Welfare of Growing Rabbits – Summary

Almost 534 million rabbits were farmed for meat globally in 2022, the majority in Asia, followed by the EU. Rabbits are most commonly housed in small, barren cages, leading to serious welfare issues due to limited space, wire flooring, high stocking densities, disease and injury, and a lack of behavioural opportunities in a barren environment.

WELFARE ISSUES IN CONVENTIONAL PRODUCTION SYSTEMS

Growing rabbits are typically housed in conventional barren cages. The most recent statistics in the EU come from a 2017 report indicating that 94% of rabbits are produced in caged systems.

- *Conventional barren cages:* The majority of rabbits (85% of EU production in 2017) are housed in small wire mesh cages which provide each rabbit with only 450 to 600cm^2 of space and 28-39 cm in height. No enrichment is typically provided.
- *Enriched cages:* Some rabbits are housed in slightly larger/higher wire mesh cages (9% of EU production in 2017) provided with a platform and a plastic footrest on the wire floor. Enriched cages provide ~600 cm^2 per rabbit a vertical height of 60-80 cm. Limited enrichment may be provided e.g. wooden gnawing blocks.

Caged systems have a low welfare potential because they cannot provide for the basic needs of the animals. Key areas of concern in caged systems are:

SPACE Restriction of movement is the most important welfare issue for growing rabbits in caged systems. Growing rabbits (with an average slaughter weight of 2.3 kg) need a space allowance of at least 800 cm^2 per rabbit to rest comfortably as well as perform basic behaviours such as standing, feeding and drinking. More active behaviour can be performed if the rabbit has at least 1200cm^2. Growing rabbits also need sufficient horizontal space, allowing them to perform at least "three consecutive hops" (EFSA, 2020). Standard cage systems also do not provide the minimum vertical space needed for rabbits to sit up with their ears erect, a typical vigilance behaviour. Open top enclosures, instead, allow rabbits to rear up to their full height without restriction.

FLOORING Most conventional cages have wire flooring, which is uncomfortable, restricts thermoregulation, causes injuries in adult rabbits, and hampers active behaviour in growing rabbits. Rabbits consistently prefer plastic slats over wire flooring and are more active if provided with more comfortable flooring. Floor hygiene is a key element for rabbit comfort – rabbits prefer to spend time

lying and resting on cleaner/dryer surfaces. Bedding can increase the comfort of the flooring but ought to be well managed to prevent excessive soiling.

ENRICHMENT In caged rabbit production, enrichment is not typically provided or very limited. In conventional barren cages, there is insufficient space to provide structural enrichment such as platforms or hiding spaces, and enrichment which meets the needs of the animals such as gnawing material is not given. While enriched cages contain a platform, and may provide gnawing material, environmental enrichment is still very limited. Additionally, conventional production is typically done under artificial light, with abrupt changes between light and dark periods.

- *Platforms:* Rabbits benefit from different levels in housing, such as platforms. Rabbits are motivated to gain access to platforms and will perform more active behaviours when platforms are present, which can have a positive effect on bone strength. Platforms also provide additional opportunities for resting undisturbed and offer hiding places during the light period.
- *Hiding Places:* Rabbits prefer to remain under shelter in daylight. Rabbits without a place to hide show more abnormal and restless behaviours, indicators of poor welfare and discomfort. Specific hiding places, such as tubes, barriers, enclosed boxes, or artificial burrow systems can allow rabbits to escape from aggressive individuals and to feel safe in an enclosed space whilst resting.
- *Gnawing Enrichment:* Chewing and gnawing on objects are an important part of a rabbit's behavioural repertoire and the inability to gnaw is the main risk factor for the development of abnormal behaviours either directed to the cage or to their pen mates. Rabbits prefer softer wood over harder wood, but much prefer hay and straw over wooden gnawing material.
- *Lighting*: Rabbits are most active in the morning and evening, which is controlled internally and by external factors such as light. Providing dawn and dusk transitions into the lighting regime can help rabbits to regulate their behavioural rhythms, while the additional of natural light increases the variation in lighting conditions across the day and season.

GENOTYPE

Alongside improvements in housing, the use of more robust breeds and selection for health and welfare are crucial to reduce the welfare issues faced by rabbits in commercial production.

HEALTH AND MANAGEMENT

DIET AND WATER PROVISION Digestive troubles are the leading cause of morbidity and mortality in growing rabbits. Provision of good quality fibre, although not often done in caged systems, is essential to reduce the risk of post-weaning digestive trouble in growing rabbits. Provision of hay contributes to a high fibre diet and enhances both gut health (helping gut movement and controlling the gut microbiota) and oral health, while reducing abnormal behaviours.

DISEASE, INJURY AND ANTIBIOTIC USE Rabbits are highly susceptible to respiratory and enteric disease and mortality rates can reach 30%. Industrialised rabbit farming has by far the highest rate of antimicrobial usage among terrestrial farmed animals, which can lead to the development of antimicrobial resistance. Poor housing, high stocking density, and a stressful environment have a detrimental effect on immune responses and leave the rabbits more open to the development of disease. Improvements to welfare, more hygienic housing and better air quality are crucial to preventing the need for routine use of antibiotics.

STOCKMANSHIP & HANDLING Gentle, frequent handling of rabbits at a young age reduces fear of humans and can improve growth rate and reduce mortality. Catching with the minimum amount of chasing is recommended, and rabbits should not be caught or held by their ears.

TRANSPORT, & SLAUGHTER Careful handling and catching are important to reduce pre-slaughter mortality and injuries to the rabbits. During transport, welfare issues faced by rabbits include lack of space, sensory overstimulation, motion stress, inappropriate thermal conditions, and prolonged hunger and thirst. These issues are compounded by longer journey times, leading to higher mortality. Gentle handling during stunning is required, and the severing of the carotid arteries must be done as soon as possible as reflexes can start to return as soon as 22 seconds after stunning.

HIGHER WELFARE ALTERNATIVES FOR GROWING RABBITS

Housing systems which offer more space (increased space allowance and increased horizontal and vertical space), comfortable flooring, and enable growing rabbits to perform more of their species-specific behavioural repertoire (such gnawing, hiding, hopping and play) have a higher welfare potential. A number of cage-free housing systems for growing rabbits exist and some are used commercially:

- *Park systems:* Small elevated pens with no height restriction and at least 180 cm in length. They can house up to 32 growing rabbits and provide between 563 and 800 cm^2 per rabbit but only systems which provide ≥800 cm^2 would be considered an acceptable cage free alternative. Platforms, gnawing material, and hiding spaces are generally provided. Although some park systems have wire mesh flooring, only park systems with non-wire flooring can be considered acceptable cage-free systems.
- *Pen systems:* Large indoor slatted or solid floored pen systems with no height restriction are used in some production systems. Pen systems house growing rabbits in far larger numbers than park systems and therefore offer the rabbits more total available space. They typically provide a space allowance of ≥ 800 cm^2 per rabbit. Pen systems include platforms which maximise the available space and include enrichment such as gnawing material and hiding spaces. Some pen systems offer the possibility of providing the rabbits with bedding material such as straw.
- *Pen systems with a wintergarden*: Some indoor pen systems provide an additional covered outdoor area. A wintergarden is an area with a solid roof but where at least one wall is constructed of open mesh to provide natural light and an outdoor climate. Wintergardens provide more space, while still offering protection, as well as natural light and fresh air, and more opportunities for behavioural expression.

- *Outdoor cage-free systems:* Cage-free outdoor systems generally provide the rabbits with access to an uncovered outdoor area which may or may not be pasture. Outdoor access provides natural light, fresh air, and a choice of environment, while providing access to pasture access allows rabbits to perform a wider behavioural repertoire, including grazing and foraging behaviour. Pasture access is associated with increased activity and reduced fearfulness. Systems with outdoor access ought to use more robust cross-breeds and provide adequate shelter and protection from predation. Outdoor cage-free systems can take various forms:
  - *Fixed housing:* Rabbits have an indoor housing (barn or hutches) with access to an outdoor run or paddock with pasture access directly from the housing.
  - *Mobile housing:* Rabbits have access to a movable shelter with an attached outdoor run. The housing and attached run can be moved around the pasture. To be considered cage-free, mobile housing should provide the minimum standards recommended below.
  - *Organic systems:* The characteristics of organic systems for growing rabbits are defined EU Council Regulation 2018/848. Organic systems may be fixed or mobile and must contain housing or a covered shelter with solid floor with bedding/litter material, and include dark hiding spaces and a platform. Rabbits must have access to an outdoor run with vegetation, preferably pasture, and a diet that consists of at least 60% forage material. The organic standards for rabbits lack specific standards on space allowance and stocking density.

HIGHER WELFARE SYSTEMS FOR GROWING RABBITS

Caged systems have a low welfare potential as the restrictions on movement, behaviour, and comfort are an inherent part of the system. Higher welfare cage-free systems for growing rabbits include park systems, large pen systems, pen systems with a wintergarden, or outdoor cage-free systems - fixed or mobile housing with access to an outdoor run or pasture and organic systems.

CIWF MINIMUM RECOMMENDATIONS FOR GROWING RABBITS

- **Adequate space** that allows rabbits to rest undisturbed, move freely and have space for behavioural expression. At least 800 cm^2 per rabbit is needed for basic behaviours
- **Sufficient pen length (>180 cm) and no height restriction** to perform active behaviours and rear upright on their hind legs
- **Comfortable flooring** (no wire mesh) to prevent pain or discomfort
- **Platforms** to provide additional space, allow rabbits to perform vigilance behaviours and hide underneath
- **Hiding places** to provide opportunities to escape any perceived danger
- **Fibre provision** (hay or straw) and **gnawing material** for good oral and digestive health.
- **Natural light** including dawn and dusk periods so rabbits can establish their daily rhythm
- **Outdoor access** via a wintergarden and ideally pasture access to enable the rabbits to engage in grazing behaviour
- **No routine use of antibiotics** throughout production cycle
- **Regular scoring of welfare outcomes** to identify any welfare issues and to set targets for improvements, such as mortality, skin lesions, disease incidence, body condition scoring, group behaviour, and reactions to humans

Welfare of Growing Rabbits – Scientific Review

RABBIT BEHAVIOURAL BIOLOGY

Rabbits are one of the most recently domesticated mammals, and domestic rabbits have retained many of the traits of their wild relatives. They were first domesticated in French monasteries between AD 500-1000[1], when they were bred for meat and began to be selected for growth. While some behaviours have changed through selection, they haven't been selected for tameness like other farmed species - 99% of genes are expressed similarly in wild and domestic rabbits[2]. If given the opportunity, farm rabbits will show similar behaviour to wild rabbits[3].

Rabbits typically live in small, territorial groups and this behaviour is also observed in domesticated rabbits. In wild or semi-natural systems, domestic rabbits live in stable matrilineal family groups of 2-9 does, 1-3 adult bucks, and their offspring[4]. Shortly before parturition, rabbit does will seek out a suitable site and construct a nest. Rabbit kits are altricial - they are born without fur and with their eyes closed. The doe encloses them in the nest and will only return once a day for a short feed[5]. The kits begin to emerge from the nest between 2-3 weeks old[6] and will start to consume solid plant material (mostly grasses and herbs, but also fruit, leaves, roots, and some bark)[7]. As the kits grow, they can eat up to 30 meals in a 24-hour period[8] and spend a large proportion of their active time eating (up to 70%[9]), the majority of which occurs during the nighttime. To prevent digestive disorders, rabbits need to consume coarse fibre in their diet[10,11]. Additionally, rabbits maintain their oral health by gnawing on objects to wear down their teeth.

Rabbits are crepuscular, meaning they are most active around dawn and dusk. Aside from eating, they have a high motivation for locomotion (particularly hopping) during their active periods. Young rabbits, in particular, engage in intense locomotor play[12,13] which involves jumping, running at speed often in a zigzag, twisting their torso while in the air, head flicking, and/or kicking the hind legs. Social play in young rabbits takes the form of play fighting[12], an important behaviour for many juvenile animals as it helps develop flexibility and resilience. Rabbits also spend a large portion of their day resting, between 12-18 hours[14]. Lying fully stretched out is not only an indication of relaxation, but also serves to aid thermoregulation[15].

Rabbits have highly sensitive senses in order to survive as a prey species. Rabbits have near 360 vision due to the placement of their eyes on the sides of their head, and they have particularly good far sight and peripheral vision but have poor depth perception and visual acuity[16]. This means they can detect potential threats from almost all angles without moving their head but cannot distinguish details[16]. Rabbits can see well in 6-7 times less light than humans would need[17], but lack a tapetum lucidium (a layer of tissue under the retina in the eye which reflects light and aids nocturnal vision). Unlike people, rabbits are dichromatic and most sensitive to green or blue light[16], meaning they have limited colour vision compared to humans and are less sensitive to red light. Rabbits are macrosmatic animals[4,14] meaning they have a very strong sense of smell – they have over 100 million olfactory receptor cells in their nose (humans have 12 million) and a relatively large olfactory lobe[16]. Rabbits communicate using a variety of olfactory signals[18], and odour cues acquired prenatally guide post-natal preferences in rabbit kits[19]. Rabbits are also sensitive to predator odours, even without any prior experience[20]. Rabbits have much sharper hearing than humans and are more sensitive to higher pitched noises, with a range from 75 Hz – 50 kHz[21]. (vs. 20 Hz-20 kHz in humans). These highly developed sensory capacities may make rabbits far more sensitive than people to elements of the housing system such as movement, odours, and sounds and can be a cause of chronic stress if they cannot perform their natural vigilance and escape behaviours in response to a perceived threat[22].

OVERVIEW OF COMMERCIAL PRODUCTION

Rabbits are farmed for meat in high numbers with almost 534 million farmed for meat in the world in 2022[23]. The majority of these rabbits are slaughtered in Asia (352 million in 2022) with China alone accounting for almost 45% of the number of rabbits slaughtered globally in 2022, followed by the EU (almost 77 million in 2022)[23]. There is currently no specific legislation establishing minimum welfare standards for rabbits in the largest rabbit producing countries or regions such as China or the EU, although some EU member states, e.g. Belgium, Austria, have introduced their own national legislation. Furthermore, there is no up-to-date comprehensive study on rabbit farming in globally, and in the EU, the latest available data is from 2017[24].

While rabbit does, female rabbits used for breeding purposes, can give birth to up to 20 kits in one litter[14], they can only nurse 8-10 kits[14]. Cross-fostering is often performed to standardise the litter size, and excess kits may be culled at day 0[25]. Numbers on how many are culled to balance litter sizes are not available. In commercial farming, rabbit kits remain with the doe until weaning at 30-35 days[14]. On some farms, the newly weaned rabbits, hereafter growing rabbits, are moved to a separate growing housing, while more commonly in commercial systems, the doe is removed and the litter remains in the same housing until they reach slaughter weight (all-in all-out system). Slaughter age ranges from 9-13 weeks depending on the carcass weights and maturity of the meat preferred by the market[26] (Table 1).

Table 1: Average slaughter ages and weights in different rabbit producing countries – Adapted from EFSA[14] & Giersberg[27] with input from data gathered by CIWF.

Country		Slaughter age	Slaughter Weight
Hungary		75-77 days	2.5 kg
Italy	*Light*	65 days	2.2 kg
	Standard	75 days	2.5 kg
	Heavy	85 days	3.0 kg
France		69-75 days	2.4 kg
		63-65 days	2.2 kg
Spain			2.1 -2.3 kg
Belgium			2.35 kg
Germany			3.0 kg
China		3-4 months	2-2.5 kg

Growing rabbits are most commonly housed in small cages, leading to serious welfare issues due to high stocking densities, disease and injury, wire flooring and a lack of behavioural opportunity in a barren environment. Development and uptake of alternative systems has been slower than for other farmed species, however, alternative systems are beginning to grow in popularity, particularly in Northern Europe and France, in response to public pressure and changes in national legislation.

- *Conventional barren cages:* Barren cages are by far the most common system used for meat rabbit production globally, and provide each rabbit with only 450 to 600cm^2 of space (Table 2). An EU report from 2017[24] indicated that stocking densities in EU Member States for conventional cages range from 45-50 kg/m^2 which works out as a maximum of just over 500 cm^2 for an average rabbit slaughtered at 2.3kg. Conventional cages are constructed entirely of wire mesh, including the flooring, and range from 28-39 cm in height. In older systems, bicellular cages which house two growing rabbits at a stocking density of 600cm^2 per rabbit can be used. In the EU, the European Commission (2017) estimated that 85% of farmed rabbits were in conventional barren cages (concentrated in southern Europe)[24].
- *Enriched cages:* Larger cages (so called "welfare cages") generally operate at a stocking density

of ~40 kg/m^2[24].They are also constructed of wire mesh but are higher (60 – 80 cm) and include a platform and a plastic footrest. An estimated 9% of rabbits in the EU were housed in enriched cages in 2017 at stocking densities of up to 40 kg/m^2. Limited enrichment may be provided e.g. wooden gnawing blocks.

- *Park systems:* Small elevated open-top pens are created by the removal of walls between adjacent single modules (typically four modules are joined). Park systems have no height restriction and at least 180 cm in length. They can house up to 32 growing rabbits[14] (although smaller group sizes ensure sufficient space for all animals) and provide between 563 and 800 cm^2 per rabbit[14] (depending on national legislation, weight of rabbit, and number of rabbits in the pen), or a stocking density of 30 kg/m^2 (767cm^2 for a 2.3kg rabbit)[24]. Floors of park systems can still be made from wire mesh, but also plastic slats, and park systems always include platforms which again can be plastic or wire.
- *Pen systems:* Large indoor pen systems are also in use although no standard designs exist. Pen systems house growing rabbits in far larger numbers than park systems and therefore offer the rabbits more total available space[14]. Pen systems have no height restriction and typically operate at a stocking density of at least 800 cm^2 per rabbit. Pen systems typically include platforms, and enrichment items such as hiding spaces and gnawing material. Pen systems can have plastic slatted floors without bedding material while some may have solid flooring and contain litter and/or bedding material (usually straw).
- *Pen systems with a wintergarden:* Some pen systems include access to a wintergarden, a covered addition to the housing where at least one wall is constructed of open mesh to provide natural light and an outdoor climate. Wintergardens increase the total available space while also reducing the stocking density and can provide additional opportunities for enrichment (platforms, hiding spaces, gnawing material).
- *Outdoor cage-free systems:* A small number of rabbits are also farmed with access to the outdoors. No standards exist for such systems. Some niche caged systems give the rabbits access to fresh air and natural light but are not truly cage-free as the main restrictions of space in caged systems remain. Cage-free outdoor systems generally provide the rabbits with access to an uncovered outdoor area which may or may not be pasture. Outdoor access provides natural light, fresh air, and a choice of environment, while providing access to pasture access allows rabbits to perform a wider behavioural repertoire, including grazing and foraging behaviour. Pasture access is associated with increased activity and reduced fearfulness. Systems with outdoor access ought to use more robust cross-breeds and provide adequate shelter and protection from predation. Outdoor cage-free systems can take various forms:
  - *Fixed housing:* Rabbits have an indoor housing (barn or hutches) with access to an outdoor run or paddock with pasture access directly from the housing.
  - *Mobile housing:* Rabbits have access to a movable shelter with an attached outdoor run. The housing and attached run can be moved around the pasture. To be considered cage-free, mobile housing should provide the minimum standards on space recommended below.
  - *Organic systems:* New standards for organic rabbit production in the EU were established in Council Regulation 2018/848[28]. Organic systems may be fixed or mobile and must contain housing or a covered shelter with solid floor with bedding/litter material (such as straw or other suitable organic material), include dark hiding spaces and a platform. Rabbits must have access to an outdoor run with vegetation, preferably pasture, and a diet that consists of at least 60% forage material. The organic standards for rabbits lack specific standards on space allowance and stocking density.

Table 2: Typical conventional housing dimensions for growing rabbits in the EU (Adapted from EFSA[4,14])

Housing Type	Width (cm)	Length (cm)	Height (cm)	Total Surface Area (cm^2)	Space allowance per rabbit (cm^2)
Bicellular Cage	25.4	44	28	1200	600
Standard Cages	38	43.5-66	32-39	3,300-3,900	450-600
Standard cage (wide)	46	95-102	35	4,370-4,700	450-600
Enriched Cage (Wire platform)	38-46	95-102	60-65	4,370-5,600	>600
Enriched Cage (Plastic platform)	46-52.5	102	65-80	5,600-6,400	>600
Park	180-200	80-102	No restriction	18,000-25,400	563-800
Pens, outdoor, and organic	Enclosure size and space allowances variable				

HOUSING

SPACE

Rabbits are active animals and need sufficient space to hop, run, crawl, jump and change direction quickly[29,30]. Play behaviour is particularly important in growing rabbits. EFSA cite restriction of movement as the most important welfare issue for growing rabbits in caged systems[14]. A standard barren cage provides only around 1% of the home range of a rabbit group, which naturally covers a $50m^2$ area[29,31]. Insufficient exercise through a lack of space leads to weak bones and skeletal abnormalities[29,32]. Rabbits are more active and interact with their environment more when provided with more space. When moved from a small to a larger pen (0.88 m^2 to 3.35 m^2), they show a rebound effect, with a significant increase in activity, demonstrating space is important to them and that space restriction jeopardizes their welfare[33]. By providing sufficient space, rabbits are able to maintain a similar behavioural repertoire to that in the wild[33].

Space Allowance/Stocking Density: How much space an animal needs can be calculated by the amount of space used for different postures and activities. Petherick (1983) proposed the allometric equation as way of calculating the space requirements of farm animals for different static positions: $A=kW^{0.67}$, where A is space in m^2/animal, W is the liveweight in kg and k is a constant which depends on the animal's body position/posture[34]. Giersberg (2015) measured the actual floor space taken up by rabbits in four different common static positions (sitting, ventral recumbency with and without legs stretched out, and lateral recumbency) and different ages and compared these with the space allowances provided by common housing systems and legislative standards across the EU[27]. They found that growing rabbits in caged systems, by the time they reach slaughter weight, take up the majority of the available surface area simply in a sitting position (up to 97% of the available space)[27]. If one considers recumbent positions, typical cage systems do not provide sufficient available surface area to allow all rabbits to rest comfortably at the same time. Using the data provided from Giersberg (2015)[27], it is possible to calculate the k-values associated with each posture and extrapolate to other weight categories. Rabbits slaughtered at 2.3kg would need a space allowance of at least $594cm^2$ per rabbit to ensure that all rabbits have enough space for all postures.

However, these measurements are for static postures only and do not consider that an animal also needs space to move within the pen to perform basic functions such as standing, feeding and drinking, and even more space to perform active behaviours (such as play or social behaviours). Studies on how much space rabbits need to perform these basic and more active behaviours are lacking but it is known that rabbits will perform more active and social behaviours with a greater space allowance and decrease self-directed behaviours and resting[35]. Studies of space requirements cross species noted that despite differences in body shape and size (e.g. dairy cow vs. laying hen), the k-value in the allometric equations does not differ by a large degree[36,37]. The k-values proposed

to enable an animal to lie down in a ventral (hereafter: sternal) posture and a more stretched lateral posture, including an additional allowance to enable the animal to stand and feed/drink, are 0.037 and 0.0457, respectively[38]. The latter is very similar to that calculated for animals to move between standing and lying[37], but does not include space for general activity or social behaviour. Extrapolation from best practice recommendations for turkeys[39], estimates a k-value for animals in a more active environment as 0.068. Using these k-values, allowing enough space for a 2.3 kg rabbit to lie fully stretched out (with additional space for basic behaviours) would require an area about 800 cm^2 per rabbit, while allowing for more active behaviours would require almost 1200 cm^2 per rabbit (appropriate stocking densities according to the allometric curve (Fig.1) for different slaughter weights are presented in Table 3). Following the active curve (or above) is recommended as rabbits are active animals and therefore need more space than that afforded by providing allowances for static postures only.

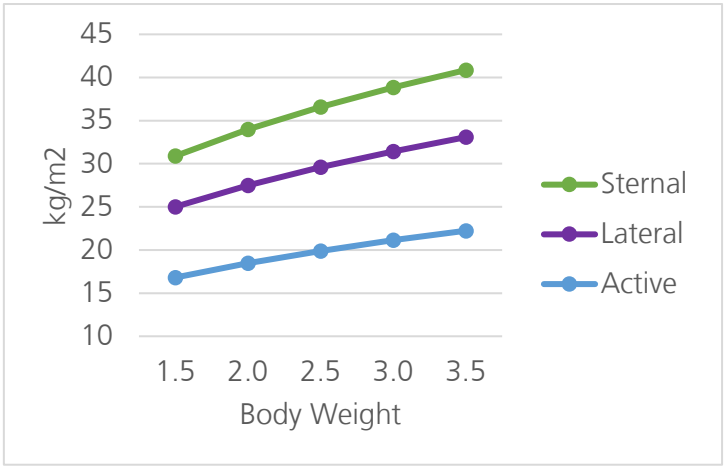

Figure 1. Stocking density for rabbits according to final bodyweight and postural or active conditions

Table 3. Space allowances and stocking densities for growing rabbits according to final bodyweight and postural or active conditions according to the allometric equation[34] $A=kW^{0.67}$

FINAL WEIGHT (KG)	based on k=0.037 STERNAL			based on k=0.0457 LATERAL			based on k=0.068 ACTIVE		
	cm^2/rabbit	rabbits/m^2	kg/m^2	cm^2/rabbit	rabbits/m^2	kg/m^2	cm^2/rabbit	rabbits/m^2	kg/m^2
2.0	589	17	34	727	14	28	1082	9	18
2.1	608	16	35	751	13	28	1118	9	19
2.2	628	16	35	775	13	28	1153	9	19
2.3	646	15	36	798	13	29	1188	8	19
2.4	665	15	36	822	12	29	1223	8	20
2.5	684	15	37	844	12	30	1256	8	20
3.0	772	13	39	954	10	31	1420	7	21

Total pen size: Not only is the space allowance per rabbit important, but the total amount of space available can impact the behaviours that a rabbit can perform. EFSA propose that for movement and locomotor behaviour, the total available space is the most relevant factor[4]. EFSA define restriction of movement for rabbits as "the rabbit is unable to perform three consecutive hops because of physical restraint or lack of space"[14]. How far a rabbit can travel in one hop depends on a number of factors, such as body size and the speed at which they are travelling, and ranges from 15-70 cm for normal movement but can reach up to 1.5m when startled. Growing rabbits engage in high-speed movements during play behaviour, as well as during social and escape behaviours[14], indicating a high need for horizontal space. It is estimated that a 2 kg rabbit needs at least 70cm for a single hop[4], suggesting a minimum enclosure length of 210 cm is required to perform three consecutive hops.

The German Haltungsform labelling scheme proposes that 1.8 m is required for a rabbit to perform two consecutive hops[40].

In terms of total available space, the existing evidence indicates that small increases in total available space in cage systems (from 0.4m^2 cage size to 1.6m^2) may not result in significant differences in activity[41,42], but fewer consecutive hops are performed when the total available space is smaller[43]. Studies comparing housing systems with greater differences in available space, do show that rabbits show more normal behaviour if given more space. Rabbits housed in pen systems show more active behaviours than rabbits housed in bicellular cages[44–46]. Even between pen systems, rabbits housed in larger pens (3.67m^2) showed significantly more running and hopping behaviour compared to rabbits housed in smaller pens (0.66m^2) and standard cages (0.39m^2)[47] . Rabbits housed large pen systems have better bone health (higher fracture toughness) than rabbits housed in cages when housed at the same stocking density, likely due to the increased total available space in pen systems (3.75m^2 vs. 0.45m^2) which allows for greater activity[48]. In the rabbit literature, it is difficult to disentangle the effect of increasing total available space from either group size or stocking density as no systematic studies have been performed as in other species[49]. In addition, activity may be impacted by the type of flooring (see below) so increasing available space without providing more comfortable flooring may also hinder natural movement. Not only is the quantity of active behaviour affected by the amount of available space, rabbits will also start to separate their space into different functional areas if given more space – if offered the choice, rabbits utilise different parts of their environment for feeding, nest building, resting and excretion[29].

Vertical Space: As prey animals, rabbits spend a significant amount of time alert, scanning their surroundings by rearing up on their hind legs[33,50]. Six- and nine-week-old rabbits housed in cages with a height of 30 cm were unable to perform this fully upright vigilance behaviour, whereas those housed in open top pens could and did do so[43]. EFSA suggest that growing rabbits need at least 38-40 cm in vertical height in order to be able to sit up with their ears erect[4] which is not provided in most conventional barren cages. Although rabbits appeared to show the least preference for open-top cages when offered the choice between areas of different heights (20 cm, 30 cm, 40 cm, and open)[51], housing in this study did not provide any hiding places for the rabbits which are an important resource for rabbits (see below) so it is likely that this preference reflects a preference for hiding places rather than a dislike of unrestricted system height.

Recommendations on Space: To have sufficient space, growing rabbits need a space allowance of at least 800 cm^2 per rabbit in order to comfortably rest and perform basic behaviours, at least a pen length of 1.8 m to enable consecutive hopping, and no pen height restriction to enable rearing behaviour. Growing rabbits can benefit from housing systems with a large total available space which enables them to perform more active behaviours like locomotor play and separate the pen into different functional areas (e.g. resting vs. active areas).

FLOORING

Floor Type: Most conventional cages have wire flooring, which is uncomfortable, restricts thermoregulation and causes hock and foot pad lesions and pododermatitis in breeding adults[29]. Pododermatitis starts out as bare patches and thickened skin which can become ulcerative with time. These lesions typically present at feet and at hock levels, which are the main pressure points when resting, and happen when the pressure is exerted over an uncomfortable surface such as wire flooring[52]. Pododermatitis is more likely to affect breeding bucks and does as meat rabbits are lighter and slaughtered before the condition can progress, although it has been recorded in meat rabbits[53]. It is a painful condition in itself[4], and can lead to reduced mobility, poor body condition, and reduced productivity[54–56]. Longitudinal studies in Spain, Portugal, and the Netherlands have demonstrated that

the addition of plastic mats/footrests to wire cages has reduced the prevalence and severity of foot pad lesions in breeding does[56,57]. Preference and choice tests indicate that both growing rabbits and breeding does prefer flooring that provides more foot support compared to wire mesh, (e.g. plastic foot mats, plastic grids, plastic slats or galvanized steel bars)[44,58–60], but this preference can be mediated by higher ambient temperatures[61]. Growing rabbits housed on plastic slatted floors were also found to have fewer head and ear lesions than those on wire mesh[62]. Flooring can also affect rabbits' activity – uncomfortable flooring can constrain their movement and result in increased stress[63,64]. Studies have shown that rabbits housed on plastic slatted flooring or in straw bedded pens showed more active/locomotory behaviours than those housed in wire-floored cages or pens[64].

Floor Hygiene: Not only the material of the floor is important, but also the cleanliness. In choice tests, rabbits will prefer to spend time lying and resting on cleaner/dryer surfaces[60,65]. The degree of soiling in commercial housing systems is strongly related to the degree of perforation of the floor but also the type perforation (e.g. slats/slots vs. holes). More supportive floors benefit the rabbit in terms of comfort but increase the risk of poor hygiene compared to wire mesh floors. Compared to wire mesh floors, plastic slatted floors with 11mm slats/slots resulted in higher weight gain and less severe foot lesions in growing rabbits, but greater soiling of rabbits' hind feet and higher mortality[62]. Looking at different types of plastic slatted flooring, it was found that a floor with 12mm circular holes (6% perforation) was associated with higher soiling and higher parasitic burden than a floor with 10mm slats/slots (38% perforation)[66]. However, a separate study found that 10 mm slats/slots (50% perforation floor, 15% perforation platform) performed most poorly both in terms of soiling of the rabbits' feet (>99% rabbits showing soiling) and for wounding to the (hind) limbs (25% of rabbits) compared with flooring with a greater degree of perforation and/or wider slots. Increasing the degree of perforation of the platform (50%) resulted in less soiling (77% of rabbits) and wounds (7% of rabbits) but was still higher than flooring with wider slot width - flooring with 5 mm slats/13 mm slots (75% perforation) had the least amount of soiling (15% of rabbits) and least wounds (0.7% rabbits), while 12 mm slats/slots (50% perforation) had an intermediate number of rabbits showing soiling (50%) and but similarly low levels of wounding (2.4%)[53]. Neither of these studies, however, investigated how rabbit behaviour was influenced by flooring type.

Young kits (7 days) showed a high level of unsteady movements (>47% of movements) on slatted floors with slot widths ranging from 10-16 mm (10 mm slat width on all floors), and the number of unsteady movements increased with slot width (up to 63.6% on flooring with a slot width of 16 mm)[67]. However, the frequency of unsteady movements decreased with age and there was an overall low level of unsteady movements and little differences between flooring with different slot widths by weaning age (0.3 – 0.9% of movements were unsteady at 35 days)[67]. Looking at the behaviour of adult does on the same flooring, it was found that in general they were more likely to orient their feet crosswise to the slats (as opposed to parallel with the slats, and this preference was higher at increasing slot widths - does oriented their feet parallel to the slats in 21.3% and 19.8% of observations on flooring with 10 and 12 mm slots respectively, while this dropped to 12% and only 7.3% of observations on flooring with 14 and 16 mm slots, respectively[67]. In parallel, squatting behaviour increased from 11.0% and 11.7% of observations on flooring with 10 and 12 mm slots, to 15.0% and 16.1% on flooring with 14 and 16 mm slots, respectively[67]. This indicates that slot widths of >14 mm impact even adult rabbits' normal movement and use of the space more than narrower slot widths. Indeed, when growing rabbits were housed on wooden slats with a 3 cm slot width, their normal movement was impeded, they showed less relaxed resting postures, and had higher levels of hair cortisol, an indicator of chronic stress, than rabbits housed on plastic flooring[63]. Very wide openings on slatted floors, while potentially beneficial for hygienic reasons, can be detrimental for animal welfare. Appropriate floor design should be combined with increased space allowance to both improve rabbit comfort and reduce the risk of poor hygienic conditions[14].

Litter provision: although some studies have shown that when given the choice of flooring including

deep litter (vs plastic and/or wire mesh), deep litter appears to be least preferred[61,68], this preference is likely due to poor cleanliness of the litter. Rabbits housed in straw bedded pens were found to spend more time cleaning their fur than rabbits housed in cages or wire floor pens[64,69]. Dirtiness of the pen, however, is a management issue, and not an inherent problem of straw provision. More recently, a 2019 study found that rearing on straw was not associated with higher parasitic load or mortality, and in fact the rabbits had cleaner fur than those reared on plastic slats[70]. The low stocking density used in this study (9.60 animals/m^2 of floor space), and the addition of fresh straw daily likely reduced the soiling within the straw pens. The type of litter itself can also impact the hygiene of the housing, with materials with a high ability to bind and release liquids less likely to contribute to foot lesions[71].

Recommendations on Flooring: Alternatives to wire mesh flooring such as plastic slats are recommended for rabbit comfort and enable more active behaviours. The ability of the flooring to provide comfort but also remain clean and dry should be considered together. The use of bedding, such as straw, can provide additional comfort, enrichment (gnawing material), and a source of ad lib fibre for dietary health, but ought to be changed frequently to ensure good hygiene and/or have a high ability to bind and release liquids. Reducing stocking density can also benefit the pen hygiene and allow for the provision of more comfortable flooring.

ENVIRONMENTAL ENRICHMENT

Rabbits need varied, stimulating surroundings to stay occupied. Restricting natural behaviours leads to frustration, stress and stereotypies such as bar biting and over grooming[29].

Platforms: Rabbits benefit from different levels in housing, such as platforms. Rabbits are motivated to gain access to platforms[72], and rabbits perform more active behaviours when platforms are present, which can have a positive effect on bone strength[73]. Platforms also provide additional opportunities for resting undisturbed, and rabbits in pens with platforms show longer durations of lying fully stretched[74] – an indicator of comfort/relaxation. While some studies have found preference for floor areas over platforms, platforms can also serve as a look out position or provide rabbits with the opportunity to escape other individuals, or even serve as a place to hide underneath. There also may be variation in the use of platforms throughout the day. In one study, up to 70% of rabbits were observed using the platform during the night while during the day, only 40% of rabbits used the platform[75]. Additionally, time spent underneath the platform was found to be higher during daylight hours[75]. Rabbits would typically spend a large portion of the day under a protected area so may choose to spend time underneath the platform for a feeling of safety. When platforms are made of solid material, significantly more rabbits than expected have been observed in the area underneath platforms than on top[65].

Hiding Places: Rabbits which are not provided with a place to hide show more abnormal behaviours, and restless behaviour[76], an indication of poor housing conditions and discomfort. Not all material provided as hiding spaces may be used as such by rabbits[74,77] so trialling of enrichment is recommended to find the most effective type. A wooden 'U' structure used for gnawing and resting can reduce faecal glucocorticioids after transport, indicating reduced stress levels[41]. Specific hiding places, such as tubes, barriers or enclosed boxes, or even artificial burrow systems (e.g., Lapin et Bien pen system, France[78]) can be provided to allow rabbits to escape from aggressive individuals and to feel safe whilst resting in an enclosed space.

Gnawing Material: Chewing and gnawing is an important part of a rabbit's behavioural repertoire[4] and necessary for good oral health – as rabbits' teeth grow continuously, rabbits need to wear down their teeth by the repeated tooth-to-tooth contact when gnawing and chewing[79]. The inability to

express gnawing behaviour is the main risk factor for the development of abnormal behaviours either directed to the cage or to their pen mates[14]. Studies have shown that the provision of gnawing material can reduce cage chewing/scratching by 33-50%[42,44,80]. Additionally, providing gnawing material has been shown to reduce negative social interactions (reduced skin and ear lesions) and increase positive social behaviour (increased social grooming) in rabbits[44,80–83]. Rabbits with access to gnawing material also show reduced stress (cortisol, glucocorticoid metabolites in faeces)[41,84] and reduced fear responses[85] to novelty. EFSA (2020) ranked the inability to express gnawing behaviour as the second most important welfare consequence in conventional cage systems for growing rabbits[14]. Hard materials provide an outlet for gnawing behaviour, whilst preventing gnawing being redirected to the cage, and help to wear down the rabbit's teeth and improve oral health[29,41]. Wooden sticks are the most common type of gnawing material provided[4], and rabbits will spend more time in areas with wooden sticks than in areas without[82]. Rabbits show a preference for softer wood over harder wood[86,87]. Wooden gnawing blocks made of White willow, White buckeye, Little-leaf linden and Norway spruce increase gnawing activity better than other types of wood[87]. However, when wooden gnawing material is compared to other materials such as hay and straw, rabbits show a clear preference for the hay and straw[88,89]. Providing gnawing blocks made from compressed organic material can also benefit production - rabbits provided with gnawing blocks of compressed hay or wood fibre had higher daily weight gain post weaning than those that had none.

Lighting: Rabbits' natural behaviour follows a diurnal pattern – as prey animals they are most active in the morning and evening, which is controlled internally and by external factors such as light[17,90]. Rabbits do the majority of their feeding during the night. Most studies on lighting and lighting schedules in rabbits have looked at their effect on reproductive performance rather than welfare. When offered the choice between areas of different light intensities, breeding does preferred housing with low lighting (10 lux) compared to all other intensities (35, 75, and 155 lux). However low lighting can hinder management and effective observation of the rabbits, and lighting levels should be sufficient to enable the stockperson to check all animals without problems[91]. The European Union Reference Centre for Animal Welfare recommend a lighting level of 50 lumen/m^2 or 50 lux to allow for visual contact and normal activity[92]. Providing hiding places to the rabbits (see above) allows them to control their own lighting environment. The importance of natural light, and the provision of both dawn and dusk transitions were recommended by EURCAW[92]. Natural light increases the variation in lighting conditions across the day and season. Natural light can be provided through windows or solar tubes and can be supplemented with artificial lighting, ensuring 8 hours of continuous darkness and a dawn-dusk transition. The dawn-dusk phase is recommended to be 30 minutes to two hours long, and involves dimming the lights during this period in the morning and evening before full light/darkness[92]. This is to naturally mimic natural light changes at dawn and dusk, when rabbits are most active.

Recommendations on Enrichment: Provide rabbits with a varied and stimulating environment which facilitates their natural behaviour. Platforms not only provide additional space for the animals, they also provide hiding opportunities and allow rabbits to perform vigilance behaviours. Hiding places are important to reduce stress and abnormal behaviours by allowing rabbits escape any perceived danger and give rabbits a place to rest in lower light levels. Provide rabbits with gnawing material for good oral health. Incorporating fibre as part of the gnawing material (e.g. through compressed forage blocks) can also serve as a source of fibre which aids digestive health. The lighting regime should include natural light, and must ensure 8 hours of continuous light and 8 hours of continuous darkness (i.e. < 0.5 lux), as well as dawn and dusk transitions of at least 30 minutes and up to two hours so rabbits can establish their daily rhythm.

OUTDOOR ACCESS

Whilst rabbit farming with outdoor access remains niche in Europe, it does offer a higher welfare potential. Outdoor access provides natural ventilation, typically more space, a choice of environment, and when pasture is provided allows expression of grazing, foraging, exploration and vigilance behaviours[93], which reduces abnormal behaviour[94].

Wintergarden: Although there is little research on providing a wintergarden for growing rabbits, evidence from poultry research shows that they have many benefits. They provide additional space, while still offering protection for the animals, as well as natural light and fresh air, and more opportunities for behavioural expression. Growing rabbits with access to a wintergarden went outside more often during the day, particularly in the morning or evening. Up to 30% of rabbits were observed in the wintergarden during peak usage times and rabbits were more likely to use the wintergarden when indoor conditions were less favourable (less sanitary conditions or higher temperatures)[95,96].

Pasture/Free-Range: In the wild, rabbits will spend 30-70% of their time grazing outside the burrow[97]. Farmed rabbits, if allowed to choose, were found to spend 57% of their time outdoor on pasture rather than in their pens inside the barn[98,99]. They will also divide their behaviours in the different areas with grazing on the pasture, while resting inside the barn. Additionally, larger pasture sizes increased the activity of the animals on the pasture[98]. Rabbits with outdoor access can be less fearful than rabbits housed indoors due to living in a more stimulating environment[94]. Robust cross-breeds are better suited to variable outdoor environmental conditions, and can show better growth performance and meat quality traits, than indoor commercial hybrids[94]. EFSA (2020) highlight that the main hazards for poor welfare of rabbits in outdoor systems are exposure to climatic conditions as well as management of biosecurity, both potentially leading to health problems[14], but these issues can be addressed by improving housing and ventilation, providing additional shelter through trees, and better management of housing hygiene, good feeding strategy, and regular monitoring of the animals. Access to outdoors may also expose rabbits to a higher risk of predation and exposure to predator odours may cause fear. Providing shelters/hiding places outdoors allows rabbits to cope with this by enabling them to perform their natural response to such events (seeking shelter). Additionally ensuring anti-predator barriers, such as robust fencing, net top protection are in place and regularly checked[14] will reduce any actual risk of predation by land or air. There can benefits for humans to providing pasture access for rabbits, as pasture access can increase the nutritional quality of the rabbit meat. Meat from pasture reared rabbits were found to have a lower lipid content, higher polyunsaturated fatty acids and vitamin E, and a more optimal omega-6/omega-3 ratio compared to caged reared rabbits[100].

SOCIAL BEHAVIOUR

As rabbits are social animals, individual housing causes isolation stress. Opportunities for natural positive social interaction (playing, grooming, lying together) should be provided by keeping growing rabbits in groups with adequate space to perform such behaviours[4]. Singly housed rabbits show responses indicative of higher fear levels in behavioural tests[46] and more aggression to humans[101]. Singly housed rabbits show a preference for cages with mirror than cages without[102] and when housed with a mirror, show a more complex behaviour repertoire[103]. Social behaviour also increases with space allowance and the addition of substrate[35].

GENOTYPE

Unlike other terrestrial farmed species, rabbits have not been selected for tameness and adaptation

to the production environment. Instead, productivity has been the predominant trait selected on. Selection efforts should include aspects of health and welfare. Some genotypes may be better suited to more complex environments and may be more resilient when provided with outdoor access. Studies consistently show lower mortality rates among kits from female lines selected over generations for reproductive longevity (an indicator of robustness)[104–106]. Selection for non-specific disease resistance in rabbits is also expected to result in a 4-6% reduction in disease incidence per generation in rabbits[107], which in time would also benefit the reduction of antibiotic usage in rabbit farming.

HEALTH AND MANAGEMENT

DIET AND WATER PROVISION

Rabbits spend nearly half their time eating[29] mostly in the evening and at night[76,90], and feed and water should be available ad libitum to prevent thirst and hunger. In commercial production, feeding practices for growing rabbits differ. Some regimes adjust the diet depending on age, while others may use fewer or even only one diet[14]. Additionally, feed restriction of growing rabbits can be practiced. In France, for example, quantitative feed restriction of growing rabbits is commonly used in conventional production in the first weeks post-weaning (15-30% reduction from ad libitum intake) to improve feed conversion and reduce the risk of digestive disorders[14]. Little research has been carried out on other potential consequences of such a restriction, and it is likely to lead to hunger in the animals[108]. EFSA highlighted digestive troubles, in terms of both prevalence and pain, as one of the main causes of poor welfare in farmed rabbits, with digestive disorders being the leading cause of morbidity and mortality in growing rabbits[14]. While hygiene plays a large role in preventing digestive disorders (see below), feeding a nutritionally balanced diet can help to reduce the risk[109]. Provision of good quality fibre is an essential element on a rabbit's diet which is usually not met in barren caged systems. Both the quantity and the quality of fibre in the rabbit diet are key to reduce the risk of post-weaning digestive trouble in growing rabbits[11].The provision of hay contributes to a high fibre diet and has multiple benefits including enhancing gut health (helping gut movement and controlling the gut microbiota) and oral health by stimulating chewing and gnawing and reducing abnormal behaviours.

Recommendations on Diet: Provide rabbits with diet high in good quality fibre. Providing forage blocks and other organic materials such as hay and straw is a good source of fibre and also serves as gnawing material.

DISEASE, INJURY AND ANTIBIOTIC USE

Rabbits are highly susceptible to respiratory and enteric disease and mortality rates can reach 30%. Compared to farming of other terrestrial animals, industrialised rabbit farming has by far the highest rate of antimicrobial usage[110,111]. In France, while a reduction in antibiotic usage in rabbits has been achieved in recent years, estimates for antibiotic use in rabbit farming in France in 2022 put usage at 180 mg/kg, far higher than the 22 mg/kg and 24 mg/kg used in pig and poultry respectively[112]. The French rabbit industry achieved a sharp drop in antibiotic use between 2021 and 2022 mostly due to large reduction in the use of medicated premixes (-78.9%). A study of Italian rabbit farmers found that, even among the farmers themselves, the majority (78%) believe that antimicrobial use could be decreased[113]. High prophylactic antibiotic use can lead to bacterial resistance and indicates the animals are in unsuitable or unhygienic housing, relying on antibiotics to keep them alive. Hygienic housing and air quality through good ventilation are crucial, preventing the need for routine

antibiotics. Coccidiosis can be reduced by ensuring there is minimal faeces build-up in housing and by using a Coccidiostat, as they are an anti-microbial (not antibiotic). As resistance can develop, however, Coccidiostats should not be permanently relied upon. Pasturellosis can be controlled through strict hygiene and ventilation; however, its aetiology is not fully understood. Across farm animals, the link between animal welfare and antimicrobial usage is clear – better welfare is associated with lower use of antimicrobials while poor welfare leads to higher usage[114]. Poor housing, high stocking density, and a stressful environment can have a detrimental effect on immune responses and leave the rabbits more open to the development of disease leading to an increase in antibiotic usage[115]. Farmers who used housing which provided slightly more space and enrichment compared to conventional cages, reported lower costs for medication (including veterinary care[116]). In the Netherlands, the shift to cage-free higher welfare housing systems for rabbits has been accompanied by a halving in antibiotic usage[117].

Recommendations on Antibiotic Usage: Use robust breeds and provide a better environment to reduce the reliance on antibiotics. Antibiotics should not be used routinely throughout production cycle.

STOCKMANSHIP & HANDLING

While domestication of rabbits has resulted in reduced fear responses towards humans, humans are still considered potential predators[14]. Handling is one of the most common causes of stress in rabbit production[118]. Staff may be present daily but growing rabbits are handled infrequently – when litters are standardised at kindling, during lactation as needed for litter control, at weaning, and finally when caught for slaughter[14]. Gentle, frequent handling of rabbits at a young age reduces fear of humans as the animals mature and can improve growth rate and reduce mortality [29,119,120]. Minimal exposure to humans in young rabbit kits (presence of human hand in the nest for 60s before nursing for seven days) results in lower fear responses to the environment and to humans[121]. Even early exposure to human smell helps reduce later fear towards humans[122]. Regular inspections are important to check on the health of the animals. Singly housed rabbits show increased fear and more negative reactions to humans (aggression). EFSA (2005) recommended regular daily gentle handling of lactating kits to reduce their fear of humans, and that in general movements around rabbits should be quiet and slow[4]. During catching, rabbits should not be caught by the ears[4], and chasing should be minimised to reduce stress. This latter point is especially important in higher welfare systems where rabbits have more space to move away – systems should be designed so that catching is done with the least stress possible e.g. being able to enclose the rabbits in one part of the pen.

TRANSPORT & SLAUGHTER

In caged systems, rabbits are often transferred into transport crates directly from their home cages, but they may need to be carried to the transport vehicle in order to be loaded into crates[123]. Feed withdrawal is sometimes done prior to catching, and once the animal is in the transport crate, they remain without feed and water until slaughter[120]. Poor handling during loading and unloading of transport containers has been highlighted as a risk factor for injury in rabbits, particularly injuries to the limbs[124], even leading to mortality[123]. Careful handling and catching, therefore, are important to reduce pre-slaughter mortality and injuries to the rabbits[120]. During the transport itself, lack of space, both horizontal and vertical, is considered a hazard for poor welfare, as are sensory overstimulation, motion stress, inappropriate thermal conditions, and prolonged hunger and thirst[123]. These hazards are all affected by the length of transport. Longer journey times/distances and longer time spent in

lairage are linked with higher mortality[125–127] - journeys above three hours were found to have a 40% increase in mortality compared with journeys of less than an hour[125], while with even longer transport durations/time in lairage (>5 hours), the mortality was three times that found for journeys under 2.5 hours[127]. A study comparing the effect of multiple transport durations (2, 4, 6, and 8 hours) found that mortality (% liveweight) increased from 2.4% and 2.9% at two and four hours respectively, to 4.4% and 4.6% for transport durations of six and eight hours[128]. Similarly, with respect to transport distances, mortality was found to increase significantly from 0.05% for journeys under 100km to 0.29% for journeys longer than 400km[126].

Recommendations on Transport: It is recommended therefore to keep transport times as short as possible and no more than four hours, including time for loading and unloading.

Controlled atmosphere stunning (CAS) is not permitted for rabbits in the EU under Council Regulation (EC) No 1099/200. Instead, rabbits are usually stunned by electrical methods, and in some cases mechanical (captive bolt, percussive blow)[129,130]. For electrical stunning methods, the rabbits are usually handled individually, and although grabbing by the ears is not permitted as it is considered painful, this is sometimes be done in practice to prevent damage to the fur[129,130]. It is important that the severing of the carotid arteries is performed as soon as possible after stunning as reflexes can start to return as soon as 22 seconds after stunning[131]. Mechanical stunning methods are often not recoverable, and in some cases, death can occur before the animal is bled out[130].

SUSTAINABILITY OF RABBIT PRODUCTION

Although consumption of rabbit meat is declining in many countries[132], rabbit production has a higher potential for sustainable production than many terrestrial farm animals more commonly reared for meat. Rabbits convert a higher percentage of their protein intake into meat than pigs and cattle (20% vs. 16-18% and 8-12% respectively)[26] and just less than chicken (22%)[133]. Additionally, rabbits forage on foods unsuitable for human feed[134] and compared to other grazing animals, require far less energy to produce 1g of meat (105 kcal vs. 422 kcal for cattle, and 427 kcal per sheep)[135]. As grazing animals, rabbits are also suitable for incorporation into other types of agriculture including integrated crop-livestock systems and agrivoltaics systems (integrating animal production with solar photovoltaic (PV) electricity production). In agroforestry systems, for example, integrating rabbit production can have multiple benefits – aside from keeping the vegetation down, rabbits also eat fallen leaves and fruit improving the sanitation, and can contribute to soil fertilisation through urine and faeces[136]. Integrating pasture-based rabbit production in an agrivoltaics system has both environmental and economic advantages – rabbits benefit the system through controlling the vegetation and provide an additional source of revenue (up to 24% increase on site revenue[137]). Integration of pasture-based rabbit production and PV production was found to produce 69.3% less emissions and use 82.9% less fossil energy than non-integrated production of rabbits and PV electricity)[138]. Such integrated systems, provided the welfare needs of the rabbits are met (e.g. through the provision of adequate shelter and antipredator measures), have a high welfare potential.

HIGHER WELFARE SYSTEMS FOR GROWING RABBITS

Caged systems have a low welfare potential as they have inherent limitations due to the restrictions they impose on the behaviour, movement, and comfort of the rabbits – none of which can be compensated for by good management. Housing systems which offer more space (horizontally and vertically) and comfortable flooring enable growing rabbits to perform more of their species-specific

repertoire such as play and other active behaviours have a higher welfare potential. The addition of enrichment such as platforms and hiding spaces offer rabbits more choice over their own environment and opportunities to escape from perceived threat, while the provision of gnawing enrichment and hay/straw not only reduces abnormal behaviours but benefits both oral and digestive health. A source of natural light allows rabbits to develop natural rhythms and provide dawn and dusk transitions, periods where rabbits are naturally more active. Systems with outdoor access have an even higher welfare potential as they offer rabbits even more space, natural light, fresh air, and a choice over environmental conditions. Access to pasture further increases the welfare potential of the environment by enabling the rabbits to graze, a behaviour which takes up much of their time if given the choice. Good welfare in these systems can be assured through the provision of adequate shelter and ventilation and protection from predation. The welfare potential of different production systems is summarised in Table 4, below. Higher welfare systems can help reduce the need for antibiotics, and the use of more robust breeds can help to reduce the risk of morbidity and mortality in less sterile environments. Pasture based rabbit systems can also be used in conjunction with other production (e.g. fruit trees or photovoltaic electricity production) with mutual benefits to each production.

Table 4. Welfare potential of rabbit production systems

							
TYPE OF SYSTEM	**CONVENTIONAL CAGES**	**ENRICHED CAGES**	**PARKS**	**LARGE PENS**	**LARGE PENS WITH WINTERGARDEN**	**LARGE PENS WITH WINTERGARDEN AND BEDDING**	**OUTDOOR CAGE-FREE**
WELFARE POTENTIAL							
HOUSING							
Space Allowance	< 800 cm^2	< 800 cm^2	= 800 cm^{2*}	≥ 800 cm^2	≥ 800 cm^2	≥ 800 cm^2	≥ 800 cm^2
Horizontal Space	Restricted	Restricted	= 180 cm	> 180cm	> 180cm	> 180cm	> 180cm
Vertical Space	Restricted ≤35 cm	Restricted ≤ 80 cm	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted
Flooring	Wire mesh	Wire mesh/plastic footrest)	Slatted	Slatted	Slatted	Slatted and/or Solid	Solid or Pasture
Platforms	None	Platform present	Platform present	Platform present	Platform present	Platform present	Platform present
Hiding places	None	None	Can be provided	Can be provided	Can be provided	Can be provided	Can be provided
Hay/straw fibre	None	None	Can be provided	Can be provided	Can be provided	Provided	Natural forage
Gnawing material	None	Sometimes	Can be provided	Can be provided	Can be provided	Provided	Natural forage
Natural Light	None	None	Can be provided	Can be provided	Provided	Provided	Provided
Outdoor access	None	None	None	None	Provided	Provided	Provided
Pasture Access	None	None	None	None	None	None	Provided

*Although can be lower in practice, this is the minimum acceptable space allowance for growing rabbits

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