establish a sufficient microclimate at cold temperatures and to lie relatively comfortably. Pigs adopt a full recumbency position over warm periods, and during such periods outdoor areas are also assumed to be used for lying.
	The lying area should provide a soft and comfortable underground.
	The lying area should provide an appropriate microclimate for the specific age group. The lying area should be climatically adaptable to facilitate thermoregulation of the animals during permanently adverse weather conditions in summer and winter. This concerns, among other things, the amount of bedding, air speed, humidity and temperature.
Elimination	The elimination area should be separated from the lying area and feeding area, preferably outside.
Thermoregulation	At high temperatures, sufficient shaded areas and cooling facilities should be available. Especially in the absence of other cooling facilities (shower, wallow), cool surfaces should be available on which the pigs can cool down via heat exchange.
Exploration	Pigs should have free access to both covered and uncovered outdoor areas.
Maternal behaviour	The environment in which sows build their nests must provide protection from adverse weather conditions (rain, wind, draught, etc.).
	The position of the nest should take into account the sow's need for isolation in the first days after birth with the possibility to search for food and elimination outside the nest.
	In the nest, it must be possible for sows to give birth and suckle in a lateral position.