EURCAW
European Union Reference Centre for Poultry and other small farmed animal

Question to EURCAW-Poultry-SFA

Reference of the query: Q2E-Poultry-SFA-2023-001
Query received 14/04/2023
Date of admissibility: 17/04/23
Replied sent: 22/06/2023

Type of production: Rabbit
Level: Husbandry
Key words: Housing system, management

Background context provided by the solicitor

We would like to have up-to-date scientific input from the experts of the competent EURCAW-poultry-SFA, who also possess hands-on knowledge on the practical implementation of rabbit housing systems.

Question

What is the maximum stocking density for the keeping of growing rabbits grouped in elevated pens that will lead to an improvement of welfare compared to a current average situation in the indoor systems in EU? Would you recommend a maximum stocking density of 32 kg/m^2, as per the thematic factsheet 'Rabbits Welfare in farm rearing systems'?

Answer

Introduction: natural behaviour of rabbits

Very little is known about the rabbit's behavioural needs under farming conditions (EFSA, 2020).

Rabbits are one of the most recently domesticated mammals, and domestic rabbits have retained the behaviour of their wild relatives (Trocino and Xiccato, 2006). They have first been domesticated in French monasteries ~1400 years ago when they were bred for meat and began to be selected for size. From the 16th to the 19th centuries, selective breeding led to increased adult weight (Petracci et al., 2018). Rabbit domestication has partially modified the natural behaviour of rabbits, which more recently have been intensively genetically selected for being reared in intensive conditions in order to increase growth rate, improve feed conversion ratio, and increase litter size and reproductive longevity (Blasco et al., 2018).

Nevertheless, wild rabbit behaviour could be helpful in understanding farmed rabbit behavioural needs. In nature, rabbits spend most of their resting time in groups and close contact, demonstrating complex social activity living in underground warrens. The social unit is composed of one to four males and one to nine females. Rabbits perform various comfort activities on their own bodies (self-grooming) and those of others (allo-grooming), locomotory and exploratory activities

like hopping, digging, sniffing and gnawing. During external activities for feeding in the early morning and late evening, some anti-predator responses such as alert positions (standing on the hind legs), high-speed running towards a shelter, and immobility may be observed (Trocino and Xiccato, 2006). These behaviours are still observed in rabbits housed the indoor systems both in pens and cages.

The consequences of inadequate space per animal in farmed conditions

According to Trocino and Xiccato, 2006, domestic rabbits still show the previously described behaviours that wild rabbits exhibit in natural environments. As highly active animals, rabbits need enough space and height for running, jumping, hopping, and performing alert positions.

Consequently, under farming conditions, an inadequate space (e.g., due to the limited size of the housing system or due to a high animal stocking density) or height per animal reduce the functional space, leading to movement restrictions and resting problems and promoting agonistic behaviour in growing rabbits, mainly when they are near to slaughter age (thus as they approach sexual maturity).

Indeed, the higher the group size and the higher the slaughtering age of the rabbits, the worst the results in terms of aggression among animals (Trocino et al., 2015). Therefore, depending on the slaughtering weight of growing rabbits, high stocking density can consequently lead, in addition to movement restrictions, also to skin injuries, wounds, abrasions or abscesses to the body or ears, causing chronic fear and stress, pain and compromising both the health and the welfare of rabbits (EFSA, 2020).

Moreover, if rabbits are in a barren environment, without any type of enrichment, they can show stereotypies and, under some conditions, they cannot completely express their social behaviour (Rödel *et al.*, 2006).

The consequences of high stocking density

In addition, a high stocking density in the housing systems (either cages or park systems) can determine some other direct or indirect welfare consequences, including:
- prolonged hunger and social stress due to reduced access to feeding points,
- prolonged thirst and social stress due to reduced access to drinkers/nipples,
- social stress due to reduced possibility of seeking isolation from other rabbits by utilising hiding tools/refuges,
- inappropriate comfort behaviour due to increased soiling of the environment (especially of the plastic floor mats)
- Poor health due to elevated concentrations of noxious gases (NH_3, CO_2).

All these consequences lead to a reduction in rabbit welfare, increasing competition for resources, impairing prolonged hunger and thirst, and promoting the occurrence and spread of both respiratory and enteric diseases, often caused by opportunistic pathogens (EFSA, 2005).

Since more space could be beneficial for reducing such negative consequences, many EU and extra-EU countries developed their own rabbit welfare legislation in order to set limits regarding cage dimensions and stocking densities (Annex 1).

Literature data regarding stocking density values

However, regarding stocking density values that could be considered as a maximum threshold for not compromising the welfare consequences previously described, there is not yet substantiated scientific evidence to provide a definitive indication.

The 2005 EFSA Report, based on studies of animals housed in conventional cages, reports 40 kg/m^2 (i.e., 16 rabbits/m^2 when they reach a final weight of 2.5 kg) as the maximum stocking density taking into account both welfare and production, above which the welfare of growing rabbits cannot be guaranteed. The report also highlighted that stocking density should be further reduced under high environmental temperature conditions.

Furthermore, preliminary data obtained experimentally and conducted in non-standardized elevated pens (Trocino et al., 2015) showed that further density reduction below 40kg/m^2 in growing rabbits housed in pens (from 16 to 12 rabbits/m^2, final weight of 2.725 kg = 32.7 kg/m^2) reduced the number of injuries from aggression. Nevertheless, when stocking density increased to 16 rabbits/m^2, and animals were slaughtered older (83 days of age in comparison with the normal slaughtering age of 72-76 days), the rate of rabbits with lesions increased. In this study, the slaughter weights per unit of pen surface of rabbits kept with 16 rabbits/m^2 was 42.2 kg/m^2, slightly higher than the EFSA recommended stocking density (40 kg/m^2 - 16 rabbits/m^2 when they reach a final weight of 2.5 kg).

In light of these findings, the Italian Ministry of Health (2021) considers just acceptable a density of ≤ 40 kg/m^2 and recommends ≤ 32 kg/m^2 as the optimum stocking density, which can lead to a welfare improvement of growing rabbits. Indeed, stocking density should not, in any case, be higher than 40 kg/m^2.

Interestingly, Szendro et al. (2015) compared different group sizes and housing systems in rabbits with the same stoking density (15 rabbits/m^2, approx. 42 kg/m^2 for rabbits housed in pens and 44,7 kg/m^2 for rabbits housed in cages at 11-12 wk of age), and reported that rabbits housed in groups of 12-14 rabbits in 190 x 50 cm pens increased ear lesions compared to smaller groups in smaller cages (3 rabbits/cage, size of cage: 61 x 32 cm, same stocking density)

In reproducing females before first insemination (**restocking does/breeders**), the maximum stocking density of 32 kg live weight/m^2 of available surface (including the platform) could be used as a reference value until 12 weeks of age. From 12 weeks until first insemination (around 18-20 weeks), with does reaching about 4 kg live weight, using the same stocking density, no more than 8 does (32 kg total/4 kg per doe=8 does) should be kept per m^2.

Note that the use of elevated pens/parks meets these requirements as it allows stocking density to be kept ≤ 32 kg/m^2. In fact, the elevated pen provides more functional space to move freely, rest and perform social behaviour (Trocino et al., 2015). Usually, four modules (four litters of 8-10 kits each) of 180-200 cm in length and 95-102 in width are joined to form one pen/park, forming a complete group of 32 rabbits (maximum of 40 growing rabbits). Thus, by making calculations of the total available area (21,600 – 25,400 cm^2, including the platform of about 4500-5000 cm^2), an acceptable and congruous stocking density value can be obtained even at the time of sending to slaughter (when the rabbits reach 2.4-2.7 kg).

According to Trocino, Zomeño and Xiccato (2019), as regards pen/park dimensions, undoubtedly, the pen system offers more possibilities of movement compared to cages, even at the same available surface per animal (i.e., they permit better functional use of the space).

On the other hand, in a study by Buijs et al. (2011) in collective pens with 8 animals and 100 cm of width, the increase of length of the pen from 40 to 46, 53, 64, 80, 107 and 160 cm (stocking density decreasing from 17.5 to 15.0, 12.5, 10.0, 7.5 and 5 rabbits/m^2, respectively) it was shown that most of the recorded behaviours of rabbits, i.e., sternal and lateral lying, standing, jumping, hopping, grooming etc. did not change significantly with cage size, even if some of the behaviours like sitting, standing and lateral lying were increased, even if not statistically significant. The only consistent finding was an increase in sternal lying with decreasing cage size, probably caused by low space availability that did not allow rabbits to lie laterally or perform active behaviours (Buijs et al., 2011). In the trial by Trocino et al. (2018), an increase in stocking density from 12 to 16 animals/m^2 (from 32.7 to 42.2 kg live weight at slaughter/m^2) showed a reduction in the time rabbits spent self-grooming (16.1 vs. 14.9%; P<0.001), and an increase of total resting time (66.7 vs. 69.1%; P<0.01) and resting in the crouched position (35.7 vs. 41.1%; P<0.001). Rabbits kept at higher stocking densities, particularly near slaughter age, showed less time spent feeding (P=0.001) and time spent resting in the crouched position (P=0.01). However, the authors conclude that this difference in resting behaviour was not likely to affect the general welfare status of the animals, as the rabbit reactivity was scarcely (open-field test) or not affected (human approach and novel object tests).

Recently published papers (Birolo et al., 2022; Kimm et al., 2021) investigated welfare effects of different housing systems, but almost all the studies were based on two fixed density levels, i.e., the same used by Trocino et al., 2015. However, no definitive outcomes of the effect of different density levels were reported.

Fetiveau et al. (2021) studied two stocking densities, i.e., high (17 rabbits/m^2) and low (9 rabbits/m^2), with or without access to outside paddocks, and concluded that i) the stocking density did not affect the behavioural traits measured and ii) providing rabbits access to a paddock could allow them to fulfil some natural behaviours but slightly reduce their growth.

In conclusion, the studies often cannot disentangle the effect of stocking density, space allowance and group size. It could be assumed that reducing stocking density under 40 kg/m^2 will have more impact on reducing aggression and injury among animals than offering more space will have on promoting wider behavioural repertoire.

Therefore, based on the productivity and behaviour of **growing rabbits**, a maximum density of ≤ 32 kg/m^2 of available surface (including the platform) calculated at the end of the fattening period, could be recommended. This density would correspond to approximately 14.5 rabbits/m^2 (2.2 kg), 12.8 rabbits/m^2 (2.5 kg), and 10.6 rabbits/m^2 (3 kg) for such different slaughter weights.
Although this assumption to date is considered the most valid for ensuring the welfare of rabbits while not reducing productivity, it is however strictly necessary to perform further research in order to precise the exact optimal or maximal stocking density.

Stocking density vs Use of the functional space

As already reported, the density value itself is not the sole factor to be considered since the functional use of the available space is equally important for guaranteeing the welfare of rabbits. In fact, a length of a minimum of 80-100 cm should permit several consecutive linear hops (until 4 consecutive linear hops). Trocino et al. (in publication), based on the results of a recent study, conclude that modules of pens or cages with a length of a minimum of 80 cm (usually corresponding to 4,000-5,000 cm^2 of surface available) would not restrict movement (based on EFSA 2020 definition) permitting both the growing rabbits and the reproducing does to perform at least three consecutive hops (preventing "movement restriction" as defined by EFSA 2020), i.e. most of the activity that characterises their hopping pattern with special emphasis on consecutive linear hops.

Stocking density vs Performances

According to Szendrő and Dalle Zotte, (2011), stocking density higher than 15-17 rabbits/m^2 could negatively impact rabbit daily weight gain, feed intake and final weight. If lower, it may not give any benefit to the animals in terms of welfare and may not be profitable.

Other studies (Szendrő et al., 2009; Trocino et al., 2015; Xiccato et al., 2013) demonstrated that stocking densities lower than 16 rabbits/m^2 (corresponding to 40 kg/m^2 at 2.5kg slaughtering weight) are not associated with higher performance even in pens with large groups. It has to be noted that welfare per se has not been assessed in these studies.

However, rabbit performance does not depend exclusively on stocking density but also on the cage or housing type and management. Research on alternative systems for collective housing in growing rabbits initially outlined some critical points, with special emphasis on the increase of aggression and the impairment of growth performance and meat quality. Then, the available results have favoured a progressive development of collective housing systems in Northern Europe, which has also raised interest in other production countries (France, Hungary, Italy and Spain).

Several factors can vary in addition to stocking density (e.g., group size and composition, slaughtering age, availability and the number of feeders and drinkers, structural enrichments, and gnawing material) (Szendrő and Dalle Zotte, 2011). Some of these factors have been deeply studied and refined; thus, optimal technical solutions in order to both optimise production and increase welfare have been identified and implemented in the field. Other factors, such as part-time grouping of does or different types of enrichment, are yet under evaluation or at a developmental stage. In fact, because of the latest introduction of elevated pen systems, technical protocols or standard equipment tested under the various conditions of the different European countries are not available yet (Trocino et al., 2019). This means that their transfer in the field will require attention to avoid risks for the farmers and negative consequences for the welfare of rabbits as well.

The first evidence of decreased growth performance in pens compared to bicellular cages was not due to the group housing per se but rather to other housing features such as the use of an unsuitable floor (e.g., full floor covered with litter or slatted floor with a too large distance between slats) (Dal Bosco et al., 2002; Lambertini L. et al., 2001; Morisse et al., 1999; Xiccato et al., 2013). In fact, the use of a plastic floor in pens resulted in growth performance and carcass traits comparable with

conventional cage systems (Trocino et al., 2015). On the other hand, other floor types (e.g., plastic or wire slats) to replace the standard wire net floor did not affect the performance or behaviour of rabbits kept in cages (Petersen et al., 2000; Trocino et al., 2008) or pens (Princz et al., 2009, 2008).

Stocking density vs mortality

Leblatier et al. (2017), in a commercial farm with rabbits subjected to scheduled rationing, found no significant differences in mortality (2.3% and 7.3%, respectively) between cages (0.51 m²/rabbit) with 8 rabbits and pens (1.55 m²) with 24 rabbits at an equivalent density of 15.4 rabbits/m^2, but there were significant differences compared to larger pens (3.10 m²) with 48 rabbits (17.7%) i.e. with similar stocking density.
In an experimental farm with rabbits under a program of restriction and gradual re-alimentation, Birolo et al. (2020) found that mortality tended to increase (P = 0.06), from rabbits reared in conventional cages (0.33 m^2, 6 rabbits/cage = 18 rabbits /m^2) and small open top pens (0.50 m^2, 8 rabbits/pen) with 2.1% and 4.7% mortality, respectively, to those raised in large open top pens (1.00 m^2, 16 rabbits/pen and 2 m, 32 rabbits/pen = 16rabbits /m^2) reaching 10.9% mortality. Recently, in the study by Fetiveau et al. (2021) the two stocking densities tested (17 rabbits/m^2 and 9 rabbits/m^2) did not influence the mortality rate of rabbits kept respectively in closed pens (WxLxH: 100 x 200 x 80 cm) and in pens with a 23 m^2 outdoor paddock (W x L: 2,9 x 8 m).
Taken together, the results of these studies show that there is not a clear and direct relationship between mortality and stocking density.

Stocking density vs other welfare parameters

In two studies of Trocino et al., 2018 and 2014, the behavioural repertoire, the reactivity of rabbits towards man or a new environment, and stress level measured in terms of glucocorticoids in faeces were tested in relation with different stocking densities:

During the study of Trocino et al., 2018, rabbits were housed in open-top collective pens (1.20×1.40 m, i.e., 1.68 m^2) at two stocking densities (12 vs. 16 animals/m^2) varying with group size (20 vs. 27 animal/pen).

In Trocino et al., (2014) animals were housed in three housing systems: i) bicellular cages (28 x 40 cm x 28 cm-height; available surface per rabbit: 560 cm^2) with top and wire floor (2 rabbits/cage, 18 animals/m^2), ii) small open-top collective pens (1.40 x 1.20 m, 1.68 m^2), stocking density varying with group size: 20-27 animal/pen, 12-16 rabbits/m^2, and iii) large open-top pens (1.40 x 2.40 m, 3.36 m^2) (40-54 animals/pen, corresponding to 12-16 animals/m^2). Thus, three stocking densities were tested: 18 animals/m2 in cages, 12 and 16 animals/m2 in collective pens with different size.

However, the assessed parameters in both studies were not significantly affected by stocking density.

Final Conclusions and Recommendations

- The stocking density of rabbits housed in pens should be set considering their age, sex, breed, live weight, group size, and environmental conditions, especially their need to move freely and to engage in normal behaviour, including social behaviour.

- As we mentioned in the factsheet, we could say that a stocking density equal to or lower than 32 kg/m^2 is recommended to improve rabbit welfare without compromising performances compared to the average situation in EU indoor commercial housing. There is still a lack of studies on the specific optimal density for fattening rabbits in parks in terms of welfare.
- Generally speaking, it is very confusing to talk about rabbits/m^2, and thus stocking density calculation should always be performed considering the final slaughter weight of the animals and calculated in terms of kg/m^2. The above-defined density of 32 kg/m^2 would then correspond to approximately 14.5 rabbits/m^2 (2.2 kg), 12.8 rabbits/m^2 (2.5 kg), and 10.6 rabbits/m^2 (3 kg) for these different slaughter weights.

References

Birolo, M., Trocino, A., Zuffellato, A., Pirrone, F., Bordignon, F., Xiccato, G., 2022. Use of Gnawing Hay Blocks: Effects on Productive Performance, Behavior and Reactivity of Growing Rabbits Kept in Parks with Different Sex-Group Compositions. Animals 12, 1212. https://doi.org/10.3390/ani12091212

Birolo, M., Trocino, A., Zuffellato, A., Xiccato, G., 2020. Effects of time-based feed restriction on morbidity, mortality, performance and meat quality of growing rabbits housed in collective systems. animal 14, 626–635. https://doi.org/10.1017/S1751731119002283

Blasco, A., Nagy, I., Hernández, P., 2018. Genetics of growth, carcass and meat quality in rabbits. Meat Science 145, 178–185. https://doi.org/10.1016/j.meatsci.2018.06.030

Buijs, S., Keeling, L.J., Tuyttens, F.A.M., 2011. Behaviour and use of space in fattening rabbits as influenced by cage size and enrichment. Applied Animal Behaviour Science 134, 229–238. https://doi.org/10.1016/j.applanim.2011.06.008

Dal Bosco, A., Castellini, C., Mugnai, C., 2002. Rearing rabbits on a wire net floor or straw litter: behaviour, growth and meat qualitative traits. Livestock Production Science 75, 149–156. https://doi.org/10.1016/S0301-6226(01)00307-4

EFSA, 2005. Opinion of the Scientific Panel on Animal Health and Welfare (AHAW)on a request from the Commission related to "The Impact of the current housing and husbandry systems on the health and welfare of farmed domestic rabbits." EFSA Journal 3, 267. https://doi.org/10.2903/j.efsa.2005.267

EFSA (AHAW), Saxmose Nielsen, S., Alvarez, J., Bicout, D.J., Calistri, P., Depner, K., Drewe, J.A., Garin-Bastuji, B., Gonzales Rojas, J.L., Gortázar Schmidt, C., Michel, V., Miranda Chueca, M.Á., Roberts, H.C., Sihvonen, L.H., Spoolder, H., Stahl, K., Velarde Calvo, A., Viltrop, A., Buijs, S., Edwards, S., Candiani, D., Mosbach-Schulz, O., Van der Stede, Y., Winckler, C., 2020. Health and welfare of rabbits farmed in different production systems. EFSA Journal 18, e05944. https://doi.org/10.2903/j.efsa.2020.5944

Fetiveau, M., Savietto, D., Gidenne, T., Pujol, S., Aymard, P., Fortun-Lamothe, L., 2021. Effect of access to outdoor grazing and stocking density on space and pasture use, behaviour, reactivity, and growth traits of weaned rabbits. Animal 15, 100334. https://doi.org/10.1016/j.animal.2021.100334

Italian Ministry of Health, 2021. Italian Rabbit Rearing and Welfare Guidelines. https://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2021&codLeg=82636&parte=2&serie=

Kimm, S., Rauterberg, S.L., Bill, J., Stracke, J., Kemper, N., Fels, M., 2021. Use of space, active and resting behaviour in fattening rabbits (Oryctolagus cuniculus) housed in a combi park system: A case study. Animal Welfare 30, 493–506. https://doi.org/10.7120/09627286.30.4.012

Lambertini L., Vignola G., Zaghini G., 2001. Alternative pen housing system for fattening rabbits: effects of group density and litter. World rabbit sci. 9, 141–147. https://doi.org/10.4995/wrs.2001.457

Leblatier, L., Menini, F., Bourdillon, A., Salaün, J., Le Floch, A., Perdriau, A., 2017. Effet d'un logement collectif en parc sur les performances zootechniques du lapin en engraissement en conditions d'élevage commercial. In: Proceedings of "17èmes Journées de la Recherche Cunicole", Le Mans, France, 51-54.

http://www.cuniculture.info/Docs/Magazine/Magazine2017/Fichiers-pdf-JRC/25-Leblattier-Parcs-performances.pdf

Maertens, L., Buijs, S., 2016. Comparison of fattening performances housed in parks or enriched cages. In: Proceedings 11th World Rabbit Congress. Qindao, China, 703-706. https://pureportal.ilvo.be/nl/publications/comparison-of-fattening-performances-housed-in-parks-or-enriched-

Masthoff, T., Lang, C., Hoy, S., 2016. Effect of group size on fattening performance and of various types of slatted floor on dirtiness and occurrence of pododermatitis in growing rabbits, in: Proceedings of the 11th World Rabbit Congress, Qingdao, China. pp. 15–18.

Morisse, J.P., Boilletot, E., Martrenchar, A., 1999. Preference testing in intensively kept meat production rabbits for straw on wire grid floor. Applied Animal Behaviour Science 64, 71–80. https://doi.org/10.1016/S0168-1591(99)00023-4

Petersen, J., Schlender-Böbbis, I., Mennicken, L., 2000. Evaluation of optimal slat distance in slatted floor for rabbits using behavioural studies, in: Proceedings of the 7th World Rabbit Congress, Valencia, Spain, Vol. B. pp. 559–565.

Petracci, M., Soglia, F., Leroy, F., 2018. Rabbit meat in need of a hat-trick: from tradition to innovation (and back). Meat Science 146, 93–100. https://doi.org/10.1016/j.meatsci.2018.08.003

Princz, Z., Dalle Zotte, A., Metzger, Sz., Radnai, I., Biró-Németh, E., Orova, Z., Szendrő, Zs., 2009. Response of fattening rabbits reared under different housing conditions. 1. Live performance and health status. Livestock Science 121, 86–91. https://doi.org/10.1016/j.livsci.2008.05.018

Princz, Z., Dalle Zotte, A., Radnai, I., Bíró-Németh, E., Matics, Z., Gerencsér, Z., Nagy, I., Szendrő, Z., 2008. Behaviour of growing rabbits under various housing conditions. Applied Animal Behaviour Science 111, 342–356. https://doi.org/10.1016/j.applanim.2007.06.013

Rödel, H.G., Monclús, R., von Holst, D., 2006. Behavioral styles in European rabbits: Social interactions and responses to experimental stressors. Physiology & Behavior 89, 180–188. https://doi.org/10.1016/j.physbeh.2006.05.042

Szendrő, Z., Princz, Z., Romvári, R., Locsmándi, L., Szabó, A., Bázár, G., Radnai, I., Biró-Németh, E., Matics, Z., István, N., 2009. Effect of group size and stocking density on productive, carcass, meat quality and aggression traits of growing rabbits. World Rabbit Science 17. https://doi.org/10.4995/wrs.2009.655

Szendrő, Zs., Dalle Zotte, A., 2011. Effect of housing conditions on production and behaviour of growing meat rabbits: A review. Livestock Science 137, 296–303. https://doi.org/10.1016/j.livsci.2010.11.012

Szendrő, K., Szendrő, Zs., Matics, Zs., Dalle Zotte, A., Odermatt, M., Radnai, I., Gerencsér, Zs., 2015. Effect of genotype, housing system and hay supplementation on performance and ear lesions of growing rabbits. Livestock Science 174, 105–112. https://doi.org/10.1016/j.livsci.2015.01.008

Trocino, A., Filiou, E., Tazzoli, M., Bertotto, D., Negrato, E., Xiccato, G., 2014. Behaviour and welfare of growing rabbits housed in cages and pens. Livestock Science 167, 305–314. https://doi.org/10.1016/j.livsci.2014.05.035

Trocino, A., Filiou, E., Tazzoli, M., Birolo, M., Zuffellato, A., Xiccato, G., 2015. Effects of floor type, stocking density, slaughter age and gender on productive and qualitative traits of rabbits reared in collective pens. Animal 9, 855–861. https://doi.org/10.1017/S1751731114003188

Trocino, A., Filiou, E., Zomeño, C., Birolo, M., Bertotto, D., Xiccato, G., 2018. Behaviour and reactivity of female and male rabbits housed in collective pens: effects of floor type and stocking density at different ages. World Rabbit Science 26, 135–147. https://doi.org/10.4995/wrs.2018.7747

Trocino, A., Xiccato, G., 2006. Animal welfare in reared rabbits: a review with emphasis on housing systems. World Rabbit Science 14, 77–93. https://doi.org/10.4995/wrs.2006.553

Trocino, A., Xiccato, G., Majolini, D., Fragkiadakis, M., 2008. Effect of cage floor and stocking density on growth performance and welfare of group-housed rabbits. Proceedings of the 9th World Rabbit Congress, Verona, Italy, 10-13 June 2008 1251–1256.

Trocino, A., Zomeño, C., Xiccato, G., 2019. A perspective about the changes of the housing systems for rabbits in conventional farms. 31th Hungarian Conference on rabbit production. https://www.researchgate.net/publication/343211689_A_perspective_about_the_changes_of_the_housing_systems_for_rabbits_in_conventional_farms

Xiccato, G., Trocino, A., Filiou, E., Majolini, D., Tazzoli, M., Zuffellato, A., 2013. Bicellular cage vs. collective pen housing for rabbits: Growth performance, carcass and meat quality. Livestock Science 155, 407–414. https://doi.org/10.1016/j.livsci.2013.05.013

Literature consulted (not cited in the text)

EU. Minimum standards for the protection of farm rabbits European Parliament resolution of 14 March 2017 on minimum standards for the protection of farm rabbits (2016/2077(INI))

López M., Cervera C., Pascual J.J. (2021). Bienestar y resultados zootécnicos en conejos de carne durante su lactancia y engorde. ITEA-Información Técnica Económica Agraria, 117(2): 108-129. https://doi.org/10.12706/itea.2020.014

Maertens, L. (2017). Recent developments in rabbit housing in Northern Europe. ILVO. ASIC Congress, 2017
http://www.asic-wrsa.it/documenti/convegno2017/presentazioni/ASIC2017_Maertens.pdf

Trocino, A., Zomeño, C., Xiccato, G. (2017). Sistemas de alojamiento: pasado, presente y futuro. Boletín de cunicultura lagomorpha, ISSN 1696-6074, Nº. 185, 2017, págs. 26-31.

ANNEX 1

Rabbit meat production in Europe: country-specific legislation and guidelines for rabbits.

Country & legislation	Details
Belgium Royal Decree concerning the welfare of rabbits in farms (2014)[1]	• All new systems built for fattening rabbits must be park systems, with exceptions for recent investments until 2025 that shall be enriched cages (enrichment material provided and min. pen size 3000cm2 and maximum 16 rabbits/m^2) • Park systems must be at least 1800 cm long and provide: - 800cm2 per rabbit - groups of at least 20, elevated platforms - space for rabbits to perform three consecutive hops - 80% comfortable plastic flooring, gnawing blocks and tubes one drinking nipple per 20 animals and a rack with permanent hay or straw. • From 2021: - The minimum height of the enclosure for "Waiting does" (does that do not appear to be pregnant after insemination) and male breeding rabbits must be at least 60 cm. - "Waiting Does" must have access to at least 4500 cm^2 per animal, male breeding rabbits about 6000 cm^2 per animal. • From 1 January 2025: - Does must also be kept in enriched parks. - Each doe must have at least 6000 cm^2. - The top of the enclosure must be open over at least 60% of the ground surface. The does will have to be kept in groups for at least part of the reproductive cycle.
Netherlands Rabbit Welfare Regulation (2006)	• Area of 700 cm^2 /animal for less than five animals • Group housing of fattening rabbits in at least pairs • Height of at least 40cm • Floor mesh at least 3mm in diameter • Platforms (if used) should be at least 10cm wide and 25cm from the top of the cage • Roughage or gnawing material • 8 hours dark period • Ad libitum access to feed and water and veterinary consultation if mortality exceeds 10%

Germany Regulation on the protection of farm animals (2014)[2]	In force from August 2014 for new holdings and by Feb 10 2024 for existing buildings: • Housing for fattening rabbits: - 1500 cm^2 /animal for groups of 1-4 rabbits; - 1000 cm^2 /animal for groups of 5 – 10 rabbits; - 850 cm^2/animal for groups of 11 – 24 rabbits; - 700 cm^2/animal for ≥25 rabbits. - Cage height of at least 60 cm over 70% of the surface area and never less than 40cm. - Minimum pen area of 8000 cm^2, at least 80 cm long and 60 cm wide. - Maximum floor hole width of 11mm for fattening rabbits and 14mm for breeding rabbits - A raised platform: ≥ 300 cm^2 /fattening rabbit and breeding rabbit ≥ 600 cm^2 /breeding rabbit. - For breeding rabbits this should have a minimum area of 1500 cm^2 or 1800 cm2 (5.5kg weight rabbits respectively) and at least 30 or 50 cm wide (respectively) and is 60 cm long. - Fattening rabbits should have ≥27cm of height from the floor to the platform and ≥ 35cm for breeding rabbits. No more than 15% of the platform can be perforated and it shall not exceed 40% of fully useable floor space. - All rabbits must have access to rough textured roughage such as straw or hay and suitable gnawing material. - During light hours, rabbits must have 40 lux at rabbit head height and direct sunlight is to be avoided. When artificial light used there must be at least 8 hours continuous darkness with < 0.5 lux. A dusk phase of 30 minutes should be provided. - Veterinary consultation if mortality reaches 10%
Switzerland The Swiss Animal Protection Act (TschG 2005)[3] and Swiss Animal Protection Ordinance (TschV 2008)[4]	• Enclosures without elevated areas: - Based on weight of rabbits, pens must be designed so that: <2.3 kg must have ≥3400 cm^2, height ≥40 cm; 2.3 - 3.5 kg must have ≥4800 cm^2, height ≥50 cm; 35 – 5.5 kg must have ≥7200 cm^2, height ≥60cm. • Enclosure with elevated areas: - Based on weight of rabbits, pens must be designed so that: <2.3 kg must have ≥2800 cm2 of which floor area is ≥2000 cm^2, height ≥40 cm; 2.3 - 3.5 kg must have ≥4000 cm^2 of which floor area is ≥2800 cm^2, height ≥50 cm; 35 – 5.5 kg must have ≥6000 cm^2 of which floor area is 4200 cm^2, height ≥60cm. • Group housing of rabbits: - Rabbits up to 1.5 kg: ≤40 animals must have min. 1000 cm2; ≥ 40 animals must have min. 800 cm^2. - Rabbits over 1.5 kg: ≤40 animals must have min. 1500 cm2; ≥ 40 animals must have min. 1200 cm^2. - Minimum number of young animals from weaning to sexual maturity – 3 rabbits up to 3.5 kg, 4 rabbits greater than 3.5 kg.

	- At least part of enclosure should be high enough for animals to sit upright. - Darkened area required for animals to hide. - Does shall be provided with suitable nesting material. - Rabbits shall be provided daily with coarse structured feed such as hay or straw and constantly with objects for gnawing. *The Regulation of the WBF over Ethoprogramme (2008) describes requirements for higher welfare systems:* *'Animal-friendly' housing systems ('BTS') must provide: 1500cm2 per fattening rabbit, a minimum of 15 lux daylight, group housing of fattening rabbits and does, 3cm2 litter per rabbit (enough to allow scratching), an elevated platform at least 20cm from the floor (from 36-84 days) and 35% of the surface must be at least 60cm in height. Free range systems ('OUT') must provide daily outdoor access for several hours, with an uncovered area of at least 50%.*
Austria Austrian Animal Welfare Act (as amended 2014)[5]	• Rabbits must be kept in pens or enclosures; barren cages and wire mesh floor are prohibited (except recently built systems up to 2020). • Gnawing material must be provided (wood etc) along with permanent hay or straw rack. • 20 lux lighting should be achieved. Natural light must be provided (minimum of 3% of floor exposed to natural light). • Minimum flooring area for does, bucks and kittens of 6000 cm^2 per pen, the area provided must at least be available on 50% of ground level. • A platform (at least 25% of the floor area and 27cm wide) • In groups of fattening rabbits up to 40 animals: - ≤1.5 kg, minimum: ceiling height 50 cm, area 1000 cm^2/animal - >1.5 kg, minimum: ceiling height 50 cm, area 1500 cm^2/animal • In groups of 40 or more fattening rabbits: - ≤1.5 kg, minimum: ceiling height 50 cm, area 800 cm^2/animal - >1.5 kg, minimum: ceiling height 50 cm, area 1200 cm^2/animal • In adult breeding rabbits: - ≤5.5 kg, minimum: ceiling height 60 cm, area 6000 cm^2/animal and additional 1000 cm^2/animal nest chamber - >5.5 kg, minimum: ceiling height 60 cm, area 7800 cm^2/animal and additional 1200 cm^2/animal nest chamber
United Kingdom The Welfare of Farmed Animals (England) Regulations 2007[6]	Rabbits must be able to move, feed and drink without difficulty, should be able to lie on their side all at the same time and to sit up without their ears touching the top of the cage and be provided shelter from the weather.

Source (modified): **https://www.compassioninfoodbusiness.com/media/7426084/rabbit-meat-production-in-the-eu.pdf**

[1]**Belgium:** Belgium, 2020. Arrête Royal relatif au bien-être des lapins dans les élevages. https://assets.vlaanderen.be/image/upload/v1615561162/DWZ_19122020_Besluit_van_de_Vlaamse_Regering_betreffende_het_welzijn_van_konijnen_in_fokkerijen.pdf

[2]**Germany:** Regulation on the protection of farm animals (2014) https://www.gesetze-im-internet.de/tierschnutztv/BJNR275800001.html

Switzerland:

[3]The Swiss Animal Protection Act (TschG 2005) https://www.fedlex.admin.ch/eli/cc/2008/414/en

[4]Swiss Animal Protection Ordinance of 23 April 2008 http://www.admin.ch/opc/de/classified-compilation/20080796/index.html

[5]**Austria:** Austrian Consolidated Federal law – RIS Entire legislation for animal husbandry GBBI. II no. 485/2004
https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20003820

[6]**United Kingdom:** The Welfare of Farmed Animals (England) Regulations 2007
http://www.legislation.gov.uk/uksi/2007/2078/schedule/9/made
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1132115/Code_of_recommendations_for_the_welfare_of_livestock_-_rabbits.pdf

Guidelines

- **Italy**: Italian Ministry of Health, 2021. "National guidelines on the protection of rabbits raised for meat production"
  https://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2021&codLeg=82636&parte=2&serie=
- **Spain**: Andalusian Regional Government - Department of Agriculture, Livestock, Fisheries and Sustainable Development, 2020. "Guide to animal welfare in rabbits - application regulations in Andalusia".
  https://www.juntadeandalucia.es/sites/default/files/202206/Bienestar%20conejos_WB.pdf
- **United Kingdom:** Animal Welfare: Codes of recommendations for the welfare of livestock – Rabbits, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1132115/Code_of_recommendations_for_the_welfare_of_livestock_-_rabbits.pdf