Farm rabbits' welfare in different husbandry systems, gaps of knowledge and recommendations

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1. Introduction

There are around 180 million farmed rabbits reared for meat consumption in the EU. Around 119 million (66%) are kept in commercial farms and slaughtered for human consumption in approved slaughterhouses. The other 61 million (34%) are reared, sold and consumed via back-yard farms, direct and local sales. Data from Member States suggest there are approximately 161,000 rabbit back-yard farms and 4,500 commercial rabbit farms in the EU.

Commercial rabbit farming for meat production is concentrated in Spain, France and Italy (83% of EU production: 48.5 million rabbits in Spain, 29 million rabbits in France and 24.5 million rabbits in Italy). There are also commercial rabbit farms in Germany, The Netherlands, Poland, Hungary, Belgium, Portugal and Greece. Together these countries produce 14% of the rabbit meat in Europe. In particular, Hungary and The Netherlands have an export-orientated rabbit farming industry with a very low level of national consumption.

As already defined by EFSA (2005), conventional rabbit farms are mainly based on family workforce, with the number of reproducing does, representing the scale of the farm, varying from hundreds to thousands. Roughly, rabbit farming can use housing systems suitable for large-scale production (conventional cages, enriched cage and elevated pens/park systems) or for niche production systems (floor pens, outdoor/organic housing). The niche production systems are small in number (e.g., organic farming, with around 50 farms in France and a few examples in other countries) and diverse in nature (European Commission, 2017).

The main market for rabbit meat is located in the areas of production (Southern Europe) and is characterised by consumers' focus on quality and cultural traditions besides price (Petracci et al., 2018). Indeed, market demand is the main driver influencing production systems. In these main areas, conventional cages have been for long time the most common farming system used. Conventional cages restrict the expression of natural animal behaviours and often do not meet the minimum recommended requirements for space allowances and cage sizes. On the other hand, conventional cages facilitate the implementation of biosecurity measures, which contributes to better health.

A secondary and much smaller market in volume covers consumers with greater focus on animal welfare. For this market, farming is moving towards enriched cages and pen housing systems. Whilst it provides better opportunities for rabbits to express natural and social behaviours, it presents weaknesses regarding biosecurity and as a result, higher mortality and morbidity rates. Rabbit meat produced in this system is more expensive at retail level and could be labelled in some countries. Throughout The European Union, production systems with enriched cages partially address shortcomings on animal welfare presented by conventional cages whilst maintaining biosecurity strength.

Since 2018 rabbit production has been included into the EU organic farming regulation (EC Reg 2018/848) and this will come into effect in 2021. Specific requirements for implementation are currently under discussion. At the moment, some (organic or not) alternative rabbit production is based on national production protocols, e.g. Label Rouge in

France (https://www.inao.gouv.fr/show_texte/4380) and organic rabbit farming in Italy (http://www.ccpb.it/wp-content/uploads/2018/02/Standard-BIO-ED-2-REV-3-2018_02_19-ITA-EDIT.pdf).

In the relative short time that has elapsed since the beginning of its use as farmed animal in industrial-like conditions for meat production, the rabbit has not been able to fully adapt to changes in the breeding environment, as these changes often do not allow the animal to manifest much of its ethogram and especially its social behaviour.

The conventional cages have led to a shift from living in groups, as is the case in nature, to fattening in single- or double-cell cages that, even if visual, acoustic and olfactive contacts are permitted, are somehow unnatural for the species. These situations of discomfort can lead the rabbit to stressful conditions which can lead, together with the high density of animals and a possible high environmental microbial load, to chronic stress, immunosuppression and consequently to the development of diseases that can affect the productivity of rabbit farms, leading to high mortality and the concomitant increase in the use of antibiotics, which in turn favours the possibility of the development of antibiotic resistance phenomena.

The growing attention to the welfare of rabbit breeding is witnessed by the interest in new housing systems such as those characterized by environmental enrichments, collective housing, outdoor systems, organic breeding, that also provides an increase in the surface area available to the animals compared to the minimum spaces of intensive single-cell cages.

This review describes the different rabbits housing and management systems existing in Europe with an evaluation of their positive and negative welfare aspects to allow a better understanding of the current situation in all its facets, highlighting also the critical points and future prospects.

The welfare consequences of these different housing systems were reviewed in EFSA (2020). Besides literature review, EFSA 2020 involved expert views, and based on these, the welfare consequences of each system were listed. Through the lack of enough other sources, the information about the negative welfare consequences and preventive measures in this review will mainly originate from EFSA 2020 completed with other references when available.

2. Conventional cages and their welfare aspects

The current rabbit conventional farm systems have been developed in the European Union since the mid of 1950. In these systems, rabbits are kept in barren wire mesh cages. Fattening rabbits are usually kept in pairs (bi-cellular cages) (Figure 1) or in small groups (dual-purpose cages) (Figure 2); breeding females are kept with their litter from kindling until weaning age (30-42 days after kindling, depending on the farm organisation). The adoption of this breeding system was mainly due to hygienic reasons, as it allows the separation between the animals and their faeces and urine. Conventional cages may be arranged on a single level, such as the “flat-desk” one, in which they are organised in two opposite rows, and “California” system, in which cages are in a ladder-like position, or the “battery” system, in which cages are organised

in several superimposed levels. These systems, particularly the last two, provide more space allowance, but require additional tools such as bulkheads or inclined panels to manage the flow of manure without soiling the cages below. In order to better optimize spaces, wire cages are designed in removable and transportable modules that can be also placed in specially designed facilities, i.e. masonry or prefabricated structures and, more recently, tensile tunnel structures, even cheaper and lighter. The Table 1 below describes the sizes of conventional cages usually used for the different rabbit categories.

Table 1: Sizes of conventional cages for housing different categories of rabbits, adapted from EFSA 2020

	Width (cm)	**Length (cm)**	**Height (cm)**	**Total available surface (cm^2)**
CONVENTIONAL CAGES				
Bicellular cages for growing rabbits	25.4	44	28	1200
Young or non-pregnant female Growing rabbits	38	43.5-66	28-41	1650-2510
Basic standard models for reproducing does with litters or for growing rabbits (**dual purpose cage**)	38	87-102	32-39	3300-3900
Wider versions for reproducing does with litters or for growing rabbits (**dual purpose cage**)	46	95-102	35	4370-4700

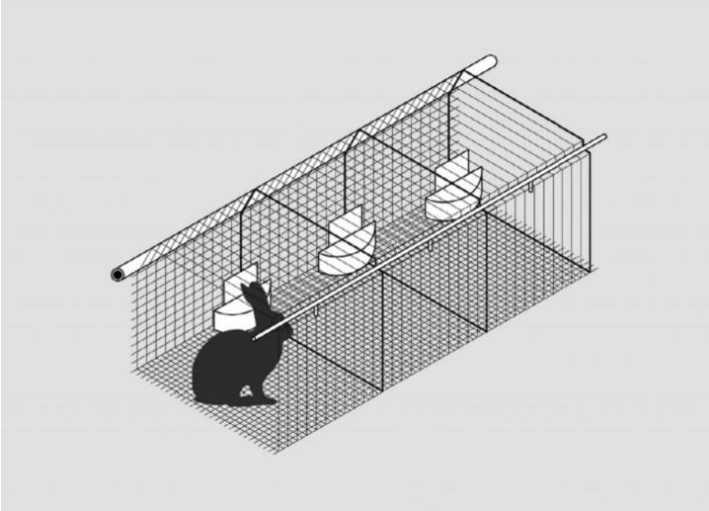


Figure 1. Example of a bicellular conventional cage (EFSA, 2020)

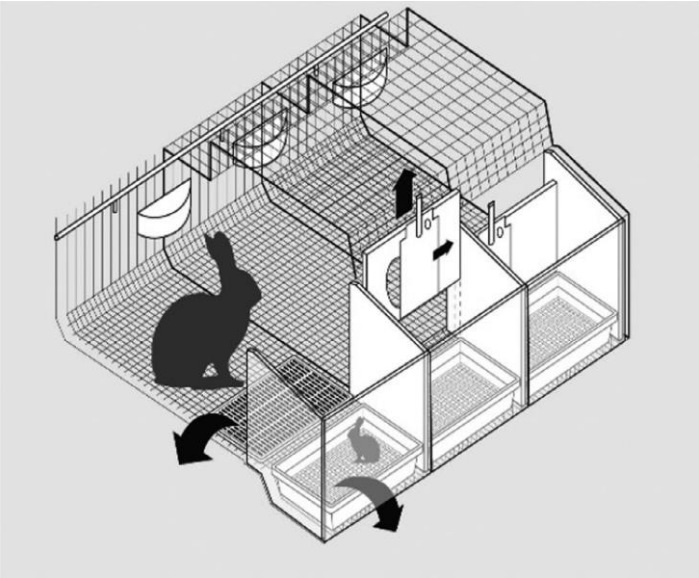


Figure 2. Example of a dual-purpose conventional cage (EFSA, 2020)

2.1. Reproducing does

a. Description of the system

A doe is a rabbit female from first kindling till culling. Females are usually inseminated at about 18 weeks of age, at a live weight of 3.4–3.6 kg, corresponding to 80–85% adult weight. Then, the length of the reproductive career may vary with genotype, reproductive rhythm, feeding regimes and sanitary status, but the average culling age in reproducing does is 15 months and 6 parturitions (Rosell and de la Fuente, 2016 a,b).

In commercial farms, reproducing does are individually housed in wire cages and, after parturition, with their offspring until the age of weaning (which varies, depending on the farm organisation, from 30 to 35 days of age).

According to EFSA opinion (2005), a breeding female rabbit at the end of pregnancy needs 65-75 cm of cage length to lie and stretch out and a minimum width of 38 cm to turn round and lye on her sternum and groom comfortably. Cages should provide locomotory behaviours, (possibly with a platform), visual contact with other animals and other enrichments to compensate for the social isolation which occurs when litters are weaned. The minimum total surface area should be 3500 cm^2.

In a large majority of specialised farms, cages are predominantly “dual purpose” (Figure 2). In farms using these cages, while the doe is moved after weaning to a clean and disinfected enclosure, kits remain in the same cage where they were born until slaughtering. This also permits the all-in, all-out approach, as well as cleaning and disinfection for the following incoming reproduction cycle. Conversely, in other farms the doe always remains in the same cage after the litter weaning, to give birth for the next litter, whereas weaned rabbits are moved into the growing enclosures (EFSA, 2020).

Dual-purpose cages are equipped for the reproducing doe and its litter with a feeder and a nipple drinker and a removable plastic nest containing the litter in the front. A plastic footrest can also be used, which can be removed or not during rearing of growing rabbits. The nest area is separated from the other part of the cage by a removable wall with a sliding door that can be closed for controlled lactation during the first 1–2 weeks after kindling. This procedure is done by some farmers from 2-3 days after parturition, so that the does can nurse their kits only once per day until 14-15 days. Controlled nursing is not contrary to doe rabbit natural behaviour, as the large majority of wild and domesticated does nurse their kits only once a day and nursing time is very short (Szendrő et al., 2019).

Nest boxes minimum width is commonly 34-45cm, length 24-27cm, and height 30-38cm (same height as the cage) and nesting material has to be adequate in quantity and quality (e.g. wood shavings, straw, hay, hemp or synthetic fibre) in order to maintain kits' thermal comfort (Szendrő et al., 2019). Rabbit females normally kindle 31-33 days after the mating or artificial insemination; after parturition, cross-fostering of kits to equalise litter size is a common practice (EFSA, 2005). At weaning, after separation of the doe, the walls between the nest and the rest of the cage and the nest box are removed to obtain a unique space in which growing rabbits will remain till slaughter age. The weaning of the kits is a very delicate moment that needs particular attention even when moving the animals. After weaning, the littermates should stay together in the same breeding cage or pen as long as possible or, better, up to the slaughter age (Italian Ministry of Health, 2014). In most conventional farms, restocking does (replacement does before breeding and inseminated does but not pregnant) are usually housed in cages smaller than reproducing cages for a brief period (5-8 weeks) before entering the batch production management system.

b. Positive welfare aspects

Compared to group housing systems, conventional system prevents the does from aggression, fighting behaviour and the consequent stress.

In these systems, reproducing does are commonly housed individually for about one week from litter weaning to the next kindling, under the most common conditions for which litters are weaned at 35 days of age and a reproductive rhythm of 42 days is used. Indeed, they are kept individually during this period because they are preparing for the next kindling and they can remain quiet and calm.

In natural conditions does with small kits tend to be separated from other adults. Indeed, scientific findings on welfare and reproductive performances of does group-housed continuously throughout the reproductive cycle have clearly shown worse outcomes than conventional breeding (Szendrő and McNitt, 2012; Hoy and Matics, 2016). Group housing also results in higher mortality and/or lower average weight of kits than individual housing, as does enter the nest of the other ones, biting and injuring other kits (Ruis, 2006; Szendrő and McNitt, 2012). Decreased sanitary status, greater haptoglobin and cortisol concentrations, higher culling and shorter lifespan have also been reported (Andrist et al., 2013; Szendrő et al., 2013; Pérez-Fuentes et al., 2020). In addition, some specific behaviours are possible in conventional

systems, mainly all those related to peripartum and lactation periods. Moreover, feed and water are always accessible, as feeding system can be highly automated, feed is usually given ad libitum and dehydration is almost never observed in a conventional system.

c. Negative welfare consequences and preventive measures

According to the EFSA opinion 2020, the overall welfare impact score for reproducing does is lower in conventional cages than in the other housing systems. Specifically, the main welfare consequences impaired by conventional cages is restriction of movement and resting problems, followed by inability to express gnawing behaviour and inability to express social behaviour. However, both the conventional and enriched cages, as well as elevated pens were scored similarly by the EFSA panel for restriction of movement for does. This evidence might be due to the definition of "restriction of movement" applied for the assessment, defined as the inability to perform three consecutive hops (EFSA, 2020). Due to physical restraint or lack of space, knowing that the length of a hop has been reported to be up to 70 cm (it depends on the rabbit's body size). This number of three hops needed for a rabbit not to be restricted in its movements is recommended by the Council of Europe for the housing of rabbits used for experimental purposes in laboratories (2006). On the other hand, EFSA (2020) itself concluded that knowledge on the space requirement which is necessary to acceptably meet the behavioural and physiological needs for all rabbit categories is still lacking.

- *Restriction of movement and resting problem*

Individual housing (from litter weaning to the next kindling) in cages limits the expression of some specific and natural behaviours, such as hopping, jumping, running, or exploring. Usually, locomotory activity under farming condition is very low, but this may be caused by the type of housing itself, which leads to reduced motivation, consequently causing frustration (EFSA, 2020). Moreover, a restricted space allowance, as well as dirty surfaces, can also affect resting behaviour. To lie stretched out is crucial for rabbit welfare, as it supports thermoregulation through heat dissipation. Rabbits which are not able to adopt a relaxed posture may experience stress, injury, and pain. During lactation and before weaning, when the doe and young rabbits are still together (during the fifth week of nursing), behaviours such as resting behaviour and mutual grooming are inevitably limited even when minimum cage dimensions are provided (EFSA, 2005).

- *Inability to express gnawing behaviour*

The inability to gnaw is a main consequence for conventional cages, which is associated with the absence of gnawing material, usually very common in this type of system. Gnawing behaviour can be satisfied by providing gnawing blocks, such as wood mash, wood mash + chicory pulp and wood mash + inulin syrup). The gnawing blocks, in a study by Maertens et al. (2013), did not prevent the doe from biting the wire walls, but on the other hand significantly increased does' active behaviours and decreased the number of visits into the nest box, which

was positively considered. However, gnawing elements should be fixed on the ceiling of the cages instead of the floor, to prevent undesirable contamination by pathogenic microorganism and consequently, severe infections.

- *Inability to express social behaviour*

As rabbits are in a barren environment and exposed to few stimuli, they may manifest stereotypies, and cannot freely and fully express their social behaviour (Rödel et al., 2006; Szendrő and McNitt, 2012). The inability to show social behaviour refers to the period between weaning and the following parturition in which the doe is kept alone (EFSA, 2020).
Although semi-group housing systems (or part-time, i.e. rabbits are kept in groups only for some specific periods, see 3.2.1.a.) have been proposed and studied, as they could be more suitable for conventional farms and increase at the same time does welfare, none of them resolved completely the risk of injuries, fighting and aggression (Szendrő et al., 2019); even varying the time of group formation (Braconnier et al., 2020). According to EFSA 2005, keeping lactating females in pairs is not recommended because of risk of aggression. Notwithstanding several recent studies aimed at defining the best solutions for part time group-housing of does, the transition to such type of housing is less obvious and not yet fully practicable without some negative consequences on animal welfare.
Social behaviour of does during the period of individual housing (one week over 42 days), could be satisfied by maintaining a visual and olfactory relationship, providing wire net walls. Indeed, solid walls may cause lower production, such as reduced kindling rate, or increased total litter loss (Szendrő and McNitt, 2012). Besides, when there are solid walls, adding mirrors as a source of sensory enrichment may reduce the effects of isolation and compensate the lack of social contact (García, 2020). These measures however do not guarantee the full expression of the normal social repertoire of rabbits (allo-grooming, laying side by side etc.).

Since single housing is for now the only system protecting does from the risk of injuries, compared to collective housing with other reproducing does, the only option to improve does welfare is to focus on environmental enrichment and design of conventional cages. Enlarge cage dimensions could increase active behaviour of does as well as their activity i.e. sitting, standing, moving considered together (Bignon et al., 2012). The importance of cage height can be due especially to the possibility of performing alert and exploratory behaviours (García, 2020). Enriching the cage by putting raised platforms over the floor aims at satisfying the doe's need for isolation from its litter rather than stimulating exercise (Trocino and Xiccato, 2006). On the other hand, platforms, when not properly designed, can impair health condition of the animals and the cage hygiene, because of the reduced removal of manure, and daily checking can be also more difficult (Szendrő et al., 2019).
In addition, the use of plastic mat over the wire mesh of the cage can reduce the development of pododermatitis, which is a very frequent welfare problem in does. Pododermatitis is painful for the animal and can lead to ulcerations. It mainly affects adult breeding rabbits, females and males. Its occurrence increased with animal's age and may vary with genetic lines, being

more frequent in heavy weight rabbit breeds. The main hazards are wire flooring and its hygiene (cleanliness and presence of faecal residuals). Furthermore, the presence of sore hocks can be very frequent because of the increased does' weight and longevity in this type of cages especially when wire mesh of cages is altered, thus causing micro-traumatic lesions with bacterial contamination. Nevertheless, the type of housing system is not considered a hazard for this pathology (EFSA, 2005), since it is mostly related to the floor type and floor bedding, humidity and genetics. Effectively, the use of platforms and plastic mats, increasing the height of the cage, means a shift from smaller conventional cages to larger enriched ones. Finally, putting gnawing elements will aim to satisfy does gnawing needs.

2.2. Kits

a. Positive welfare aspects

According to the EFSA scientific opinion (2020), no difference in the welfare of kits in conventional cages, enriched cages, floor pens and organic systems can be detected, although conventional cages had the second-best welfare impact scoring for kits after elevated pens. Mikó et al. (2014) evaluated the performance and welfare of rabbit does in various caging systems demonstrating that kindling rate, litter size and kit mortality were not significantly influenced by the cage type. Nevertheless, single cages rather than group housing, prevent the kits from being attacked by other females, reducing kit mortality during lactation (Szendrő et al., 2013; Dal Bosco et al., 2019; Szendrő et al., 2019; Pérez-Fuentes et al., 2020).

Moreover, conventional systems protect kits from thermal stress (which is a crucial welfare consequence for kits), as in this type of systems the climatic conditions are strictly controlled. However thermal stress, hypothermia, and death can be occasionally observed under conventional farm condition due to inadequate amount of nesting material or hair, and of soiling of the nest by the doe with manure; in fact, during the first 10-12 postnatal days, the kits have only a limited capacity for independent thermoregulation.

Under current conventional rabbit farming, the risk of prolonged hunger or thirst appears to be infrequent. Situations of chronic hunger may arise in kits before weaning, just when the milking capacity of the doe is insufficient (poor body condition, pathology, poor maternal behaviour).

Restriction of movement for kits in conventional cages is not a problem, as they prefer to remain closely together for most of the time in the nest box. They start to leave the nest around 16-18 days (even if there is a lot of individual variability). Kits are not able to jump over a platform until around the weaning period. According to García (2020), when kits begin to leave the nest box and a platform is provided, the use of this facility by the doe decreases and the kits begin to use it from 66% to 94% of the time.

b. Negative welfare consequences and preventive measures

The main negative welfare consequence for kits in conventional cages is the inability to gnaw (EFSA, 2020).

- *Inability to express gnawing behaviour*

The inability to gnaw resulted the most important welfare consequence for kits in conventional cages. This result was unexpected for EFSA (2020), because there is not published literature on kits' motivation for gnawing or use of gnaw material.

2.3. Fattening rabbits

a. Description of the system

A fattening or growing rabbit is a rabbit from weaning to the slaughter age, which can vary from 63-77 days (2.2 -2.5 kg) to 85 days (3.0 kg), depending on the market demand. In conventional systems, fattening rabbits can be kept in pairs or in groups of 4-5 animals. The in-pairs housing system uses bicellular cages (from weaning until the end of fattening). Additionally, in dual-purpose cages, growing rabbits are reared in small groups (4-6) from birth to slaughter after the removal of the doe. Bicellular cages (Figure 2) are usually 25.4 cm width, 44 cm length and 28 cm height, with a total surface of 1200 cm^2. The floor most commonly used for growing rabbits is wire mesh; additionally, only in case of dual-purpose cages, the floor can be paired with a plastic footrest pad (usually 25 x 36 cm with space between slats equal to 1,6 x 7 cm).

The stocking density of fattening rabbits in terms of animal reared/m^2 and kg final live weight/m^2 differ according to each national regulation or national guidelines (EFSA, 2020). Stocking density can be adapted also by farmers according to microclimate, genetic lines, conditions and equipment (e.g. ventilation) of the structures in which animals are kept (management of growing, feeding, and biosecurity measures).

Conventional commercial rabbit farms in Europe, during the growth and fattening phase, usually have stocking densities varying between 16 and 20 animals/m^2 (Trocino and Xiccato, 2006) (Table 2).

However, according to EFSA (2005), these rearing conditions are not adequate to ensure the welfare of rabbits on farm. Fattening rabbits should be kept in collective cages with minimum 75-80 cm depth, 35-40 cm width and 38-40 cm height according to EFSA (2005). As stated by EFSA (2005), minimal individual surface should be 625 cm^2 and maximum density at 40 kg live weight at slaughtering/m^2. According to that, changes in systems all over Europe have occurred and nowadays most farmers work with such maximum range, or even lower, which corresponds to 16 rabbits/m^2 when slaughtering weight is 2.5 kg.

Table 2: Dimensions of cages and stocking density used in Europe for rearing of fattening rabbits and EFSA opinion (2005) (Adapted from Trocino and Xiccato, 2006)

Country Type of cage	Width (cm)	Depth (cm)	Height (cm)	Total surface(cm^2)	Rabbits per cage	Individual surface (cm^2)	Stocking density (rabbits/m^2)	Slaughter weight* (kg/m^2)
France / Belgium / The Netherlands								
Dual-purpose (multi-function)	40	90-100	29-30	3600-4000	6-7	515-570	17.5-19.4	40.3-46.6
Italy/Hungary								

Fattening in pair (bi-cellular cages)	28	43	35	1200	2	600	16.7	41.8-41.5
Dual-purpose (multi-function)	38	95	35	3600	5-6	720-600	13.9-16.71	34.8-45.0
Spain								
Dual-purpose (multi-function)	40	85	33	3400	7-8	485-425	20.6-23.5	45.3-51.7
EFSA (2005)								
Dual-purpose (multi-function)	35-40	75-70	38-40	-	-	625	-	40

Feed distribution can be manual or automatic. Feeding programmes can be specific to the different growth stages to satisfy specific nutritional requirement during growth. Feeding can be *ad libitum* or restricted. Feeding (post-weaning) restriction (15–30% reduction from *ad libitum*) can be applied in order to reduce post-weaning digestive disorders and to improve the feed efficiency (EFSA, 2020).

b. Positive welfare aspects

Positive welfare aspects of bicellular cages are limited to the better control of pathologies and reduced incidence of injuries and traumatic lesions.

In a study comparing behaviour and welfare of growing rabbits housed in cages and pens, rabbits housed in bicellular cages had a lower hair corticosterone concentration than rabbits housed in collective pens (Trocino et al., 2014). As the authors highlighted, this result could reflect the housing condition per se or could be attributed to other factors, such as the difficulty of establishing a stable social hierarchy due to the high number of conspecifics in the case of collective housing.

Housing fattening rabbits in small groups can reduce the risk of injuries and fighting, as aggressive behaviour is one of the main problems of housing rabbits in large groups. This behaviour can be related to group size or related to the greater possibility of an aggressive and dominant male to injure more group-males (Szendrő and Dalle Zotte, 2011). However, until sexual development (around 10-11 weeks of age) fighting is seldom observed in fattening rabbits. This problem can be observed in the production of “heavy rabbits” (till 3.0 kg) which are slaughtered later.

c. Negative welfare consequences and preventive measures

According to EFSA (2020), the welfare of growing rabbits is worse in conventional cages when compared to other systems. In particular, the main welfare consequences impaired are restriction of movement, followed by inability to express gnawing behaviour and resting problem.

- *Restriction of movement and resting problem*

It has been recently accepted that rabbits should be able to perform at least three consecutive hops (EFSA, 2020) as a parameter of freedom of movement, even if this statement has never

been scientifically validated. Undoubtedly, current conventional cage dimensions and surface area per rabbit restrict the normal locomotor behaviour especially when reaching the slaughter weight (EFSA, 2005). Several studies have demonstrated that locomotor activity of fattening rabbits is slightly lower (less time spent rearing, hopping, and running) in cages compared to pen-systems, mainly due to a lack of space (EFSA, 2020). However, it should be considered that, in general, locomotory activity under farming conditions appears to be low; running and rearing were observed in less than 1% of the scans in several studies (Buijs et al., 2011; Trocino et al., 2014; Buijs et al., 2015; Trocino et al., 2019).

The high stocking density constrains resting behaviour for growing rabbits kept in conventional cages. As well as does, fattening rabbits' resting behaviour can be impaired by floor properties as well. Rabbits can show physical discomfort (heat stress, lesions, pain) when they are not able to adopt relaxed postures or are forced to lie on inadequate dirty surfaces (EFSA, 2020). As well as does, the restriction of movement and resting problem for fattening rabbits can be solved only by reducing stocking density and shifting from conventional to enriched cages or other alternative systems.

- *Inability to express gnawing behaviour*

Rabbits can also show some stereotypes such as licking or biting the cage. Straw, hay or wood supplements have been shown to be a way of reducing this kind of stereotypes (EFSA, 2005). Gnawing material is very uncommon in conventional cages, but it is considered an important tool to extent the behavioural repertoire of rabbits (EFSA, 2020). A study by Princz et al. (2008a) concluded that these animals preferred cages provided with gnawing sticks. Moreover, the resting, locomotive and aggressive behaviour was modified by the housing system and the presence of gnawing sticks decreased the frequency of physical injuries (ear lesions) in the case of collective housing.

2.4. Conclusions on the conventional cages

	Positive welfare aspects	Negative welfare aspects	Recommendations
Does	– Higher health condition / Lower incidence of infectious diseases – Prevention of fighting, aggression and injuries – No competition for nest sites – Better body condition – Longer lifespan	– Restriction of movement (insufficient space) – Resting problems – Inability to express gnawing behaviour (insufficient gnawing materials) – Inability to express social behaviour (during some specific periods)	– Increasing available space allowance – Use of plastic mesh floor and plastic mesh elevated platform – Provide gnawing materials (e.g. wood mash) – Guarantee wire net walls (to maintain at least a visual and olfactory

			relationship with other animals)
Kits	– Thermal comfort – Lower mortality – Prevention from aggression and injuries by other females	– Inability to express gnawing behaviour (insufficient gnawing materials) – Poor nest quality	– Provide plastic mesh floor – Provide gnawing (e.g. wood mash) and good nest materials – Frequent nest control to reduce wet and dirty nests
Fattening rabbits	– Less aggression and injuries caused by other and dominant animals	– Restriction of movement (insufficient space) – Resting problems – Inability to express gnawing behaviour (absence of gnawing materials)	– Increasing available space/decreasing the stocking density – Provide gnawing materials at all ages (even after weaning)

3. Alternative husbandry and management rabbits rearing systems and their welfare aspects

3.1. Enriched cages

3.1.1. Reproducing does

a. Description of the system

Enriched cages have greater floor area and height than conventional cages: up to 52.5 cm of width, 102 cm of length and 60-80 cm of height against 46 cm, 102 cm and 35 cm for wider versions of conventional cages. These cages are equipped with wire-mesh or plastic-mesh elevated platforms and plastic footrests, occasionally a gnawing block can be present. Enriched cages are usually dual-purpose, they are used for does and their litter before weaning and then for small groups of fattening rabbits (4-5 rabbits). Does are placed in this cages a few days before kindling and stay with its litter until weaning (depending on the farm organisation, from 30 to 35 days of age).

When the cage is inhabited by a doe and its kits, a removable plastic nest is present in the front of the system for the litter until 15 to 21 days after kindling before removing (to stimulate solid feed intake of the kits). This nest area is separated from the rest by a removable wall with a sliding door, which can be closed during the first 1-2 weeks after kindling for controlled lactation (Figure 3).

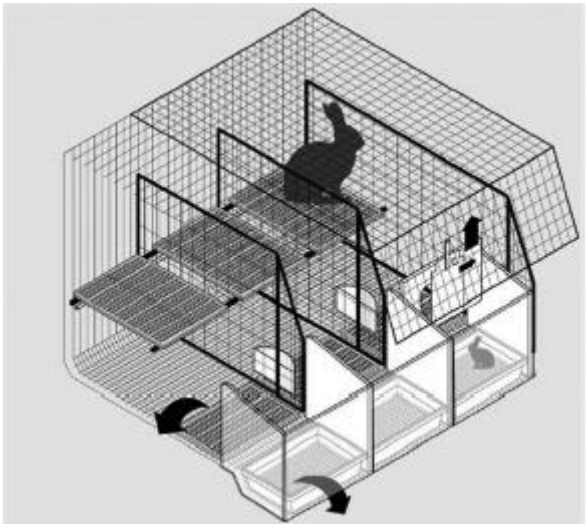


Figure 3. Example of a dual-purpose enriched cage (EFSA, 2020)

b. Positive welfare aspects

One main positive welfare aspect of enriched cages is that they allow greater space for animals than conventional cages and thus, more freedom of movement (4370 cm^2-6400 cm^2 of total available surface and 60-80 cm of height for enriched cages against 3300 cm^2-4700 cm^2 of available surface and 28-41 cm of height for conventional cages)(EFSA, 2020). Knowing that adult rabbits are about 60 cm tall in a standing position, enriched cages could permit them to stand up. But, even if there is sufficient length for them to sit up with their ears erect (38-40 cm minimum) (EFSA, 2005), enriched cages' space could be insufficient for the expression of vigilance postures (Dorning and Harris, 2017). Nevertheless, according to EFSA recommendations (2005) the space available is sufficient to stretch out, turn round and lie on their sternum for breeding female rabbits toward the end of pregnancy, during lactation and towards the time of weaning with her litter.

Plastic footrests have positive welfare aspects by reducing the incidence of footpad problems (pododermatitis and sore hocks) (Rosell and de la Fuente, 2009; Rommers and De Jong, 2011; Buijs et al., 2014; Miko et al., 2014) which are commonly observed in breeding animals staying on wire mesh floors (EFSA, 2020). However, plastic flooring would be preferable to only plastic footrest because even minimal contact with wire mesh floor can cause footpad problems (Rosell and de la Fuente, 2009; Buijs et al., 2014) depending on the wire mesh type and the hygiene conditions. As reviewed by Dorning and Harris (2017), several studies' results suggest that plastic flooring is more comfortable for breeding and fattening rabbits than wire (Matics et al., 2003; Princz et al., 2008a; Rashed and El-Edel, 2015). Nevertheless, lesions may also appear on unsuitable plastic floor according to the slot and slat width and the degree of perforation (Masthoff and Hoy, 2019). In addition, several studies showed that breeding and fattening rabbits have a preference for plastic-mesh floors (Matics et al., 2003; Princz et al., 2008b; Alfonso-Carrillo et al., 2014b; Alfonso-Carrillo et al., 2014a) and a study from Gerencsér and colleagues (2012) revealed that growing rabbits avoid significantly wire mesh flooring. As for plastic-mesh floor, rabbits seem to prefer plastic-mesh elevated platform to wire-mesh platform (Mikó et al., 2012; Miko et al., 2014; Martino et al., 2016). As plastic-mesh is more

comfortable for rabbits' feet, plastic-mesh elevated platforms should also be favoured. However, plastic mesh floor and elevated platforms should have appropriate characteristics to avoid the development of lesions, such as 5 mm slat width, 13 mm slot width and 75% of perforation (Masthoff and Hoy, 2019).

Providing gnawing materials improves animal welfare by reducing oral stereotypies (Luzi et al., 2003; Princz et al., 2007) and conspecific aggression (Princz et al., 2007; Princz et al., 2008a; Princz et al., 2009) in group housing (fattening rabbits).

Finally, the presence of a platform improves welfare by providing more floor space and increases locomotor activity (Martino et al., 2016), allowing a better view of their environment and providing a shelter (Dorning and Harris, 2017), and permitting does to escape their kits when they leave the nest and want to suck, only before they are also able to climb on the platform (Mikó et al., 2012; Szendrő and McNitt, 2012; Alfonso-Carrillo et al., 2014b). Another positive impact of platforms is that they help rabbits to cope with disturbance (Dorning and Harris, 2017).

c. Negative welfare consequences and preventive measures

According to EFSA's work (2020), the system of enriched cages provides better welfare than conventional cages, floor pens and outdoor systems but provides worse welfare outcomes than elevated pens and organic systems. The main welfare issue for does in enriched cages is the restriction of movement. The most important cause for the restriction of movement and lack of locomotor activity seems to be the total surface available (EFSA, 2020; EFSA, 2005). This issue in enriched cages cannot be solved or reduced without changing profoundly the system, notably by providing more space. Another welfare problem which could result is insufficient mother-offspring distances, which prevents does to retreat from kits even if platforms could provide some opportunity before kits start using it (Dorning and Harris, 2017).

3.1.2. Kits

a. Positive welfare aspects

There is a gap of knowledge on positive welfare aspects regarding the housing system of enriched cages for kits.

b. Negative welfare consequences and preventive measures

According to EFSA's work (2020), the system of enriched cages provides worse welfare than conventional cages, elevated pens and organic systems. The main welfare consequence for kits in enriched cages is the restriction of movement. As for does and fattening rabbits, the restriction of movement is caused by an insufficient individual space.

3.1.3. Fattening rabbits

a. Description of the system

See 3.1.1.a.

At weaning, the doe is removed from the cage and the fattening rabbits are left in the enriched cages without the nest box, its door and sometimes the plastic footrest.

b. Positive welfare aspects

According to EFSA's work (2020), the system of enriched cages is better in terms of fattening rabbits' welfare than conventional cages. As it has been previously mentioned, young rabbits need minimum length of 75-80 cm and a minimum width of 35-40 cm to carry out some of their natural behaviours (EFSA, 2005). Enriched cages have greater length and width than these recommendations (up to 52.5 cm of width, 102 cm of length and 60-80 cm of height). Although the stocking density corresponds to approximately 8-10 rabbits/m² that is less than the minimum stocking density recommended by EFSA (2005) to prevent restriction of movement, it is still one of the main welfare issues for fattening rabbits in this system (EFSA, 2020). Thus, enriched cages sizes are better than conventional cages but improvements can still be done.

Another positive welfare aspect of enriched cages is the presence of a platform (Dorning and Harris, 2017).

c. Negative welfare consequences and preventive measures

According to EFSA's work (2020), the main negative welfare consequences for fattening rabbits in enriched cages are restriction of movement (see 2.3.c) and skin disorders. Concerning the restriction of movement, even if enriched cages size is better than conventional cages, improvements need to be done by increasing the space allowance available by animals or decreasing the stocking density. In addition, providing platforms space is a welfare improvement for fattening rabbits in this system (in comparison with conventional cages) but due to competition for space with their increasing body weight, they have less opportunity to use the platforms as they grow (Lang and Hoy, 2011). Thus, provide more platforms space could be a welfare improvement for fattening rabbits in this system.

Skin disorders concern rabbits which has physical damage to the skin or underlying tissues like multiple scratches, open or scabbed wounds or abscesses to the body or ears (EFSA, 2020). These disorders have various causes like ringworm (the most important skin disorder, affecting many rabbits especially kits and growing rabbits (EFSA, 2020), different types of mange (sarcoptic form, psoroptic form…), pseudomonosis, viral infection like myxomatosis or fibromatosis, etc. Behavioural dermatopathies can also be seen in some farms, within litters for example. This disorder may correspond to maladaptive behaviours due to the stress of an inadequate environment (Tynes, 2013). Thus, to reduce risks of skin disorders, the biosecurity management needs to be improved, special attention should be paid to the new breeders entering to the farm, housing conditions need to be adapted to the animals and the ambient conditions need to be controlled (high temperature and humidity could enable the diffusion of dermatophytes) (EFSA, 2020).

3.1.4. Conclusion on the enriched cages

	Positive welfare aspects	**Negative welfare aspects**	**Recommendations**
Does	- More available space than in conventional cages	- Restriction of movement (insufficient space)	- Increase available surface

	- Plastic footrests - Possibility of expression of gnawing behaviour - Platform		- Plastic mesh floor and plastic mesh elevated platform
Kits	Gaps of knowledge	- Restriction of movement (insufficient space)	- Increase available surface
Fattening rabbits	- More available space than in conventional cages - Plastic footrests - Platform - Gnawing materials (when present)	- Restriction of movement (insufficient space) - Skin disorders	- Increase available space/decrease the stocking density - Platforms - Gnawing materials and at all age - Improve prophylaxis procedure

3.2. Elevated pens

3.2.1. Reproducing does

a. Description of the system

Elevated pens system is a conventional system together with conventional and enriched cages. This system comprises single modules (larger than enriched dual-purpose cages), usually four, that can be connected to create a single larger pen. The modules are open-top, with wire mesh walls and its floor of wire mesh or, more frequently, of plastic slats. In case of using a net floor, plastic floor should cover at least 80% of the available surface. A platform is always present.

Single modules are used for individual housing of reproducing does from a few days before kindling until weaning. These modules are equipped with a space in the front for a removable plastic nest. The nest is separated from the rest of the cage by a removable wall with a sliding door that can be closed for controlled lactation during the first 1-2 weeks after kindling. Then, it is removed, together with the nest box around 21 days of age to stimulate solid feed uptake of the kits and to provide a unique space for fattening rabbits (*see 3.2.3.a*) (Figure 4).

Does might be kept in groups for some periods (part time-group housing) by removing the wire walls between single modules of the pen (EFSA, 2020). In part time-group housing, does are group housed while they are pregnant, and 2 or 3 days before parity they are separated (normally the removable wall in their home module). They give birth and live with their kits during part of the lactation period, and between 11 and 23 days, the walls are again removed and the does are mixed (Villagrá, 2020). Positive and negative consequences of part time-group housing on rabbits' welfare are described below.

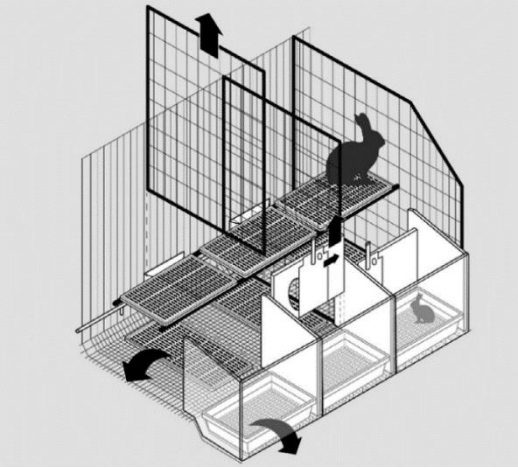


Figure 4. Example of a dual-purpose elevated pens (also called parks) (EFSA, 2020)

b. Positive welfare aspects

According to EFSA's work (2020), the welfare of reproducing does in elevated pens is better compared to conventional cages. However, among the other systems (structurally enriched cages, floor pens, outdoor/partially outdoor systems, and organic systems) no distinction can be made.

Elevated pens, as reported by farmers themselves, provide the best conditions for rabbits to express their natural behaviour (Dorning and Harris, 2017). Rabbits are livelier and avail of the extra space provided, to hop, stand up, and move around, hide under the platform, inside plastic tubes or other types of hiding tools, and gnaw at the different materials provided (DG Health and Food Safety , 2017).

Additional space supplied by the elevated pens provides rabbits with more available space allowance to move freely and perform more active behaviours. Rabbits prefer longer and higher cages (Villagrá et al., 2019). Group housing, once walls are removed, together with the use of elevated platforms provide a larger space; in particular, platforms increase space availability (± 25%) compared to flat-deck cages and provide greater opportunities for does and their kits to move and jump up and down. Breeding does can freely choose between staying on, under (safety part) or in front of the platform (highest part of the cage). As it has been mentioned before, the platform also offers mothers the possibility of escaping from their kits once they leave the nest box (Mirabito et al., 1999).

Floor mats or grids, usually made of plastic, provide rabbits with a comfortable surface to lie and, at the same time, to maintain adequate levels of hygiene (Italian Ministry of Health, 2020). In fact, it has been previously shown (EFSA, 2005) that in breeding females kept for long periods on wire mesh floors footpad lesions are commonly observed, and the use of floor mats (floor rests) reduces such lesions. Regarding cage height, the rearing of rabbits for their entire reproductive life in an open-top cage allows them to freely stand up on hind legs and, thus, perform alert and exploratory behaviours. However, under standard and controlled farming conditions the motivation to display this behaviour seems to be very low (Szendro et al., 2016).

When rabbits are kept in groups, refugees or hiding places are especially important, as they provide a place to hide when animals are threatened. In addition, the presence of hiding places can help to reduce the number of animals culled because of aggressive interactions (Villagrá, 2020). The provision of gnawing elements also helps reducing conspecific aggression as well as decreases oral stereotypies. In addition, gnawing opportunities reduce inactivity and restlessness, which can indicate stress (Dorning and Harris, 2017) as well as help to avoid the excessive growing of incisors, which is helpful especially in group systems, to decrease the intensity of the injuries when aggressive episodes take place (Villagrá, 2020).

c. Negative welfare consequences and preventive measures

The main negative welfare consequence in elevated pen systems described at EFSA's report (2020) is the restriction of movement, always considered when the animal cannot perform three consecutive hops. This may explain why restriction of movement was contemplated as a negative aspect even though the surface area is clearly larger. Restriction of movement of does can be ameliorated by group housing. However, according to EFSA (2020), this system is not recommended as it has been observed a decrease of animal welfare associated with increased aggressive interactions, inadequate nesting behaviour and poor maternal care. Indeed, better understanding of social relationships between rabbit does is needed to adjust this system. If elevated pens are not used for group housing of does, a platform and suitable gnawing materials should be provided to increase total space allowance and dimensions of the cage (EFSA, 2020).

According to EFSA (2020), there are some other does' welfare problems linked to elevated pens such as inability of gnawing and skin lesions. However, they cause relatively less important consequences:

- *Inability to express gnawing behaviour*

  Inability to express gnawing behaviour occurs when suitable gnawing materials, to permit rabbits to develop gnawing behaviour, are not provided or they are unsuitable. In fact, elevated pens should include them as a basic feature in their construction design. They permit to decrease competition and consequently aggression in collective housing. The presentation of the gnawing material is also important. For example, sticks attached to the wall are easier to manipulate than hanging sticks (De Jong, 2011) and prevent undesirable contamination by pathogenic microorganisms that could cause the animals severe illnesses.

- *Skin lesions*

  When elevated pens are used for group housing of does, aggressive interactions between adult animals are the most important reason for skin lesions (EFSA, 2020). Isolation of does between littering and insemination and their subsequent regrouping

may be an important trigger for aggressive behaviour, which mainly takes place in the first days after grouping, when the hierarchy is re-established (Andrist et al., 2013). Group composition, individuality and season are discussed as relevant factors for the extent of agonistic interactions (Braconnier et al., 2020). Other factors that can affect the level of aggressiveness during the mixing process are the group size, as aggression level rises as the group size increases, and the age of the kits when the does are grouped. Aggression can be reduced by providing sufficient space allowance during introductions (Dorning and Harris, 2017). Selective breeding of rabbits for tameness may enhance the welfare benefits of parks. Moreover, reducing fear of humans through early handling reduces social aggression and contributes to more stable hierarchies (Verwer et al.,2009). Continuous monitoring is always necessary to ensure that group members remain compatible (Dorning and Harris, 2017).

3.2.2. Kits

a. Positive welfare aspects

According to EFSA (2020), the welfare of kits is higher in elevated pens than in conventional cages, enriched cages, floor pens and organic systems. However, more research is needed in this category of animals to understand the advantages of this system.

b. Negative welfare consequences and preventive measures

Regarding negative consequences, the results for kits show that inability to express gnawing behaviour is the main welfare concern in elevated pens. However, the occurrence of this welfare consequence is unexpected as there is no literature description about this topic in such young rabbits (EFSA 2020).

According to EFSA's work (2020), other kits' welfare issues linked to elevated pens are prolonged hunger and neonatal disorders. Prolonged hunger in kits and neonatal disorders (such as dehydration, hypothermia or infanticide) may result from inadequate nesting behaviour and poor maternal care. During the first days of life, survival of kits requires an adequate environment, i.e., a well-built nest in a separate section of the mother's living environment. EFSA (2005) stated that neonatal mortality is higher when does are kept in groups rather than when they are singly caged. Therefore, this problem could be found if elevated pens were used for rearing does in continuous-group housing, practice currently discouraged. In individual housing, infanticide of the doe's own kits can occur, but does cannot injure, hurt, or cannibalise the kits of another doe.

3.2.3. Fattening rabbits

a. Description of the system

See 3.2.1.a

After separation of the doe, the walls between single modules are removed to form a pen/park for group housing of fattening rabbits. Usually, four modules are joined to form one pen/park for 20 to 40 animals. The dimensions of the pen range between 180-200 cm of length, 100 cm of width and with no height restrictions, since there is no roof and it is open at the top (Kollenda et al., 2020). The specific characteristics of the elevated pen system for

growing rabbits and does are already described in some national guidelines (e.g. Wallonia, Italy, Belgium, The Netherlands…).

b. Positive welfare aspects

According to EFSA (2020), the welfare of fattening rabbits is better in elevated pens than in the other systems. For fattening rabbits, elevated pens/parks are preferable to the conventional cages (e.g., two-celled cages) because they allow social interactions and do not limit the possibility of movement as they provide more space once the walls have been removed at weaning (Italian Ministry of Health, 2021). In addition, the elevated platforms provide more functional area for rabbits to move as well as other structures such as plastic tubes or metal cabins permitting rabbits to hide or refugee (Hoy, 2012). The fact that elevated pens are open-top cages allows the rabbits to hope and jump as well as show more social interactions. Group housing is increasingly being used for growers, which are sexually immature and therefore easier to group than adults, often showing little or no aggression before puberty. Group-housed growers have a more diverse behavioural repertoire compared to single and pair-housed conspecifics. They are less fearful and show less or no stereotypical behaviour (Dorning and Harris, 2017). Gnawing materials improve welfare by decreasing stress levels in group housed growing rabbits (EFSA, 2020).

c. Negative welfare consequences and preventive measures

Regarding negative consequences, the results reported in the EFSA report (2020) for fattening rabbits indicate very low scoring levels for the different welfare consequences. In particular, the main welfare consequences impaired are skin disorders, followed by resting problems.

- *Skin disorders*

  Skin disorders are the main negative welfare consequence in elevated pens. The main hazards for skin diseases relate to the presence and spread of the causal agents (EFSA, 2020). Thus, prevalence of dermatophytosis in commercial farms depends on biosecurity measures (Cafarchia et al., 2010) and attention to treatment. Bacterial infections (Staphylococcus aureus, Pseudomonas sp, etc.) risk arise from poor design of housing or damaged structures. Wet skin/fur could be the result of malfunctioning or of a poor disposition of the drinkers, which must be evaluated in relation to the body size of rabbits. Commensal skin agents can cause skin disorders as result of traumatic injuries, also due to aggressive behaviour.

  Biosecurity procedures to avoid introduction of pathogens, climate control to maintain moderate air temperature and relative humidity, positioning of the drinkers so that wetting of the fur is prevented, are measures to reduce the occurrence of skin lesions. Reducing potential traumatic events by removing old and damaged structures and limiting aggression by bringing forward the age of slaughter are other precautions and measures to reduce the occurrence of skin disorders (EFSA, 2020).

- *Resting problems*

  Soiling and inadequate resting behaviour can be improved through appropriate floor quality and increased space allowance. In terms of floor type, Trocino et al. (2018)

found that growing rabbits housed on wooden slats rested more in the crouched position (41.4 vs. 35.5% of the observed time) and showed less allogrooming than those housed in plastic grid pens (EFSA, 2020). Moreover, an adequate slat design of plastic flooring should be considered to minimise soiling of the pen. Fattening rabbits should be housed in groups from weaning, but with sufficient space for conspecific avoidance, especially as they grow, which may involve limiting stocking density (Dorning and Harris, 2017). As described above, Belgium legislation established 12.5 rabbits/m^2 (800 cm^2/rabbit). Similarly, the Italian guidelines recommended, based on the productivity and behaviour of rabbits, an optimal density of 32 kg/m^2 at the end of the fattening period, which indeed shall never exceed 40 kg/m^2. This maximum permitted value should decrease during the warmest period of the year unless effective cooling systems are available.

3.2.4. Conclusions on elevated pens

	Positive welfare aspects	Negative welfare aspects	Recommendations
Does	- More available space than in conventional cages - Plastic footrests - Gnawing materials (when present) - Platform - Refugee and hiding places - Open-top cage	- Restriction of movement (individual housing) - Inadequate nesting behaviour (group housing) - Poor maternal care (group housing) - Skin lesions (group housing)	- Plastic mesh floor and plastic mesh elevated platform - Suitable and enough gnawing materials - Selective genetic selection and breeding of rabbits for tameness - Early handling
Kits	Gaps of knowledge	- Inability to express gnawing behaviour - Prolonged hunger - Neonatal disorders	- Good nesting practice and adequate nest environment (separate of the mother's living environment) - Part-time group housing which prevents injured kits by alien/other does, and pseudo pregnancies - Regular daily handling of lactating kits - Good control of the ambient condition
Fattening rabbits	- More available space than in conventional cages - Plastic footrests - Gnawing materials (when present) - Platform	- Skin disorders - Resting problems - Difficult to monitor	- Improve biosecurity - Good control of the ambient condition - Good positioning of the drinkers - Appropriate floor quality

	- Refugee and hiding places - Open-top cage		- More space allowance - Good prophylaxis procedures - Feeding strategies - Correct access and kind of gnawing materials - Placing an upper limit on slaughter age to reduce aggression - Good handling

3.3. Floor pens

3.3.1. Reproducing does

a. Description of the system

Floor pen is a niche system used in Switzerland for group housing of reproducing does or growing rabbits, therefore very limited literature has been found on this system. Males may also be reared in this system. It is characterized by large indoor open-top pens based on solid floors (totally or partially) with litter, usually straw (Figure 5).

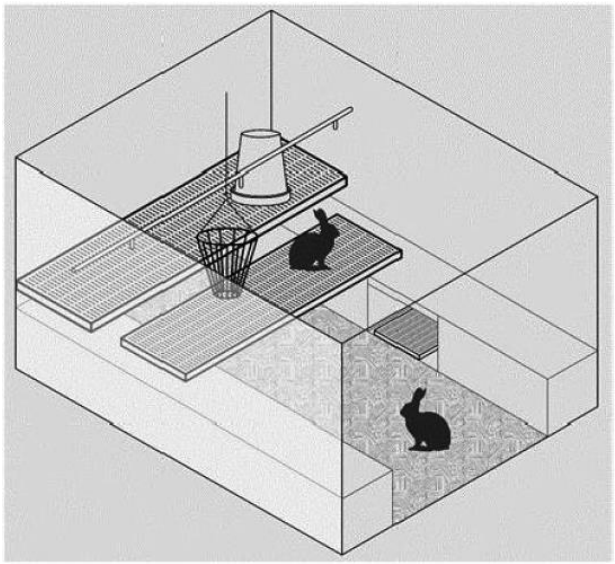


Figure 5. Example of a floor pen (EFSA, 2020). In this example, the floor pen is equipped with: solid walls, two platforms with plastic slatted flooring, closed nest boxes with plastic footrests, automatic nipple drinkers, a circular feeder and a rack.

b. Positive welfare aspects

According to EFSA (2020) experts' opinion, floor pen is better in terms of does' welfare than conventional cages. The presence of a complete or partial solid floor may mitigate footpad problems (pododermatitis and sore hocks) which are common in breeding animals housed on wire mesh floor (EFSA, 2005). However, Ruchti et al. (2018) reported more pododermatitis in group-housed breeding does reared in floor pens than in single housed system with wire floors and plastic footrest or plastic slatted floor. Nevertheless, they found less pododermatitis in their studies on wire floors than what it is usually found in studies on single housed animals

on wire floors. Thus, complete solid floor seems to be better for pododermatitis than entire wire floors but worse than plastic slatted floor and footrests. Nevertheless, the flooring is not the only risk factor for footpad problems. The relative humidity of the barn, the body weight, the number of kindlings, does' age and claw length are also positively correlated with pododermatitis in floor pens (Ruchti, 2019).

In floor pens, animals are housed in groups. Although group-housing does have more injuries and are more stressed (Szendro et al., 2012; Szendrő et al., 2013; Mugnai et al., 2009), alone-housing is more detrimental to social animal welfare (Dorning and Harris, 2017) and leads to more stereotypic behaviours (Mugnai et al., 2009). As rabbits are more aggressive in the breeding season and notably close to their nest, part-time group housing could be considered. Does are isolated in partitioned area of the pen from 1 to 3 days before kindling to 12 to 18 days (Dorning and Harris, 2017) or 23 days post-partum (Rommers and de Greef, 2018), or from one day before parturition until 11 days post-partum (observed farms with artificial insemination in Ruchti et al. 2018). However, this management induces hierarchy destabilisations, in particular if new does are added to the initial group (after regrouping) leading to a higher rate of aggression and injuries compared to permanently group-housed does (Andrist et al., 2013). Thus, group-housing can be considered as a positive welfare aspect considering the possibility for does to express normal social behaviour, but the number of aggressions remains high in part-time group-housing systems after regrouping of familiar or unfamiliar does (Rommers et al., 2006; Andrist et al., 2013; Rommers et al., 2014; Buijs et al., 2015; Dorning and Harris, 2017). To reduce negative interactions and consequences in group-housing, it is highly recommended to provide adequate space allowance per animal (female aggression increases with density, even in wild conditions) (Myers and Poole, 1961), restricted group size, stable group of does (to maintain hierarchy) (DiVincenti and Rehrig, 2016) and well structured environment allowing animals to escape their peers in case of aggression such as multiple hiding areas (platforms and pipes for example) (Rommers et al., 2014).

c. Negative welfare consequences and preventive measures

According to EFSA (2020) experts' opinion, floor pen is worse than the other systems (enriched cages, elevated pens, outdoor systems, organic systems). Main negative welfare consequences are more related to health problems than to behavioural restrictions in contrast to other systems like conventional cages, elevated pens and enriched cages. The EFSA opinion concluded that does are more likely to have prolonged hunger in floor systems than in the other systems. EFSA (2020) suggests that other main welfare consequences of this system could be heat stress, and resting problems (see 2.1. c.). Rabbits are sensitive animals to high temperatures because of their fur and their limited abilities to eliminate excess body heat since they have few functional sweat glands (Marai et al., 2002). In case of heat stress, rabbits show increased respiration rate, higher temperatures of ears and keep their ears spread open and away from the body (EFSA, 2020). In all the indoor rearing systems, the ambient temperature depends on the relative humidity, the air velocity and other atmospheric conditions. Cooling and heating systems are often controlled and settled by the farmer. Under good farming practices, ambient temperature and relative humidity are maintained in optimal

range during hot and cold seasons. For reproducing does, ambient temperature is optimal between 16 and 21 °C and relative humidity is optimal between 60 and 70% (Verga et al., 2007). Hence, heat stress is more linked to management practices and buildings accommodations. It can be reduced by an appropriate design of the building and adequate cooling and ventilation system.

Many of these issues may be the consequences of hygiene problems in floor pens system (EFSA, 2020). Indeed, soiled bedding could lead to resting problems. Resting problems are also related to group-housing (disturbance of resting animals and aggressions). Soiled feeders and drinkers impair food and water consumption. Heat stress might be due to management practices but also to an isolating bedding material in case of hot weather.

To avoid these welfare issues, hygiene conditions need to be well managed (bedding quality and quantity, feeder and drinker good design and cleanliness). In addition, to reduce aggressive interactions, the space allowance per animal needs to be increased and the size of the groups decreased.

3.3.2. Kits

a. Positive welfare aspects

There is a gap of knowledge on positive welfare aspects regarding the housing system of floor pens for kits.

b. Negative welfare consequences and preventive measures

According to EFSA (2020) experts' opinion, kits in this system are susceptible to suffer from hunger and thirst issues and neonatal disorders. As mentioned previously, prolonged hunger and neonatal disorders in kits (dehydration, hypothermia, and infanticide) may result from inadequate nesting behaviour, poor maternal care and inadequate nest design (allowing kits to get out the nest before they are sufficiently mature). Before three weeks, kits cannot access to solid feed and are dependant of the milking capacity of the doe. If this milking capacity is insufficient, because of poor maternal behaviour or poor doe body and health conditions, prolonged hunger may appear in kits (EFSA, 2020). Cannibalism of kits by does, also part of the "neonatal disorders", is more susceptible to occur in reproducing does group-housing than in singly caged systems (EFSA, 2005). Indeed, in group-housed systems, events as does attacking kits of other does or more than one doe kindling in a single nest and causing trouble have been observed (Mirabito et al., 2005; Szendro et al., 2013). This can be prevented by part-time group housing of the does.

3.3.3. Fattening rabbits

a. Description of the system

See 3.3.1.a

b. Positive welfare aspects

There is a gap of knowledge on positive welfare aspects of floor pens for fattening rabbits.

c. Negative welfare consequences and preventive measures

As for reproducing does, fattening rabbits' welfare issues are more related to health problems in floor pens than to behavioural restrictions in contrast to other systems like conventional cages, elevated pens and enriched cages. EFSA experts indicate that the main welfare consequences for fattening rabbits in this system are: gastrointestinal disorders, skin diseases (see 3.2.3.c.), hunger (due to soiled feeders and drinkers) and resting problems (see 3.2.3.c.). Gastrointestinal disorders concern animals with impaired function of the gastrointestinal tract resulting in inappetence, loss of weight, abnormal faeces consistency (mucus excretion, diarrhoea) and/or hard consistency of the abdomen (EFSA, 2020). These disorders could result from infectious, parasitic or toxigenic agents. Poor proxylaxis procedures (unadapted housing, poor hygiene, lack of pest control…) result in these disorders. They also may be the consequences of some management problems like an early weaning of young animals, the lack of roughage, an excessive feed intake after weaning and an unbalanced diet (EFSA, 2020). According to some studies, nutrition strategies can reduce the occurrence of digestive disorders like the use of high fibres (Gidenne et al., 2010) or the feed restriction after weaning (Gidenne et al., 2012). However, although feed restriction reduces the incidence of digestive troubles after weaning, it could also lead to another welfare issue, hunger. Thus, two ways to minimise gastrointestinal disorders are the use of a balanced diet and an appropriate weaning age (EFSA, 2020).

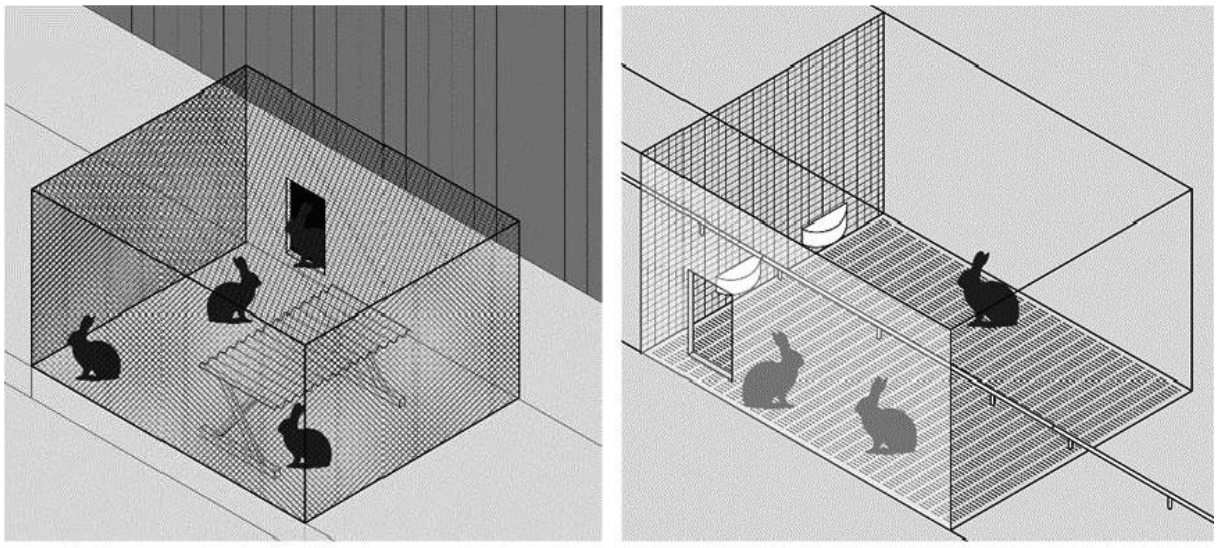
3.3.4. Conclusions on the floor pens

	Positive welfare aspects	Negative welfare aspects	Recommendations
Does	- Solid floor - Group-housing allowing social behaviour	- Hunger issues - Heat stress - Resting problems	- Hygiene conditions well managed: adequate quantity of suitable bedding and frequent removal of soiled bedding, feeding and drinking facilities free of bedding and regularly cleaned. - Increase space per animal - Decrease group size - Controlled ventilation systems to avoid thermal stress and unbedded area of floor in case of hot weather
Kits	Gaps of knowledge	- Hunger and thirst issues - Neonatal disorders	- Correct health status and feeding of the doe - Individual nest for a doe and its kits inaccessible to the other does (part-time grouphousing)

			- Better nest design to avoid kits to get out before they are sufficiently mature
Fattening rabbits	Gaps of knowledge	- Gastrointestinal disorders - Skin diseases - Hunger issues - Resting problems	- Hygiene conditions well managed - Adapted diet and provision or roughage - Increasing available space/decreasing the stocking density

3.4. Outdoor system

Not organic outdoor systems are niche systems using fixed (cages, hutches, paddocks) or moveable housing systems (usually cages) made of different materials which provide different degrees of protection against weather and predators. No standards are available but, as a rule, animals have the possibility of accessing an outdoor area, which is not necessarily pasture. Rabbits are reared in groups from weaning onwards. The outdoor area is protected from wild animals with mesh. It includes a solid floor, and it can be equipped with a shelter as well as a rack to provide hay. An opening in the wall permits the movement of the animals between the outside and the inside of the system where large pens with wire mesh walls are present. These pens have plastic slatted flooring and are equipped with an automatic nipple drinker for water distribution as well as feeders for feed provision. There is a wide diversity of outdoor systems (EFSA 2020). Examples of outdoor system are presented in Figure 6 and 7.



a) b)

Figure 6. Example of an outdoor housing system for fatteners (EFSA, 2020). Figure 6a shows the part of the system outside, figure 6b inside.

Figure 7. Example of outdoor system: indoor area with roofless pens and outdoor area with pasture (INRA, Fetiveau et al., 2021)

As far as to our knowledge, outdoor systems are used only on small scale in Italy (only few farms) and France (approx. 10 farms). Only fattening rabbits are housed in these systems with outdoor access.

Scientific literature on rabbits housed in outdoor system is scarce and those papers mainly deal with growth performance and meat quality of fattening rabbits (Mattioli et al., 2007; Preziiuso et al., 2009). Only one source was found in which effect of an outdoor rearing system on welfare of a slow-growing rabbits breed was investigated (D'Agata et al., 2009). The use of the outdoor pen and behaviour was studied by Fetiveau et al. (2021) and Guene-Grand et al. (2021). There is a huge gap of knowledge concerning this type of housing system.

3.4.1. Reproducing does

a. Positive welfare aspects

No literature was found assessing positive welfare aspects of rabbit does kept in outdoor systems. In EFSA 2020 it was stated that the welfare of reproducing does is lower in conventional cages compared to the other systems (including outdoor housing systems), but without comparison among them (different type of conventional cages and organic systems). However, the question arises if rabbit does are housed in outdoor systems, because no literature concerning outdoor housing of rabbit does has been found.

b. *Negative welfare consequences and preventive measures*

In EFSA 2020 heat stress, fear, skin lesions and wounds, pododermatitis, and respiratory disorders are listed as the five main welfare consequences for rabbit does housed in outdoor systems. In outdoor systems extreme temperatures can cause heat or cold stress. Rabbit does are more sensitive to heat stress than cold stress because of the fur coat that protects them against cold temperatures (only around kindling does remove their hair to build a nest and can be really naked) but limits their ability to eliminate excess body heat by high temperatures. In fact, rabbits can withstand temperatures of -10 ºC (CAB, 2020). High temperatures can cause heat stress resulting in health problems. Heat stress can induce physiological changes,

e.g. reduction in feed intake (when temperature rises above 30°C), disturbances in water, protein, energy and mineral balances, enzymatic reactions, hormonal secretions and blood metabolites (EFSA, 2020). Fear may result from perceived exposure to predators. With outdoor access there is also a problem with parasitism (both gastrointestinal parasites such as nematodes (Legendre et al., 2019b) or coccidies (Legendre et al., 2019c) and higher susceptibility to external parasites such as ticks. Because Viral Haemorrhagic Disease (VHD) comes from wild rabbits, it is necessary to vaccinate the animals if they have access to outdoor, which is an economic cost.

In system with outdoor access pododermatitis can occur in case the outdoor access is muddy and dirty with faeces, that might soften the skin of the footpad, that are then more vulnerable for it. This situation will be frequent in outdoors conditions. On the other hand, the hygiene is better in mobile devices or rotative pastures. Skin lesions and wounds may cause pain and chronic fear to the animals and compromise their health and thus their welfare. Lesions can result from inadequate housing equipment but is often observed in does housed in wired cages and/or kept in groups by agonistic behaviour.

3.4.2. Kits

a. Positive welfare aspects

No literature was found dealing with positive welfare aspects of kits kept in outdoor systems.

b. *Negative welfare consequences and preventive measures*

According to EFSA (2020), the welfare of kits in outdoor systems is lower compared to other housing systems. Neonatal disorders, heat and cold stress, gastrointestinal disorders and hunger are identified as main negative welfare consequences. Neonatal disorders may stem from greater concerns about maternal health, environmental control and kit management practices. Kits are more vulnerable to cold than to heat stress. Cold stress will occur in case of disturbances in maternal behaviour (e.g. kindling out of the nest, inadequate nest quality, being outside the nest) and can cause hypothermia and death of kits. Some situations of chronic hunger may arise in kits before weaning, when milking capacity of the doe is insufficient (poor body condition, pathology, poor maternal behaviour) but also during heat stress when feed intake of the rabbit doe is suppressed. Gastrointestinal disorders are often seen around weaning. It can range from slight troubles to acute painful ones. It can be caused by an unbalanced diet or early weaning where parasites and bacteria can overtake the digestive (mainly gut) flora.

3.4.3. Fattening rabbits

a. Positive welfare aspects

Fattening rabbits kept in an outdoor system demonstrated a lower fear level in the open field test compared to indoor rabbits (D'Agata et al., 2009). These authors argue that outdoor-reared animals were probably exposed to greater number of stimuli and appeared to be habituated to them, be less stressed and therefore appeared better adapted to stressors. They

concluded that outdoor rabbits showed higher digging activity and lower biting activity than indoor rabbits and this response could be considered a positive reaction to a new environment. Fetiveau et al. (in prep) also reported that, when they are outside in a pasture area, the rabbits are mainly grazing (>25% of time) and often running (>2.5%). Behaviours such as standing up, game or antics are also observed, not often observed in indoor systems such as cages. This positively contributes to their welfare. Guene-Grand et al. (2021) reported that on average 13% of the rabbits were outside during the day, but it was not known if they were the same or different rabbits that would always go outside. The outdoor access increased the diversity of the behaviour repertoire (more active; Fetiveau et al., 2021). In case of pasture, 50 or 25 rabbits having access to a 23 m² of pasture area needed only 10 to 17 days to fully consume the pasture (Fetiveau et al., 2021), so the pasture area should be increased to supply sufficient grass biomass over the whole fattening period. (Fetiveau et al., 2021). Legendre et al. (2019a) proposed access to 0.65 m2/rabbit to cover grass intake capacity of growing rabbits. Warin et al. (2021) performed a welfare assessment and concluded that there were more social interactions, higher score for ability to move in the outdoor system (2 m² pens with plastic slats in a building unit that allows permanent access to a grassy paddock of 23 m²) than in the indoor system (2 m² pens with plastic slats).

b. *Negative welfare consequences and preventive measures*

Gastrointestinal disorders, respiratory disorders, fear of predators, prolonged hunger and resting problems are mentioned by EFSA (2020) as main welfare consequences in fattening rabbits housed in outdoor systems. As stated above, the weaning process is in general a stressful event that can cause diarrhoea. But also, more acute painful problems such as caecal impaction, intestinal inflammation can occur after weaning and can be caused by poor prophylaxis procedures (including hygienic measures). This is not specific for outdoor system. Fetiveau et al. (2021) reported a slightly increased mortality and reduced growth without interaction with stocking density for fatteners with access to an outdoor area.

The main hazards relevant for rabbits housed outdoors are related to climate conditions (heat- and coldstress) and difficulties to implement biosecurity measures (as hygiene). Therefore, improving housing (indoor and outdoor area) to provide better protection would be an important measure to reduce climatic impact in the indoor area of the outdoor system, investments in fans and humidifiers is perhaps required. In the outdoor area, the choice of the fence (which hides the rabbits, such as picket fences, or not, such as electrified wire mesh) but also the layout of the paddock (trees, medicinal plants, hiding places...) is very important to improve welfare of the rabbits as previously shown in poultry production. There are several alternatives to improve health and mitigate welfare consequences. Training of the farm staff is important in addition to the time and effort invested in the care and observation of rabbits, checking of the kit in the nests, especially when temperatures are < 12 o of > 30 °C. For resting problems, increasing the surface area for does or decreasing the density for growers in the resting area together with good hygienic conditions can be useful solutions. Gastroenteric disorders can be prevented by providing the rabbits a suitable diet including high fibre levels

and increase pasture rotation time (Legendre et al., 2019b and 2019c). However, the diversity of outdoor systems means that solutions need to be tailored to each set of circumstances. It seems necessary to evaluate the benefits of changing the genetic type of animals (for more robust animals). Indeed, Fetiveau et al. (in prep) showed that corticosterone level in the hair was significantly lower in rabbits from a robust line than from a line selected on prolificacy reared in a mobile building with permanent access to a pasture area.

3.4.4. Conclusion on outdoor systems

Outdoor systems comprise wide diversity of systems that give access to an outdoor area or pasture.

There are no standards available. Rabbits do go outside, and outside access increases the diversity of the behaviour repertoire. When the animals have access to pasture, they like to graze and run (which is impossible in indoor systems). It could be useful to use animals of a genetic type adapted to outdoor systems. The main hazards are related to climate conditions and the difficulty to implement biosecurity measures.

There is a huge gap of knowledge concerning the positive aspects in rabbit does, kits and fattening rabbits.

	Positive welfare aspects	Negative welfare aspects	Recommendations
Does	Gaps of knowledge	- Heat stress - Biosecurity	- Improve housing conditions - Improve hygienic and biosecurity measures
Kits	Gaps of knowledge	- Heat and cold stress - Hunger	- Improve housing conditions - Improve kits management - Balanced diet for does - Balanced diets for kits around weaning
Fattening Rabbits	- More diverse behaviour repertoire.	- Heat stress - Biosecurity - Health problems	- Improve hygienic and biosecurity measures

3.5 Organic system

3.5.1 Reproducing does

a. Description of the system

Organic housing systems are niche production systems based on open-air enclosures or underground facilities that combine wire cages and underground confined spaces as well as hutches. Organic systems may be very different, but usually do not contain equipment to control environmental conditions (EFSA, 2020).

Basic organic production requirements, included in the EU Reg 889/2008 and the EU Reg 2018/848 (see Annex 1), comprise the access to pasture whenever conditions allow for it, group housing, access to a covered shelter including dark hiding places, availability of raised platforms and nesting material for all nursing does. From 1 January 2022, the Regulation for the breeding of organic rabbits will be established at European level by the Commission implementing EU Reg 2020/464.

Although organic systems are very diverse, they usually house individual reproducing does with their littler. Despite EU Reg 2018/848 states that animals have to be reared in groups, in the practice it appears to be difficult, especially for lactating does (see 3.5.1.c).

The two main facilities used within the organic production are movable cages (Figure 7) and paddocks or fixed parks (Figure 8). Movable cages are made of wire-mesh and they permit foraging on pasture through a wire floor. The cages are moved as often as possible in order to have access to fresh grass and to prevent the spread of parasitosis such as coccidiosis (Martin et al., 2017). They include a sheltered area with solid walls, used as nest boxes for reproducing does. In this sheltered area, a feeder providing compound diets and/or hay is included as well as materials for nest construction. Movable cages are also equipped with drinkers for manual provision of water (EFSA, 2020). The quality of the sheltered part is essential, and the closure system must resist the attack of potential predators (dogs, raptors, even foxes or other small carnivores such as cats, martens, weasels) (Martin et al., 2017). Paddocks, fenced areas of grass, are often placed next to each other. With one or more shelters per park, rabbits roam freely on the land. As in mobile shelters, the sheltered surface allows the breeder to provide the rabbits with food and water. Rabbits can rest there, hide or make their nests. There are different models; low to the ground or raised to human height (CAB, 2020).

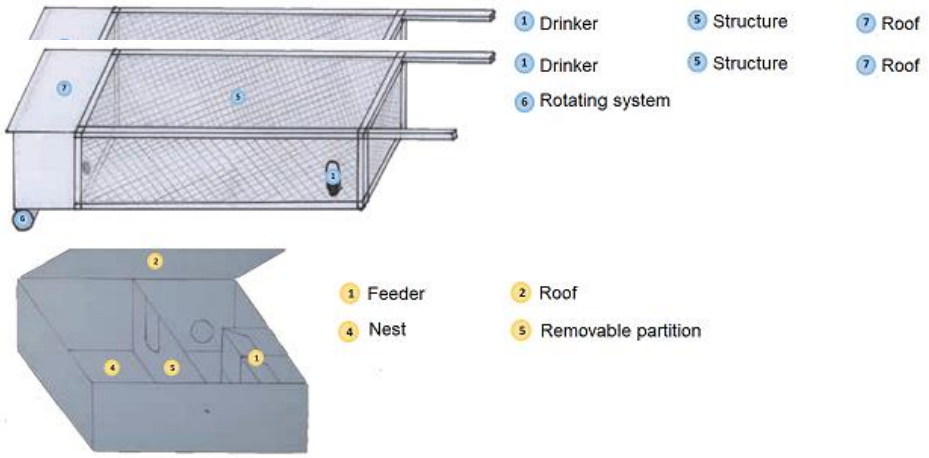


Figure 7. Example of movable cage (CAB, 2020)

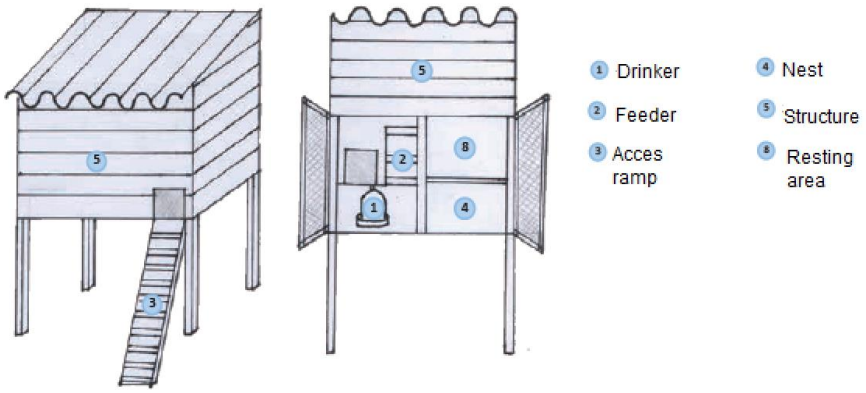


Figure 8. Example of fixed park (CAB, 2020)

b. Positive welfare aspects

EFSA 2020 stated that the welfare of reproducing does is lower in conventional cages compared to the other systems (including organic systems), but without comparison among the other systems (different type of conventional cages and outdoor systems).

Organic rabbit farming generally shows good welfare outcomes, even though there are wide variations depending on the facilities (EFSA, 2020). In general, organic systems enable grazing and provide access to more space and natural light than indoor systems (Dorning and Harris, 2017). In addition, behavioural restrictions are less prominent in comparison to other production systems such as conventional cages, elevated pens or enriched cages (EFSA, 2020).

Organic systems allow greater space allowance than conventional cages as animals have access to both an indoor area (minimum 0,5 m^2 – 0,72 m^2/ doe depending on its liveweight and reproductive phase) plus an outdoor with vegetation (minimum 2,5m^2/doe with kids) (see Annex 1). Moreover, if a raised platform is present in the organic housing, this structure provides an extra floor space for the animals, increases does' locomotor activity, and aims at satisfying the doe's need for isolation from its litter.

Another positive welfare aspect of the organic system is the presence of foraging substrates; pasturage or fibrous feed provided by the farmer when grass is not available, that allows the animals to express foraging behaviour in a relatively natural way, reducing the development of abnormal stereotyped behaviour patterns as well as aggression (EFSA, 2020). In addition, the provision of gnawing materials also reduces oral stereotypies (Dorning and Harris, 2017).

Reg (EU) 2018/848 requires the provision of a comfortable, clean, and dry resting area, consisting of a solid construction (not slatted) strewn with litter material such as straw or other suitable natural materials. The presence of deep-litter is considered to be important for animal behaviour as an environmental enrichment by some authors (Dorning and Harris, 2017). However, in the experiment of Morrisse et al. (1999) young rabbits spent the most part of their time on wire-mesh floor instead of straw deep litter. According to the results of Orova et al. (2004) in case of free choice in higher temperature (>15-20 ºC) rabbits preferred wire-mesh, while in lower temperature (< 15º C) they chose deep litter. These results

demonstrated that fattening rabbits kept under intensive conditions preferred a wire floor to a straw deep litter.
In niche systems with outdoor access, such as organic systems, chronic hunger should be encountered more rarely, provided the pasture (or hay supply) is accessible (EFSA 2020).

Finally, group housing facilitates social contact between does and permits the expression of natural reproductive behaviour. However, it leads to major changes in management and housing and it is associated to other important welfare problems (Maertens and Coudert, 2006) (see 3.5.1.c).

c. Negative welfare consequences and preventive measures

Negative welfare consequences within the organic system relate especially to the outdoor housing. Exposure to thermal stress and limitations on biosecurity measures may cause important health problems (EFSA, 2020).

Restriction of movement was the highest welfare consequence found for does in EFSA's report, 2020. Welfare consequences related to restriction of movement may occur when access to outdoor pasture is restricted due to inadequate climatic conditions. Modification of the housing system could reduce this problem, by enlarging the sheltered part of the movable cage or the paddock. However, this modification would probably make cages heavier and thus difficult to move.

According to EFSA's opinion (2020), other does' welfare problems linked to organic systems are:

- *Thermal stress*

As mentioned previously, when rabbits are kept in conventional indoor systems the ambient temperature is often controlled by the air velocity, the relative humidity, the dust level as well as other atmospheric conditions. When rabbits are kept outdoors, however, ambient temperature cannot be controlled and animals must be protected as far as possible from thermal discomfort (EFSA, 2005) and direct exposure to environmental factors such as direct sun, wind, rain, etc. Thermal stress can be mitigated by insulating the shelter or by adding shade in the outdoor area (EFSA, 2020).

- *Reproductive disorders*

Reproductive disorders might be a consequence of concurrent health disorders of the doe which have welfare implications, such as gastroenteric disorders and therefore enteric pain. Thus, they are not specific to organic systems. Hazards for reproductive disorders include lack or quality of water, poor energy provision in the feed, poor body condition and health disorders of the doe. The main (indirect) hazards for reproductive disorders which are secondary to respiratory and gastroenteric disturbances relate to housing (mainly poor ventilation related to humidity and temperature) (EFSA, 2020).

Moreover, in organic farming, natural mating is used, since hormonal treatment for the reproduction control is forbidden. Natural mating, apart from being labour intensive and time consuming for the farmer, requires frequent movement of the animals between cages which can facilitate the spread of diseases, such as pasteurellosis and *Treponema cunimdi* (Morrell, 1995).

Reproductive disorders could be reduced by using a strict management of housing hygiene combined with a good feeding strategy and a daily checking of the animals looking at their health (EFSA, 2020).

- *Resting problems*

As it has previously been mentioned, floor properties and space allowance are important determinants of resting behaviour. Organic facilities are usually provided with a resting area, consisting of a solid construction which is not slatted, and a dry bedding strewn with litter material comprising straw or other suitable natural materials (Reg EU 2018/848). According to Morisse et al (1999), rabbits prefer a wire floor over straw littered areas, especially for lying. As reported by the authors, the cleanliness and dryness of the wire is the most plausible explanation for this finding (EFSA, 2020). However, as mentioned previously, other studies showed that fattening rabbits have a preference for plastic-mesh floors over wire mesh floor (Matics et al., 2003; Gerencsér et al., 2012; Princz et al., 2008b; Alfonso-Carrillo et al., 2014a; Alfonso-Carrillo et al., 2014b). In addition, the use of elevated platforms can also cause hygiene problems, as rabbits can defecate and urinate in the platform (and beneath). Consequently, the level of cleaning of both does and kits is reduced and the possibility of infection rises, as the animals are in contact with their faecal material. Daily health checking is also impaired because the animals are less visible and handling of the animals becomes more dangerous as does are hidden below the platform and defensive attitudes can be developed (Villagrá, 2020).

Other negative welfare consequences related to organic systems are:

- *Prolonged thirst*

In organic systems, hazards related to prolonged thirst may be caused by changing environmental temperatures which can be either too high, increasing the need to provide supplementary fresh water, or too low, when water may freeze. The water intake of a rabbit can be reduced when the temperature of the water is <10ºC or >25ºC. When temperature falls below zero, drinking water freezes and this could lead to prolonged thirst without intervention of the farmers (EFSA, 2020).

- *Skin lesions and wounds*

Skin lesions and wounds, such as multiple scratches, open or scabbed wounds or abscesses to the body or ears, may cause pain and chronic fear to rabbits, as well as compromise their health and thus their welfare. Lesions and wounds can result from inadequate housing

equipment or aggression or chewing between animals. As it has been previously mentioned, lesions from aggression can occur among growing rabbits or reproducing animals when kept in groups, and in kits because of aggression from reproducing does. Literature has confirmed that continuous group housing of reproducing does usually results in very high rates of aggression among females and competition for nesting areas, which impairs animal welfare in terms of frequency and degree of injuries among reproducing does, as well as towards kits. Even in part-time systems aggression, fighting and presence of injured rabbits (46–66%) after each re-grouping remain unsolved problems (EFSA, 2020). Rommers and De Greef (2018) also concluded that group housing of lactating rabbits does involves animals getting injured, but only described 5 to 6% of them severely injured (wounds). The aggressive behaviour is triggered by the separation as well as the reintroduction of new does, as sick and non-reproducing animals are constantly removed and replaced. This causes a regular change in the hierarchy of the groups, accompanied by agonistic behaviours (Braconnier et al., 2020).

3.5.2 Kits

a. Positive welfare aspects

There is a gap of knowledge on positive welfare aspects of organic systems for kits.

b. Negative welfare consequences and preventive measures

According to EFSA's work (2020), prolonged hunger, heat and cold stress are the three most important welfare consequences for kits in organic systems, followed by gastrointestinal and neonatal disorders.

Prolonged hunger in kits and neonatal disorders may result from inadequate nesting behaviour and poor maternal care. Such conditions may be found more frequently in group housing of does. For kits, the occurrence of prolonged hunger should be reduced by, firstly, a correct health status and feeding of the doe, and, secondly, by a correct design of the nest-box to only allow kits access to the main cage when sufficiently mature.

Rabbit kits are mainly affected by cold stress which can lead to hypothermia and death of kits. Cold stress can be found in case of disturbances in maternal behaviour or when there is a reduced environmental control. In buildings, the ambient temperature and other atmospheric conditions are controlled to a certain extent, whereas this is not possible in outdoor or organic systems.

Finally, when does are group-housed, kits' mortality rates increase significantly mainly due to the free entrance of does to the nest boxes of other does (Hoy et al., 2006). Although part-time group housing has shown to avoid double litters in one nest box at birth as well as the reduction of infanticides (mostly restricted to the first 10 days after parturition), negative welfare consequences in does are still present in this kind of systems (Braconnier et al., 2020). (see 3.5.1.c)

3.5.3 Fattening rabbits

a. Description of the system

See 3.5.1.a

Growing rabbits are reared in groups, usually outdoors. However, movable and fixed facilities include a sheltered area with solid walls, used as functional resting/refuge area for the animals (EFSA, 2020).

b. Positive welfare aspects

See 3.5.1.c

Organic facilities allow greater space allowance than conventional cages as growing rabbits have access to an indoor area (minimum 0.15 m^2 /animal in fixed housing and 0.2 m^2/animal in mobile housing) plus an outdoor run (minimum 0.5 m^2 /animal in fixed housing and 0.4 m^2/animal in mobile housing).

c. Negative welfare consequences and preventive measures

According to EFSA's work (2020), the two main welfare consequences are resting problems and gastrointestinal disorders (see 3.1.1.c). Resting problems in organic systems might be linked to housing the animals on litter. Indeed, this flooring material could provoke unhygienic or more humid conditions which favour the development of sore hocks (Szendro et al., 2019). According to Villagrá (2020), litter could also impair the productivity and increase overall mortality due to enteric disorders, primarily caused by coccidia infection. Rabbits consume the litter material, which opens the infection chain of coccidiosis. Moreover, the litter material contains low levels of nutrients, and the correspondingly reduced pellet intake lowers the performance of the animals for most production and carcass traits (Szendro et al., 2012). In addition, choice tests do not show a preference for straw flooring as compared to wire and plastic flooring (Villagrá, 2020).

Gastrointestinal disorders within the organic production can be caused by parasites such as coccidia. Coccidiosis can cause growth retardation, digestive disturbances and even death. Reproductive adults, who are immune, are therefore reservoirs for coccidia; kits, benefit from their mother's immunity during lactation but young weaned rabbits (between 5 and 10 weeks), that do no longer have this maternal protection, are the ones mainly affected by the disease. The appearance and concentration of coccidia are favoured by poor hygiene in animal housing, the absence of prophylactic measures and the access to pasture (required in organic systems). Vigilance must be strong at certain stages of the rabbit's life such as weaning, or when accessing pasture in the high growth season (spring and autumn). Parasites multiply easily in hot and humid conditions. Moreover, the coccidia can be disseminated in their form of resistance (oocysts) in the excrements by the reproducers and they can be easily stored in the housings and meadows. Therefore, cleaning and a good grazing management is required (CAB 2020). The feeding strategy can contribute to the prevention of digestive troubles of the growing rabbit. As feed restriction strategies are not permitted in organic systems, preventive measures such as the use of prebiotics and probiotics (mainly live yeast) or phytotherapeutic

products may be used, although their real contribution to reduce the prevalence of digestive disorders is questionable (EFSA, 2020).

According to EFSA (2020), other growing rabbits' welfare problems associated with this system are:

- *Thermal stress*

Regarding thermal stress (see 3.5.1.c), rabbits after weaning age are mostly affected by heat stress, especially in Mediterranean countries or in hot summer periods.

- *Fear*

See 3.2.3.c

In semi-outdoor or outdoor systems, regardless of the specific housing enclosure (fixed or moveable cages, underground systems, hutches), rabbits may be exposed to predator challenges (from both birds and carnivores). D'Agata et al. (2009) observed more escape attempts and digging and less exploratory biting behaviour during the open field test in rabbits in colony wire cages kept outdoor under a shelter compared to indoor. Even the odour from predator proximity may elicit a fear response in rabbits, which are macrosmatic animals. Fear in growing rabbits can be minimised by protections against potential predators, such as a robust electrified fence, a net top protection against birds of prey, and setting up hiding places in paddocks. Familiarity with people by regular visits from the farmer to the animals should also be beneficial (EFSA, 2020).

3.5.4. Conclusions on the organic system

	Positive welfare aspects	Negative welfare aspects	Recommendations
Does	- More available space than conventional cages - Mother offspring distance (Platforms) - Expression of foraging behaviour - Expression of gnawing behaviour (gnawing material) - Expression of social behaviour (group housing) - Littered resting area (not slatted floor)	- Restriction of movement (when outdoor access not possible) - Thermal stress - Reproductive problems - Resting problems (dirty littered areas) - Prolonged thirst - Aggression with conspecifics (group housing) - Inadequate nesting behaviour (group housing) - Lesions and wounds (group housing)	- Increase the sheltered part of the movable cage or the paddock - Insulate the shelter or adding shade in the outdoor area - Strict management of housing hygiene - Daily checking of the animals looking at their health - Semi group housing for non-pregnant and reproducing does
Kits	Gaps of knowledge	- Prolonged hunger - Cold stress	- Correct health status and feeding of the doe

		- High mortality (group housing of does)	- Correct design of the nest-box - Better control of the ambient condition
Fattening rabbits	- More available space than conventional cages - Platforms - Expression of foraging behaviour - Expression of gnawing behaviour (gnawing material) - Littered resting area (not slatted floor)	- Resting problems - Gastrointestinal disorders - Thermal stress - Fear	- Improvement of food grazing management (a return time greater than 2 months, co-grazing with other species (hens, sheep, etc.), the inclusion of the pasture within a crop rotation, alternation of mowing and grazing, loading limitation, etc.) - Feeding strategy (prebiotics and probiotics) - Improvement of biosecurity management - Regular visits from the farmer

4. Welfare of bucks

The farming systems for commercial rabbit meat production are based almost exclusively on artificial insemination (AI) programmes, used in over 99.9% of conventional rabbit farms in Italy (and likely also in other countries such as France and Spain).

A breeding buck is considered a rabbit from first mating/semen collection to culling. Nowadays, very few farms still have a limited number of bucks within the farm for being used as semen producer. In addition, nobody uses bucks for internal restocking since the genetic quality is lower and the costs higher than simply buying fresh semen. Indeed, it is almost impossible to buy bucks from genetic companies because the commercial strategy of large producers of genetic traits is to sell female/does for restocking but not males.

Instead, the same genetic companies producing females have large, specialized semen collection centres, which house only breeding males.

In these farms breeding males are kept individually, once they reach maturity (12 weeks), for long periods of time in a dedicated type of cage that is slightly larger and higher than those used for reproducing does. Individual housing of bucks is necessary to avoid testosterone-induced aggression and to facilitate semen collection.

In the case of use of male semen for artificial insemination from animals of the same farm, these animals should be housed in dedicated structures (buildings and shelters).

4.1. Main welfare issues in bucks farming

There are mainly two aspects of bucks farming that can affect their welfare: semen collection and the type of cage/housing.

4.1.1. Semen collection

Semen collection is normally carried out every 12 days and can be a source of stress for rabbits. In fact, an increase in faecal cortisol has been recorded in conjunction with such manual handling (Cornale et al., 2016). Indeed, animals do not well tolerate infrequent handling associated with uncomfortable procedures (Dorning and Harris, 2017). Therefore, frequent and correct handling of the animals by adequately trained staff, even in the time between sampling, can allow a correct human-animal relationship and consequently contribute to reduce stress.

Moreover, during this procedure it is essential to carry out health and hygiene procedures in order to guarantee animals' health and welfare. Rabbit semen is collected by means of an artificial vagina filled with a warm liquid (about 45°C) under strict hygienic conditions in order to prevent infections. In addition, a different artificial vagina should be used for collection from each buck, to avoid cross-contaminations (Boiti et al., 2005).

4.1.2 Housing of rabbit bucks

Specific scientific studies on bucks' natural needs and welfare are very few. However, since these animals are individually housed, it may be asserted that they have similar welfare issues as does kept in conventional single cages: restriction of movement and resting problems, inability to show social behaviour and gnawing problems. Consequently, similar preventive measures should be applied, with some exceptions. In fact, it is not recommended to use platform cages for bucks, which could increase the risk of trauma during semen collection. Therefore, other enrichment elements must be provided, including a visual barrier between bucks, that prevents males from showing aggressive behaviour between neighbouring males, gnawing sticks and a plastic footpad or a full plastic pavement, which is essential to prevent sore hocks. As well as in does, these are very common lesions in breeding males, and they commonly increase with age.

EFSA 2005 recommend that cages should be provided with an area where breeding rabbits can retreat (a minimum height of 20-25cm), and where they can sit and stand up with their ears erect, that has a minimum height of 38-40cm. In addition, according to the Rabbit Farming Guidelines of the Italian Ministry of Health (2020), cages for males should have a minimum length of 65 cm; a minimum width of 38 cm; a minimum height of 50 cm and an area per animal of at least 2500 cm2. Some evidence show that 50 cm high cages could favour these animals to sit and stand with their ears erect, and occasionally to rear up, as these are conserved behaviours to increase the rabbits' field of vision on arousal, and to thermoregulate (EFSA, 2005). However, one of the main aspects concerning the welfare of rabbits kept in single cages is the inability to express social behaviour.

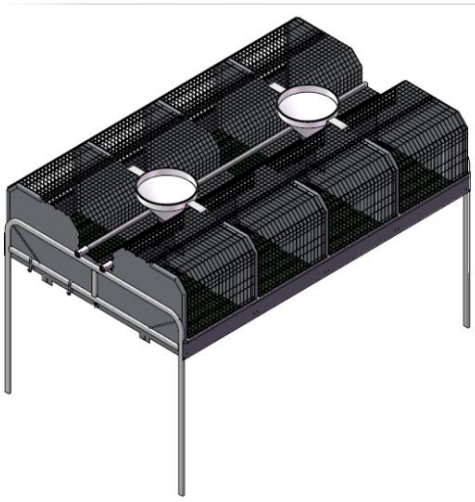
In the wild, rabbits live in stable matrilinear family groups of 2-9 does, 1-3 adult bucks, their offspring and, eventually, some sub-adult satellite males. The dominant buck is tolerant of young rabbits and does, but it can be very aggressive against sub-adult males. Conflicts are avoided by keeping distance and displaying submission, but high population densities may lead to considerable aggression in male groups (Rodel, 2021 –in press-; EFSA, 2005). Therefore, when considering bucks reared in conventional farms, wire net walls would ensure social behaviour between males kept alone, but the size and design of housing structure should also permit to rabbits to choose whether to hide to avoid conflict or seek social contact (Dorning and Harris, 2017). Regarding the possibility of group housing for breeding bucks, DiVincenti and Rehrig (2017) first describing male social behaviour, found a wider behavioural repertoire and increased positive interactions between males housed in pens and in pair cages compared to those kept in single cages. This demonstrates the need for social interactions for male rabbits as well. However. In that study the agonistic behaviour occurred and persisted, in pair cages in particular, to a such extent that they were forced to separate the animals. Therefore, given the lack of scientific evidence, further studies are needed on new breeding methods applicable to intensive rabbit farming that would allow social interactions between bucks limiting aggressive behaviour.

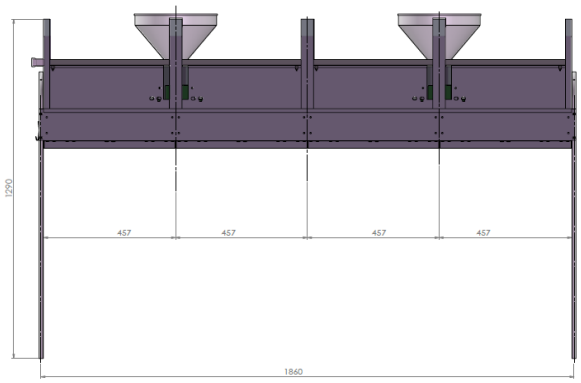
4.2. Example of a bucks' module

In the images below (Figure 9) an example of one housing module for breeding bucks', which could be considered the best actual solution available on the market. The side and the back cage walls are made of stainless-steel sheet, because urine would quickly ruin, for example, the galvanized sheet. Furthermore, the "closed" walls ensure the visual barrier of the males next to them, and avoid stress and aggressive behaviour caused by competition with other males.

On the bottom a plastic panel is used designed to ensure both comfort and cleanliness. The doors have a special design to guarantee the operator easy access "in front" of the box, to better facilitate handling of rabbits and thus the collection of semen with the artificial vagina.

Regarding the surface, the measure of 46 cm wide by 85 cm depth allows a certain mobility and also facilitates the operator when collecting the semen. The height (45-60 cm) should be such as to allow the rabbit to sit upright on its hind legs. The design in the sheet is for manual feeding, but an automatic version also exists featuring the spiral tube instead of the plastic cone.

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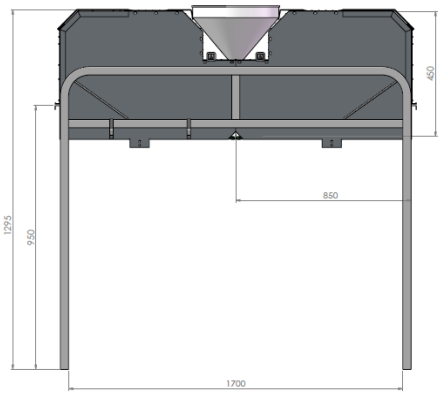
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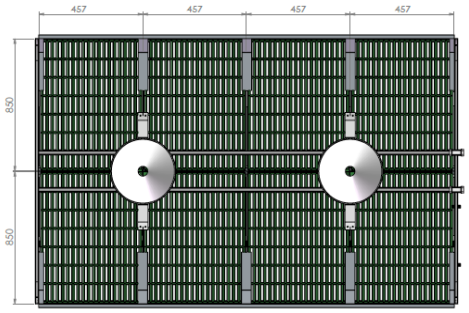

Figure 9. Example of a cage module designed for bucks, based on a model available on the market

5. Conclusions, gaps of knowledge, research perspectives and recommendations

The main conclusions about all the systems are gathered in Annex 2.

General recommendations to improve the rearing conditions of rabbits are to:

- **Increase the available space allowance (horizontally and vertically)**: The available space needs to be sufficient for rabbits to stretch out, turn round and lie on their sternum. It should be at least 75-80 cm depth and 35-40 cm width. For bucks, the recommendations are similar: 65 cm length and 38 cm width with 2500 cm² per animal. Rabbits should be able to stay in a standing position to let them express vigilance postures, to hope and jump as well as show more social interactions. Adult rabbits are about 60 cm tall in a standing position thus, in non-open-top systems, they should have more than 60 cm roof' height to stand up.
- **Decrease the stocking density in rabbit groups:** individual space needs to be sufficient and the minimum individual space allowance should be 625 cm² and the maximum stocking density at slaughter weight, 40 kg/m².
- **Provide plastic mesh floor:** plastic mesh floors are more comfortable than wire mesh floor and reduce footpad problems.
- **Provide platforms:** Platforms improves rabbits' welfare by providing more space, increasing locomotor activity, allowing a better view of their environment, coping with disturbance, permitting does to escape their young kits, and providing a shelter. The number of platforms needs to be sufficient to avoid competition in group-housed rabbits.
- **Provide gnawing materials:** Gnawing materials are essential for rabbits to satisfy their gnawing behaviour, reducing oral stereotypies and conspecific aggression but they need to be available at all age (for all animals: fattening rabbits, does and bucks), until

the weaning, and in a sufficient number to avoid competition for group-housing rabbits.

- **Improve environmental conditions** (e.g. optimal temperature and humidity, good quality of the air with low presence of gases and dust etc.) and sanitary conditions, biosecurity and prophylaxis.
- **Provide wire net and visual barrier between neighbouring bucks** to let animals choose whether hide to avoid conflict or seek social contact.

Gaps of knowledge and research perspectives

There still remain gaps of knowledge in rabbit welfare linked to their housing systems. For example, no literature was found on the positive effects of the enriched cages for kits, elevated pens for kits, floor pens for kits and fattening rabbits, outdoor systems for does and kits, organic systems for kits.

There is a lack of information on many of the behavioural needs of rabbits. Concerning bucks' natural needs and welfare, there are very scarce scientific studies. Furthermore, more research should be done to determine the appropriate number of platforms and gnawing materials to be provided.

Rabbits are social animals and to fulfil their need for social behaviour, they should be housed in part-time group housing. However, the social dynamics of group housed does are insufficiently understood and might be important to reduce damaging behaviour in part-time group housing. More research has to be done to find the appropriate housing conditions for does to fulfil their social needs without risking severe aggression and injuries.

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ANNEX 1: Main legislative requirements of the organic system

The main legislative requirements of the organic system are related to housing, reproduction, feeding and disease prevention.

Feeding

Requirements related to nutrition (EU Reg 2018/848):

- Restricted feeding shall not be permitted unless justified for veterinary reasons.
- Animals shall be fed with organic or in-conversion feed that meets the animal's nutritional requirements at the various stages of its development.
- At least 70 % of the feed shall come from the farm itself or, if this is not feasible or such feed is not available, shall be produced in cooperation with other organic or in-conversion production units and feed operators using feed and feed material from the same region.
- Rabbits shall have access to pasturage for grazing whenever conditions allow it.
- Rearing systems shall be based on maximum use of grazing pasturage by reference to the availability of pastures in the different periods of the year.
- Fibrous feed such as straw or hay shall be provided when grass is not sufficient. Forage shall comprise at least 60 % of the diet.

Housing

Requirements related to housing and husbandry practices (EU Reg 2018/848 and Regulation (EU) 2020/464):

- Rabbits shall be kept in groups (EU Reg 2018/848)
  - Preservation of the broods' integrity upon transfer to the fattening phase shall be permitted. (Regulation (EU) 2020/464)
  - It is possible for bucks, pregnant and reproductive does to be separated from the group for specific animal welfare reasons and for a limited period of time provided they can keep eye contact with other rabbits (Regulation (EU) 2020/464)

- Rabbits shall have access to:
  - Covered shelter including dark hiding places in sufficient number for all categories of rabbits (Regulation (EU) 2020/464)
  - An outdoor run with vegetation, preferably pasture (EU Reg 2018/848)
    - The outdoor run shall be surrounded by fences that are high and deep enough to prevent flight either by jumping or digging (Regulation (EU) 2020/464)

  - If the outside run has a concrete outside area, there should be an easy access to the part of the outdoor run with vegetation. Without such easy access, the surface of the concrete area may not be included in the calculation of the minimum surface of the outdoor area (Regulation (EU) 2020/464).

- Raised platforms in sufficient number and evenly distributed on its minimum surface, on which they can sit, either inside or out (EU Reg 2018/848 and EU Reg 2020/464).
- Access to nests and nesting material for all nursing does (minimum one nest per nursing doe with kits) (EU Reg 2018/848 and EU Reg 2020/464)
  - Does shall have access to nest at least one week before the expected date of birth and at least till the end of the nursing period of the kits.
  - Does shall be able to move away from the nest and return in the nest for nursing the kits.
- Materials to allow rabbits to gnaw (EU Reg 2018/848).

- Housing shall be provided with a comfortable, clean, and dry laying or rest area of sufficient size, consisting of a solid construction which is not slatted. Ample dry bedding strewn with litter material shall be provided in the rest area. The litter shall comprise straw or other suitable natural materials. (EU Reg 2018/848).
- The indoor area shall have sufficient height to allow all rabbits to stand with their ears erect (EU Reg 2020/464).

- The outdoor area in facilities with fixed housing shall be constructed in such a way that (Regulation (EU) 2020/464):

Stocking density and minimum surface for indoor and outdoor areas (Article 18, Regulation (EU) 2020/464):

For rabbits, the stocking density and the minimum surface for indoor and outdoor areas shall be:

	Indoor area (net area usable per animal excluding platforms m^2/head) for the rest area	**Outdoor area** (outdoor run with vegetation preferably pasture) (net area usable per animal excluding platforms m^2/head)

Nursing does with kits until weaning	Fixed housing	Mobile housing	Fixed housing	Mobile housing
	0,6 m^2 /doe with kits if doe liveweight is below 6 kg 0,72 m2 /doe with kits if doe liveweight is above 6 kg		2,5 m^2 /doe with kits	
Pregnant does and reproductive female rabbits	0,5 m2 /pregnant doe or reproductive female if liveweight is below 6 kg 0,62 m2 /pregnant doe or reproductive female if liveweight is above 6 kg		2,5 m^2 /doe	
Fattening rabbits from weaning to slaughter Replacement rabbits (end of fattening to 6 months)	0,2 m^2/animal	0,15 m^2/animal	0,5 m^2/animal	0,4 m^2/animal

Characteristics of and technical requirements for mobile and fixed housing (Regulation (EU) 2020/464)

- During the grazing season, rabbits shall be kept in mobile housing on pastures or in fixed housing with access to pasture.
- Outside the grazing season, rabbits may be kept in fixed housing with access to an outdoor run with vegetation, preferably pasture.
- Mobile housing on pastures shall be moved as often as possible to ensure the maximum use of grazing pasture and shall be constructed in such a way that it is possible for rabbits to graze the pasture on the floor.

Reproduction

Requirements related to the reproduction practices:

- Rabbit farms shall use robust breeds adapted to outdoor conditions (848/2018)
- Minimum period for feeding with maternal milk shall be 42 days after birth (464/2020)
- Reproduction shall use natural methods; however, artificial insemination shall be allowed (848/2018)

- Reproduction shall not be induced or impeded by treatment with hormones or other substances with a similar effect, except as a form of veterinary therapeutic treatment in the case of an individual animal (848/2018).

Health/disease prevention (EU Reg 2018/848)

The fight against diseases in organic farming begins with the implementation of preventive measures. Veterinary treatments can be used under certain conditions.

- Chemically synthesised allopathic veterinary medicinal products, including antibiotics and boluses of synthesised allopathic chemical molecules, shall not be used for preventive treatment.
- Disease shall be treated immediately to avoid suffering of the animal. Chemically synthesised allopathic veterinary medicinal products, including antibiotics, may be used where necessary, under strict conditions and under the responsibility of a veterinarian, when the use of phytotherapeutic, homeopathic and other products is inappropriate. In particular, restrictions with respect to courses of treatment and withdrawal periods shall be defined.
- Substances to promote growth or production (including antibiotics, coccidiostatics and other artificial aids for growth promotion purposes) and hormones and similar substances for the purpose of controlling reproduction or for other purposes (e.g., induction or synchronisation of oestrus) shall not be used.
- Where animals become sick or injured despite preventive measures to ensure animal health, they shall be treated immediately.
- With the exception of vaccinations, treatments for parasites and compulsory eradication schemes, where an animal or a group of animals receives more than three courses of treatments with chemically synthesised allopathic veterinary medicinal products, including antibiotics, within 12 months, or more than one course of treatment if their productive lifecycle is less than one year.
- The withdrawal period between the last administration to an animal of a chemically synthesised allopathic veterinary medicinal product, including of an antibiotic, under normal conditions of use, and the production of organically produced foodstuffs from that animal shall be twice the withdrawal period referred to in Article 11 of Directive 2001/82/EC, and shall be at least 48 hours.

ANNEX 2: Conclusion Table on all the rearing systems

	Positive welfare aspects	Negative welfare aspects	Recommendations
Conventional cages	- Higher health condition / Lower incidence of infectious diseases - No competition for nest sites - Better body condition - Longer lifespan - Thermal comfort - Lower mortality - Prevention from aggression and injuries by other females and/or dominant animals	- Restriction of movement (insufficient space) - Resting problems (lack of space and floor properties) - Inability to express gnawing behaviour (insufficient gnawing materials) - Inability to express social behaviour - Poor nest quality for kits	- Increase Increasing available surface - Reduce stocking density in fattening rabbits - Provide plastic mesh floor and plastic mesh elevated platform - Provide gnawing materials at all age (e.g. wood mash) - Provide good nest materials - Frequent nest control to reduce wet and dirty nests - Guarantee wire net walls for does (to maintain a visual and olfactory relationship with other animals)
Enriched cages	- More available space than in conventional cages - Plastic footrests - Possibility of expression of gnawing behaviour - Platform - No risk of aggression between kits and other does	- Restriction of movement (insufficient space) - Skin disorders for fattening rabbits	- Increase Increasing available surface - Reduce stocking density in fattening rabbits - Provide plastic mesh floor and plastic mesh elevated platform - Improve prophylaxis procedure - Provide gnawing materials at all age

Elevated pens	- More available space than in conventional cages - Plastic footrests - Gnawing materials (when present) - Platform - Refugee and hiding places - Open-top cage	- Restriction of movement (in individual housing) - Inadequate nesting behaviour (in group housing) - Poor maternal care (in group housing) - Inability to express gnawing behaviour (if gnawing materials are not present or insufficient) - Skin lesions (in group housing) - Resting problems - Prolonged hunger for kits - Neonatal disorders - Skin disorders for fattening rabbits - Difficult to monitor	- Provide plastic mesh floor and plastic mesh elevated platform - Suitable and enough gnawing materials - Selective genetic selection and breeding of rabbits for tameness - Early handling - Good nesting practice and adequate nest environment (separate of the mother's living environment) - Part-time group housing which prevents injured kits by alien/other does, and pseudo pregnancies - Regular daily handling of lactating kits - Good control of the ambient condition - Improve biosecurity - Good control of the ambient condition - Good positioning of the drinkers - Appropriate floor quality - More space allowance - Good prophylaxis procedures - Feeding strategies - Correct access and kind of gnawing materials

			- Placing an upper limit on slaughter age to reduce aggression - Good handling
Floor pens	- Solid floor - Group housing does allowing social behaviour	- Hunger and thirst issues - Heat and cold stress - Resting problems - Skin diseases - Neonatal disorders - Gastrointestinal disorders	- Hygiene conditions well managed: adequate quantity of suitable bedding and frequent removal of soiled bedding, feeding and drinking facilities free of bedding and regularly cleaned. - Increase space per animal - Decrease group size - Controlled ventilation systems to avoid thermal stress and unbedded area of floor in case of hot weather - Correct health status and feeding of the doe - Individual nest for a doe and its kits inaccessible to the other does (part-time group housing) - Better nest design to avoid kits to get out before they are sufficiently mature - Adapted diet and provision or roughage
Outdoor system	- More diverse behaviour repertoire	- Heat and cold stress - Biosecurity - Hunger for kits - Health problems for fattening kits	- Improve housing conditions - Improve hygienic and biosecurity measures - Improve kit management - Balanced diet for does

			- Balanced diets for kits around weaning
Organic system	- More available space than conventional cages - Mother offspring distance (Platforms) - Expression of foraging behaviour - Expression of gnawing behaviour (gnawing material) - Expression of social behaviour (group housing) - Littered resting area (not slatted floor) - Platforms	- Restriction of movement (when outdoor access not possible) - Thermal stress - Reproductive problems - Resting problems (dirty littered areas) - Prolonged thirst (does) and hunger (kits) - Aggression with conspecifics (group housing) - Inadequate nesting behaviour (group housing) - Lesions and wounds (group housing) - High mortality for kits (group housing of does) - Gastrointestinal disorders for fattening rabbits - Fear	- Increase the sheltered part of the movable cage or the paddock - Insulate the shelter or adding shade in the outdoor area - Strict management of housing hygiene - Daily checking of the animals looking at their health - Semi group housing for non-pregnant and reproducing does - Correct health status and feeding of the doe - Correct design of the nest-box - Better control of the ambient condition - Improvement of the housing conditions - Improvement of food grazing management - Feeding strategy (prebiotics and probiotics) - Improvement of biosecurity management - Regular visits from the farmer