Pastured rabbit systems and organic certification: European union regulations and technical and economic performance in France

Thierry Gidenne, Laurence Fortun-Lamothe, Yayu Huang, Davi Savietto

World Rabbit Science

World Rabbit Sci. 2024, 32: 83-97
https://doi.org/10.4995/wrs.2024.20894
WRSA, UPV, 2003

PASTURED RABBIT SYSTEMS AND ORGANIC CERTIFICATION: EUROPEAN UNION REGULATIONS AND TECHNICAL AND ECONOMIC PERFORMANCE IN FRANCE

Thierry Gidenne, Laurence Fortun-Lamothe, Yayu Huang, Davi Savietto

GenPhySE, Université de Toulouse, INRAE, ENVT, F-31326 Castanet Tolosan, France.

Abstract: In the European Union (EU), organic rabbit farming (ORF) remains uncommon (≈50 farms), found mainly in France, and to a much lesser extent in Austria, Switzerland, Spain and Italy. As rabbits are herbivorous, ORF is based mainly on grazing. This review summarises information on the functioning and performance of rabbit farming systems in France, with organic certification and/or access to pasture. Recent studies have quantified the grass intake (30 to 80 g dry matter/d/rabbit) and growth rate of rabbits on pasture (15 to 30 g/d). ORF has an extensive production cycle with a mean of 2.7 parturitions per doe and per year. The main concerns for the farmers developing ORF include available land and managing health and feeding. However, in France, a herd with 40 does on 4 ha (of pastures and complementary crops), can provide a half-time minimum salary. Since January 2022, a new regulation on ORF is applied for all EU member countries that recommends a maximum use of pasture but nevertheless allows farmers to keep a herd with 40 does on only 200 m^2 of pasture. It also does not require rotating rabbits on the pasture between batches of animals, wich increases the risk of parasitism. A smartphone application (GAELA) was recently developed to assist with daily management of rabbit farming, and to build a database of technical benchmarks to support the development of organic and pastured rabbit farming in France.

Key Words: rabbit, pasture, grazing, organic farming, production system, biotechnical performance.

INTRODUCTION

Organic rabbit farming (ORF) is based on grazing, maximum use of pasture and locally produced food resources. Although organic animal production has increased greatly since 2009 in Europe, ORF remains a niche market (*ca.* 100 farms in Europe). Approximately 50 of these farms are in France, of which 20 have more than 30 does, and they produce 15,000 organic rabbits per year. This small supply of organic rabbit meat is not enough to meet consumer demand in France (Roinsard *et al.*, 2016). Nevertheless, since ORF is only beginning to emerge in Europe, France is the leading organic rabbit producer in Europe (and worldwide), likely producing more than 90% of the world supply.

Few studies have researched organic or pastured rabbit systems, and those that have,often analyse the production performance and/or meat quality. A few older studies (1970-1980) focused on rabbit farming with outdoor access, as did a more detailed guide to rabbit farming published by the U.S. National Information Service on Sustainable Agriculture, that describes the potential contribution of rabbit production to developing sustainable agricultural systems in the USA (Fanatico and Green, 2012). Research on ORF began in France in 2010, and in Europe, only Italy, Spain and France are currently researching ORF. However, the specific provisions of each country's regulations make it difficult to compare and extrapolate results. In Spain and Italy, the need for pasture is not specified, justifying the lack of pasture in alternative systems. Conversely, French regulations require at least 60% coarse fodder (*i.e.* grass

Correspondence: T. Gidenne, *thierry.gidenne@inrae.fr*. Received *December 2023* - Accepted *May 2024.*
https://doi.org/10.4995/wrs.2024.20894

Cite as: Gidenne T., Fortun-Lamothe L., Huang Y., Savietto D. 2024. Pastured rabbit systems and organic certification: European Union regulations and technical and economic performance in France. *World Rabbit Sci., 32: 83-97. https://doi.org/10.4995/wrs.2024.20894*

Figure 1: Movable cages on pasture for organic rabbit farming (© INRAE, T. Gidenne).

and hay) in the diet, as well as access to pasture as soon as environmental conditions allow. In France, research has focused on nutrition and parasitism, in particular grass intake and grazing management, which has resulted in several publications, including a recent guide for organic rabbit farmers (CAB, 2020).

The first regulation on ORF was developed in 2000 in France (JORF, 2000; 2010). This required year round grazing, natural mating and a slaughter age of 100 d. Rabbits are housed in movable cages (Figure 1) or fixed pens (Figure 2), and breeds adapted to grazing and outdoors are highly recommended. In January 2022, new European regulations on organic production, including ORF, came into effect for all European Union (EU) member countries (regulations n° 2018/848 and 2020/464).

These new EU regulations differ in several key points from the previous national regulations in France, Italy and Spain, and could encourage the development of new organic rabbit farming systems. As no literature review has examined pastured rabbit systems, this review illustrates the limitation and production potential of existing ORF operations, particularly those developed in France.

We discuss the components of ORF systems (*i.e.* feeding, reproduction and health management) in France, current knowledge about production capacity and potential developments in the design and management of these systems in the light of recent changes in EU regulations on ORF.

DATA SOURCE

We identified 45 research and review articles in the ISI Web of Knowledge and Google Scholar databases using the keywords *rabbit*, *pasture*, *organic farming* and *outdoor rabbit systems* alone and in combination. Articles that focused on outdoor systems in developing countries (e.g. Africa, East Asia) were excluded, as their climate conditions differ greatly from those in the EU. After examining the articles' relevance to ORF in the EU, 32 of them were retained for the review.

Figure 2 : Fixed enclosure “paddock” with grazing rabbits (© INRAE, T. Gidenne).

RESULTS AND DISCUSSION

Pastured rabbit systems and organic certification

Main grazing systems used in France

The 2000 French regulation for ORF was based on maximising use of pasture, as rabbits are herbivores, and required at least 60% coarse fodder in the diet, as for other herbivores such as ruminants. Two housing systems have been developed to provide rabbits with full access to pasture, i.e. fixed fenced pens and movable cages (Figures 1 and 2). In practice, movable cages are preferred for breeding adults. Individual fixed pens can also be used for adults (*ca.* 10 m^2 per animal), but collective pens (50 m^2) are often used to keep growing rabbits. The most common housing systems in ORF combine movable cages (for adults) and fixed pens (for growing rabbits).

Current regulations allow a third type of housing system based on a fixed building with an outdoor exercise area. However, it requires intensive feeding to comply with EU regulations on feeding systems (see next subsection). This housing system may be useful under extreme climate conditions, or to reproduce better (*e.g.* lighting schedule, controlling parturition and protecting litters) (Martin *et al.*, 2016; Legendre *et al.*, 2019).

The fixed pen grazing system is similar to continuous grazing: the rabbits graze the same area throughout the entire fattening period (*ca.* 70 d). This type of housing reduces the workload, but it requires careful grass management. Excess grass (mainly in spring) should be cut, and groups of appropriate size should be grazed when the little grass is available in order to avoid overgrazing, which would decrease the grass quality. In addition, exposure to parasites could be high, as only rabbits use the pens (not used for any other production on the farm). The only prophylactic measure to reduce parasitism is a two-month waiting period between groups of grazing rabbits. Fixed pens also have a higher risk of predation than in movable cages.

The grazing system with movable cages is similar to rotational grazing: housing is moved daily, on the principle of “graze and rest” used for ruminants. Moving the cages each day requires more work, but decreases refusals and overgrazing. Good management consists of having a grazing area sufficiently large to provide enough grass and maximise intake without decreasing the grass quality. This system also reduces contact between animals and their droppings, which lowers the risk of exposure to parasites, such as *Eimeria* sp., which cause coccidiosis.

In ORF, farmers usually design their own housing systems and build them using local resources, adapting them to their specific conditions and working methods. However, all housing systems have a grazing area and a shelter area, the latter which is often built with hardwood to protect the rabbits from the weather and predators (e.g. dogs, foxes, weasels, raptors). Additional protection from predators is provided by wire fencing (movable cages) or electric fencing (fixed pens). Several housing designs for ORF were provided in the guide for organic rabbit farmers (CAB, 2020).

The production cycle in ORF is extensive, with four months between parturitions (Figure 3). EU regulations require weaning at no earlier than 42 d of age, but in practice, kits are weaned even later, when they have reached a live weight of at least 1 kg. Since the parturition interval exceeds four months (Table 1), *ca.* 17 kits are weaned per doe per year, which corresponds to the sale of *ca.* 14 rabbits weighing *ca.* 2.5 kg each. Based on this production, a herd of 40 does can produce *ca.* 560 rabbits, providing an income of *ca.* 14 000€/yr (assuming a selling price of 25€/rabbit). After subtracting the variable costs (*ca.* 35% of the income), this production can provide half of the French minimum salary, assuming that products are sold through short distribution channels (*e.g.* on-farm). As a result, ORF is often combined with other types of livestock or crop production on the same farm (Roinsard *et al.*, 2016).

In agreement with the EU regulations and to maximise use of pasture, it is recommended to have *ca.* 2 ha of pasture and hay production for a herd with 40 does and their kits (Table 2). In the most common ORF system in France, 1 ha is allocated to fixed pens for growing rabbits and 1 ha to movable cages for does. In addition, 2 ha are required to produce the cereal and protein crops used to meet daily nutritional requirements. Thus, 4 ha is the recommended area for setting up an organic rabbit farm for 40 does and their kits, 5 bucks and 5 nulliparous does, which corresponds to half-time work.

Consistency and inconsistency in EU regulations on organic rabbit farming and their influence on its development

Compared to the previous French regulation, the current EU regulations on ORF maintain the recommendations for maximum use of pasture, a diet containing 60% coarse fodder and several types of housing systems. Several provisions have changed, however, such as no minimum age at slaughter, a minimum age of 42 d at weaning, and no requirement to perform rotational grazing. The regulations also require the sheltered part of housing to be tall enough for rabbits to stand upright with their ears pricked up (i.e. lookout position, 80 cm). We believe that the main changes related to access to pasture and feeding, discussed below, are the most important for changing current ORF systems.

EU regulations no longer mention “vegetated areas” or “fixed pens”. Moving movable cages each day is no longer required, and there is no minimum waiting period (two months in the previous regulation) before grazing a new group of rabbits on the same plot. Even though this easing of regulations increases the risk of exposure to internal parasites, the outdoor area does not need to be used for grazing. However, concrete floors are prohibited. In addition, the

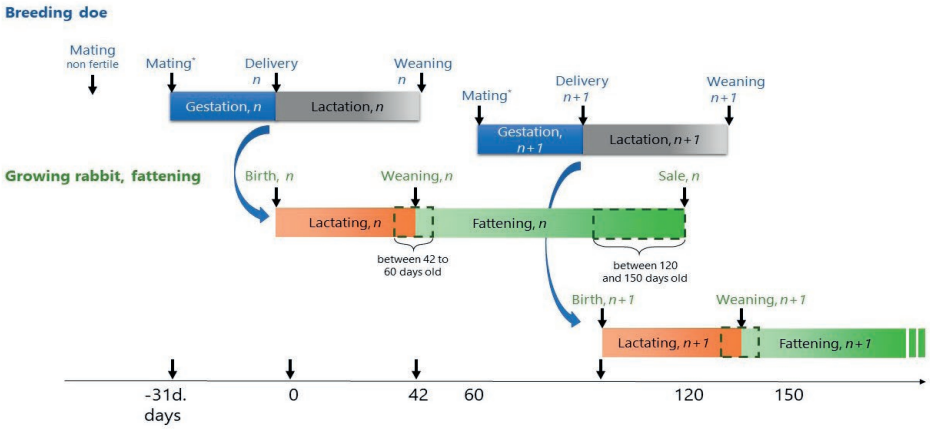

Figure 3: Typical production cycle in organic rabbit farming (source: Gidenne *et al.*, 2022).

Table 1: Productive performance of four French organic rabbit farms from 2018-2020 calculated by the smartphone application GAELA.

Performances	Farm A	Farm B	Farm C	Farm D
Matings/doe/yr	3.7	5.7	3.4	3.0
Matings/buck/yr	21.8	38.9	23.0	7.8
Fertility rate (%)	63.0	59.5	79.3	80.9
Parturition/doe/yr	2.3	3.4	2.7	2.4
Parturition interval (d)	159	107	135	152
Total born/parturition	7.7	9.5	7.9	5.3
Born alive/parturition	7.3	9.0	6.6	3.9
Age at weaning (d)	42.5	65.0	45.1	55.3
Weanlings/parturition	6.1	6.4	5.9	1.8
Weanlings/doe/yr	14.4	21.8	9.6	4.3
Survival rate at weaning (%)	81.9	70.2	89.0	46.2

regulations do not limit the number of does per production unit (previously limited to 100). Based on these regulations, the minimum outdoor area required to set up an ORF with 40 does was calculated for a fixed building (200 m^2) or movable cages (*ca.* 13 000 m^2) (as with the previous French regulation), assuming the cages were moved each day (Table 2).

Thus, for the fixed building, the minimum outdoor area in EU regulations is much less than that required to meet the rabbits' forage requirements, especially to comply with the minimum of 60% coarse fodder in the diet. As a growing rabbit weighing 2 kg grazes 0.5-1.0 m^2 every day, the 0.5 m^2 area per rabbit recommended by the EU regulations will be completely grazed in *ca.* 24 h. Obtaining 60% of 120 g of feed intake on a dry matter (DM) basis (i.e. 72 g DM of coarse forage) requires grazing nearly 1 m^2 of high-quality grass per rabbit per day. The minimum area recommended for a fixed building thus requires supplying a large amount of hay or grass each day. This contradicts Article 21 of EU regulation 2020/464, which specifies that (1) "The vegetation of the outdoor runs shall be maintained regularly and in such a way that it is attractive to rabbits" and (2) "During the grazing season, pastures shall be rotated regularly and managed in such a way that the grazing of rabbits is optimised".

Table 2: Outdoor area required based on EU regulations for organic rabbit farming (ORF).

Groups	Outside the grazing period, fixed building, with an outdoor area, preferably a pasture	Outdoor movable cages, moved daily
40 does (gestating or not, or lactating), and their litter until weaning	[40×2.5 m^2/doe with kits]=100 m^2 minimum	2.5 m^2/doe with kits each day (moved daily), over 73 d/reproductive cycle (31+42 d): [73 d×2.5 m^2]×40=7300 m^2
5 nulliparous does	[5×2.5 m^2/doe]=12.5 m^2 minimum	[50 d/cycle×2.5m^2]×5 does=625 m^2
5 bucks	[5×2.5 m^2]=12.5 m^2 minimum	[73 d per reproductive cycle×2.5 m^2×5]=912.5 m^2
150 growing rabbits[a], from weaning age (42 d) to slaughter (110 d)	[150×0.5 m^2/rabbit]=75 m^2 minimum	[68 days×150×0.4 m^2]=4,080 m^2
Total area required	200 m^2 minimum	12 917 m^2 minimum

Values calculated considering an ORF with 40 rabbit does and their offspring, 5 bucks and 5 nulliparous does.
[a]We assumed 25 gestating rabbits (out of 40) and 6 weaned rabbits per litter to obtain 150 fattening rabbits per reproducing cycle of 73 d.

For the movable cages, moving the cages each day resulted in an estimated minimum grazing area for a herd with 40 does of *ca.* 13000 m². In a season with high biomass production, this area can produce enough forage to meet the required 60% of coarse fodder, but in autumn or winter, hay supplementation will be necessary.

Studies have found that the target of 60% coarse fodder in the diet cannot be reached in many situations (Martin *et al.*, 2016; Legendre *et al.*, 2019). It can be achieved at the end of the fattening period with an abundant supply of high-quality grass (> 3 t DM/ha). If the dehydrated lucerne in supplemental pelleted feed (mean of 25% by mass) is considered a source of coarse fodder, coarse fodder intake reaches 50-60% of the diet, and peaks at 65% at the end of fattening. For lactating does with a litter of five or more kits, the diet should be supplemented with a concentrated feed that has high protein and energy contents (e.g. mixture of cereal and protein grains) or commercial pelleted feed. Under these conditions, coarse fodder intake represents *ca.* 40% of the diet. Therefore, based on measured grass intake (see section on Grass intake by pastured rabbits) and nutritional recommendations, it would be appropriate to set a regulatory threshold for the percentage of coarse fodder in the diet adapted to the digestive physiology of rabbits (i.e. monogastric and herbivorous), estimated at 40% for lactating does and suckling rabbits, and 50% for growing rabbits.

Technical and economic performance of French organic rabbit farms

Performances of conventional rabbit farms in France have been benchmarked in a national database for more than 40 yr by ITAVI, the French applied research institute for poultry, rabbits and aquaculture. The database can be used to identify technical progress or difficulties on farms and can guide development and research. The lack of benchmarks for biotechnical performance of organic or pastured rabbit systems, particularly for helping potential farmers determine the structure and size of their farms, may help explain the slow development of this sector. INRAE began creating biotechnical performance benchmarks for ORF in 2017 (Gidenne *et al.*, 2020b) using data gathered from six farms over three years. These benchmarks are now being extended due to the development of a smartphone application called GAELA (French acronym for *Gestion Assistée d'un Elevage de LApin*) (Huang *et al.*, 2021). It enables rabbit farmers to manage their daily tasks (e.g. mating, birthing, weaning) using direct (i.e. in-the-field) and one-time (i.e. no transcription from a farm notebook) data entry (Figure 4). Data are secured in a national database via automatic synchronisation.

More than 30 organic rabbit farmers have used GAELA since 2018 (Huang *et al.*, 2021). We highlight the reproductive performances of four farms that regularly recorded their performance using GAELA from 2018-2020 (Tables 1 and 3). The number of does varied greatly among the farms, ranging from 15 (new farmers) to more than 70 (a farmer with more than 10 yr of experience) (Table 3). The reproduction rate (natural mating) was high, with 104 parturitions/year for 37 does (i.e. 2.7 parturitions/doe/yr) (Table 1).

The mean interval between parturitions was 138 d. The mean fertility rate was 71% but varied greatly among farms. The mean litter size (6.9 born alive) varied greatly among farms (3.9-9.0 kits). For these four farms, the mean age at weaning was 52 d but ranged from 42-65 d, which illustrates the diversity of practices. The mean survival rate of kits from birth to weaning was 72% but varied greatly among farms. The more experienced farmers (A to C) recorded a mean survival rate of 80%, which is similar to that observed in previous studies (Lebas *et al.*, 2002; Gidenne *et al.*, 2020b). The farms' does had a mean of 5.1 weanlings/parturition.

Table 3: Characteristics of four French organic rabbit farms from 2018-2020 calculated by the smartphone application GAELA.

Characteristics	Farm A	Farm B	Farm C	Farm D
Does (mean number/yr)	29.1	70.8	32.0	15.5
Bucks (mean number/yr)	4.9	10.4	3.8	6.1
Doe/buck ratio	5.9	6.8	8.5	2.6
Matings/yr	108	405	87	47
Parturitions/yr	68	241	69	38
Weaning/yr	64	204	45	26

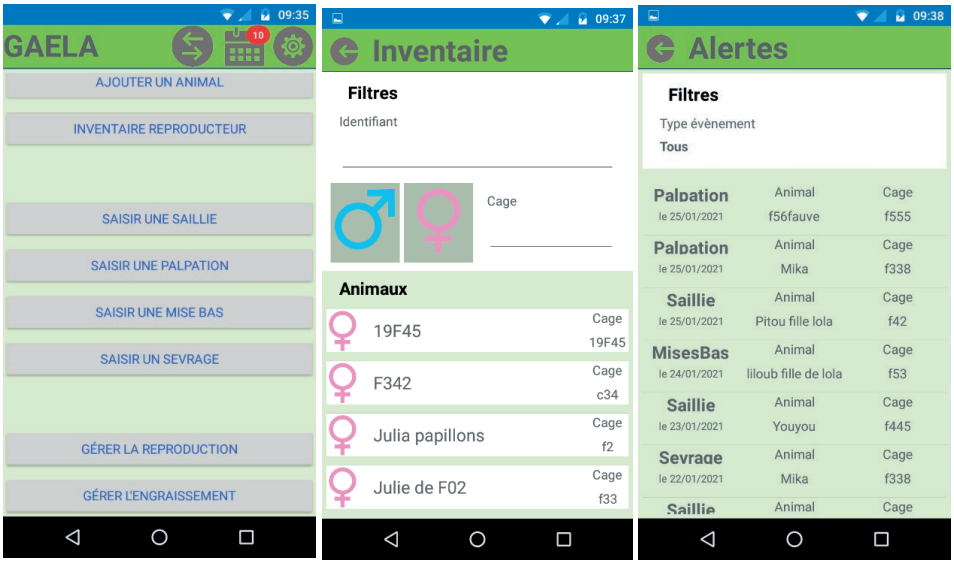

Figure 4: Screenshots of GAELA (French acronym for "Gestion Assistée d'un Elevage de Lapin'). GAELA is a smartphone application to help farmers manage their rabbit farm and monitor its biotechnical performance. It can also be used as a decision-making tool (French terms' translation: "ajouter un animal" for "adding an animal"; "saillie" for "mating"; "MisesBas" for "parturitions").

These results indicate that management of the maternity unit can be improved, such as by increasing the survival rate before weaning (e.g. housing management, prophylactic measures) or shortening the parturition interval without decreasing the survival rate after weaning. For example, increasing the survival rate at weaning from 72 to 85% would increase income by 2508 €/yr for a farm with 40 does that each produce three litters per year (assuming a mean carcass weight of 1.6 kg sold at 15.00 €/kg).

Production techniques for organic and pastured rabbit systems

Feeding systems

The feeding system must meet the following two regulatory criteria:

i. Maximise use of pasture. Rabbits should have access to pasture for grazing whenever weather conditions allow. If direct grazing is insufficient, high-fibre feed must be provided by feeding dry coarse fodder (i.e. hay) or green forage (e.g. cut grass, branches of fodder trees, grass preserved by ensilage or wrapping).

ii. Provide at least 60% coarse fodder in the diet (on a DM basis). Fodder is defined as fibre-rich plant-based feed (>20% crude cellulose on a DM basis) corresponding to the aerial part of plants available for direct grazing or fodder (dry and/or green). Other feeds can be considered coarse fodder, such as fibre-rich ingredients (>20% acid detergent fibre on a DM basis) mixed with cereals and oilcakes, often compressed into balanced "complete pellets" (e.g. dehydrated lucerne, beet pulp, wheat bran). Depending on the season, hay may also be necessary, but hay that is too coarse (i.e. low proportion of leaves) is less attractive to rabbits, and less of it will be consumed (*ca.* 15-30 g DM/d) (Duprat *et al.*, 2016).

As rabbits are monogastric herbivores, their diets should be supplemented with feeds that have high energy and protein contents. Cereals, legumes, and oilseeds (e.g. oats, barley, peas, broad beans) supplied as raw grain in mixtures, roots (e.g. beetroot), or balanced complete pelleted feeds are provided to rabbits of all ages. Supplementation is particularly important for lactating does to meet their energy and protein requirements (Gidenne et al., 2015).

Grass intake by pastured rabbits

The grass intake of adult rabbits has not been documented. However, it was measured for growing rabbits using a differential cutting technique for a movable cage system with 0.4 m^2 of pasture and 60 g of pelleted feed per rabbit per day (Martin *et al.*, 2016). Grass intake represented 46-50% of the total intake of 120 g DM/d and depended on the live weight of the rabbit (+7 g DM/d per 100 g of metabolic live weight) and the biomass available. Grass intake was higher (79 g DM/d) on a natural pasture (in spring), which had more available biomass (5 t DM/ha), than on tall fescue (44 g DM/d) producing 3 t DM/ha or on a pasture consisting mainly of sainfoin (51 g DM/d) (Martin *et al.*, 2016) (Figure 5). For every 10 g increase in available biomass, individual grass intake increased by 6.8 g DM/d.

Based on a grass supply of 69 g DM/d, the mean grass intake of growing rabbits was 51 g DM/d (i.e. assuming fresh grass with 20% DM, a 2 kg rabbit consumes 100-150 g DM/d, corresponding to up to 750 g/d of fresh grass). This intake corresponded to a grass-use rate of *ca.* 75% (assuming grass is cut 3 cm high). To optimise the use of pasture, its biomass should exceed 3.5 t DM/ha (grazing on natural pasture), which would correspond to an initial grass height of *ca.* 30 cm and rabbits consuming at least 90% of their maximum intake.

When rabbits can choose between grazing and a "complete pelleted" feed distributed *ad libitum*, they consume at least half of their ration (on a DM basis) as pellets and the rest as grass. Rabbits consume more grass when the pellets or mixture of cereal and protein grains are restricted (e.g. to 50 g/d). When rabbits have no choice but to graze, they can consume large amounts of grass if it is palatable. For a 1.5 kg rabbit, intake can exceed 400 g/d (i.e. *ca.* 80 g DM/d) for fresh lucerne and can reach 600 g/d (i.e. 120 g DM/d) for fresh, palatable plants (e.g. carrots, cabbage) (Goby *et al.*, 2013, 2017, 2021). Thus, rabbits can consume up to 150 g DM/d of grass, which would likely meet their growth requirements.

Rabbit intake of dry hay is poorly documented (Fetiveau *et al.*, 2023a), although it is frequently distributed in ORF. As with grazing, the quality of the hay is crucial: high-quality legume hay distributed alone can be consumed at a relatively high rate: 50-80 g DM/d for a 2 kg rabbit (Goby *et al.*, 2013, 2017). However, hay intake is often moderate to low (15-30 g DM/d), as hay is usually distributed to supplement a more concentrated feed (*e.g.* mixture of cereal and protein grains, pelleted feed) (Goby *et al.*, 2013, 2017; Fetiveau *et al.*, 2023a).

Newly developed methods for estimating grass intake of rabbits in movable pens (Plagnet *et al.*, 2023) indicate that rabbits can consume large amounts of grass. A grazing-intake simulator "PastRab" (Joly *et al.*, 2018) was provided to rabbit farmers and agricultural advisors that can compare several types of management for growing rabbits and thus promote discussions among farmers about their grazing and rearing practices. The simulations consider the housing

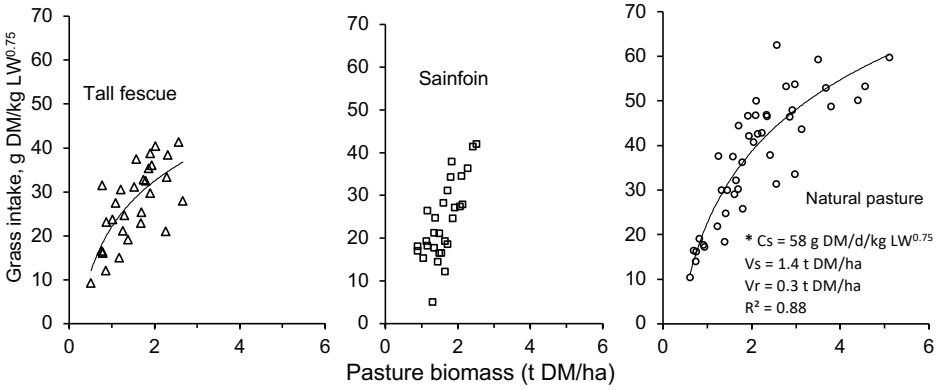

Figure 5: Relation between p(a) tall fescue (b) sainfoin, and (c) natural pasture biomass (in spring) and grass intake of grazing rabbit between 52 and 110 d old (adapted from Duprat *et al.*, 2016). Cs: maximum grass intake (satiety, g of DM/d/kg $LW^{0.75}$); V: pasture biomass (t DM/ha); Vs: pasture biomass equal to 63% of Cs (Ton of DM/ha); Vr: residual biomass of the pasture after grazing (refusals, t DM/ha). DM: dry matter.

system (movable cages or fixed pens), climate, biomass production, supplementary feed intake, mortality rate and the farmer's technical management. The simulator predicts technical (growth and grass intake) and economic (gross margin after feed costs) results.

Rabbit growth on pasture

Growing rabbits begin grazing at 3-4 wk of age. Grazing lasts *ca.* 10 wk, allowing the rabbits to reach a selling weight of *ca.* 2.4 kg with a mixed feeding system: grazing, supplementary concentrated feed (e.g. mesclun) and hay. The growth rate of rabbits depends strongly on a pasture's quality, especially its protein content (influenced by its proportions of grasses and legumes): rabbits consume less grass when it has a high protein content (a mean of –4 g DM/d for each additional percentage point of protein). However, pastures with more protein better meet the protein requirements of growing rabbits. Grazing rabbits can reach the selling weight of 2.4 kg at 100 d of age. For example, 90 g/d of supplementary feed (*i.e.* mesclun grown on-farm) and a grazing area of 0.4 m^2/rabbit/d enable a growth rate of *ca.* 22 g/d (Joly *et al.*, 2018). Without supplementary feed, the grazing area would have to be tripled (Duprat *et al.*, 2016), and legumes (e.g. sainfoin, lucerne, clover) would have to be fed to achieve a similar growth rate. However, when crossbreed rabbits (of selected breeds) were reared with pasture and received a commercial pelleted diet *ad libitum*, their mean growth rate was 44.3 g/d from 31-67 d of age, for a final live weight of 2.4 kg and a mean intake of pelleted feed of 110.7 g/rabbit/d (Fetiveau *et al.*, 2023a).

Practical feeding in organic rabbit farming

With a fixed pen, to meet the grazing requirements of growing rabbits from weaning (at least 42 d of age) to slaughter (mean of 2.4 kg at 100 d of age), at least 25 m^2/rabbit should be allocated with 100% grazing (assuming biomass production of 3 t/ha with at least 50% legumes). If 40% concentrated feed is fed, at least 15 m^2/rabbit should be allocated. With a movable cage, the daily grazing area required is 0.43 m^2/rabbit without concentrated feed or 0.26 m^2 with 40% concentrated feed (also assuming biomass production of 3 t/ha). These areas could be obtained by moving a mobile cage with an area of 3.0 m^2 each day. Thus, a herd of 40 does that wean *ca.* 150 kits per cycle (2-3 parturitions per year) requires 3750 m^2 without concentrated feed or 2250 m^2 with 40% concentrated feed. Rotating fixed pens between fattening groups requires at least two fixed pens, or twice the area (i.e. 4500-7500 m^2).

In addition, the diet needs to be supplemented with cereals, which are usually produced on the farm. For example, a herd with 40 does and their kits needs at least 3.6 t/year of cereals (i.e. in France, at least *ca.* 1.3 ha of cereal crops). Along with pasture and hay, other types of fodder can be fed (e.g. fodder trees, roots, cabbage). Rabbits have selective feeding behaviour: like other herbivores, rabbits prefer leaves to stems and soft green parts to dry parts (Gidenne *et al.*, 2020a). If given a choice, rabbits prefer to graze than to consume dry hay. Rabbits, especially young ones, take longer to adapt to consuming dry hay instead of green forage.

Thus, when consuming green forage, especially legume sprouts in spring, a 1.5 kg rabbit can consume at least 500 g of fresh grass/day (i.e. *ca.* 120 g DM/d). This high grass intake capacity can cause rabbits to consume too much digestible protein, which often causes digestive disorders. For example, consuming too much young clover, whose protein concentration can exceed 20%, can increase the risk of diarrhoea due to consuming too much protein and too little fibre. However, further studies are needed to confirm these field observations. In this case, grazing opportunities should be limited (i.e. moving movable cages less frequently) to condition the rabbits to consume more dry fodder (i.e. hay and/or a fibrous supplemental feed). It may be useful to cultivate mixed grass-legume pastures, and provide dry fodder (i.e. hay or straw) at all times and *ad libitum*. Fodder or fruit trees (e.g. leaves and twigs of ash, mulberry, lime, and apple trees) can also be used as a source of fodder, especially in late summer and autumn, when grass has lower biomass and quality.

At present, the nutritional values of forage from pasture for rabbits are unknown, as the digestibility of pasture for rabbits was first measured only recently (Goby *et al.*, 2021). However, rabbits are assumed to digest forage like horses do, since both have similar digestive physiology (i.e. caecal/hindgut fermenter). Thus, the nutrient concentrations of feeds for rabbits could be similar to (for cereal or protein grains) or 5-10% lower than (for forage) those for horses (e.g. www.feedipedia.org, equipedia.ifce.fr, www.feedtables.com). Some data on the nutritional values of forage for rabbits are available, such as lucerne and ryegrass hay (Table 4).

Table 4: Nutritional value of hay and pasture for rabbits.

Feeds	Digestible energy (kcal/kg DM)	Crude proteins (% DM)	Crude fibre (% DM)	References[1]
Hays				
Alfalfa type A	1800	15	27	A, B, C
Alfalfa type B	1670	14	29	D
White clover	2400	18	24	D
British ryegrass	2460	18	19	
Green forages (pasture)				
Sainfoin	2300	18	26	?
Tall fescue	1300	13	30	?
White clover	2400	21	25	?

[1] References: Cheeke, 1987; García *et al.*, 1995; Fernández-Carmona *et al.*, 2001; Gidenne, 2015.
DM: dry matter.

Future research is needed to provide more information on the grass-intake capacity of growing rabbits as a function of the season and pasture quality. Studying the grass intake of breeding rabbits also seems necessary. When few concentrates are fed, lactating does cannot consume enough feed to meet their nutritional requirements, particularly when regulations require at least 60% coarse fodder in the diet.

Reproduction and genetics

As ORF prohibits the use of hormones, reproduction is exclusively via natural mating. Because does experience no lactation anoestrus, they can mate immediately after parturition and throughout lactation. Because current EU regulations require weaning at no earlier than 42 d of age, a doe could theoretically have five litters per year, or even more if mated before weaning. In practice, however, kits are weaned from 42-60 d of age or later and does are often mated after weaning. In addition, does are less receptive during the short day lengths of winter and require several matings to become pregnant. Thus, does in ORF have a mean of *ca.* three parturitions per year (Table 1).

Organic rabbit farmers in France usually use traditional breeds (e.g. Fauves-de-Bourgogne, Papillon), whose reproductive traits —fertility rates of 35-68%, a nest mortality rate of 10-38%, and a mean of 4.8 weanlings per litter (Bolet *et al.*, 2004)— were relatively similar to those in ORF (Table 1). ORF could benefit from more productive rabbit breeds or from crossbreeding prolific breeds with local breeds (Savietto *et al.*, 2021), but this aspect remains to be studied, as ORF currently has no selection programme. Participatory selection approaches should also be considered to improve reproduction in ORF and development of grazing systems.

Prophylactic measures for grazing rabbits

In ORF, adults experience mainly viral diseases (i.e. myxomatosis and viral haemorrhagic disease (VHD)), whereas young rabbits often experience digestive diseases (e.g. diarrhoea, helminthiasis, coccidiosis). Prophylactic measures against myxomatosis and VHD are based mainly on initial vaccination and booster doses, which are essential. In practice, vaccinating kits before weaning is recommended in regions with a high presence of wild rabbits and hares. Farmers must follow the vaccination schedule closely, especially for breeding stock.

The risk of parasitism, mainly coccidiosis, remains a major problem in rabbit farming. In practice, it is impossible to eradicate coccidia from the animals' environment, and the EU regulations on ORF (i.e. no more two-month waiting period between groups of grazing rabbits, no need to move movable cages each day) increase the risk of parasitism, especially coccidiosis. Future studies are needed to better assess, reduce and control the risk of parasitism in organic or pastured rabbit systems.

Sustainability of organic rabbit farming – case study in France

As ORF prohibits the use of hormones, reproduction is exclusively via natural mating. Because does experience no lactation anoestrus, they can mate immediately after parturition and throughout lactation. Since current EU regulations require weaning at no earlier than 42 d of age, a doe could theoretically have five parturitions per year, or even more if mated before weaning. In practice, however, kits are weaned from 42-60 d of age or later, and does are often mated after weaning. In addition, does are less receptive during the short day lengths of winter and require several matings to become pregnant. Thus, does in ORF have a mean of *ca.* three parturitions per year (Table 1).

Organic rabbit farmers in France usually use traditional breeds (e.g. Fauves-de-Bourgogne, Papillon), whose reproductive traits —fertility rates of 35-68%, a nest mortality rate of 10-38%, and a mean of 4.8 weanlings per litter (Bolet *et al.*, 2004)— were relatively similar to those in ORF (Table 1). ORF could benefit from more productive rabbit breeds or from crossbreeding prolific breeds with local breeds (Savietto *et al.*, 2021), but this aspect remains to be studied, as ORF currently has no selection programme. Participatory selection approaches should also be considered to improve reproduction in ORF and development of grazing systems.

Prophylactic measures for grazing rabbits

In ORF, adults experience mainly viral diseases (i.e. myxomatosis and viral haemorrhagic disease (VHD)), whereas young rabbits often experience digestive diseases (e.g. diarrhoea, helminthiasis, coccidiosis). Prophylactic measures against myxomatosis and VHD are based mainly on initial vaccination and booster doses, which are essential. In practice, vaccinating kits before weaning is recommended in regions with a high presence of wild rabbits and hares. Farmers must follow the vaccination schedule closely, especially for breeding stock.

The risk of parasitism, mainly coccidiosis, remains a major problem in rabbit farming. In practice, it is impossible to eradicate coccidia from the animals' environment, and the EU regulations on ORF (i.e. no more two-month waiting period between groups of grazing rabbits, no need to move movable cages each day) increase the risk of parasitism, especially coccidiosis. Future studies are needed to better assess, reduce and control the risk of parasitism in organic or pastured rabbit systems.

Sustainability of organic rabbit farming – case study in France

Fortun-Lamothe *et al.* (2013) studied the sustainability of ORF using the DIAMOND method (https://means.inrae.fr/means-refonte-eng/emc-tools/diamond), which was developed according to principles described by Lairez *et al.* (2017). Its conceptual framework consists of six main objectives of equal importance, two for each of the three pillars of sustainability: economic ("is cost-effective" and "is flexible and adaptable"), environmental ("conserves and/or produces resources" and "protects and manages ecosystems"), and social ("preserves the quality of life and working conditions of the producer and "meets the demands of the citizen-consumer"). Indicators are used to assess the degree to which each of these six objectives is attained (Fortun-Lamothe *et al.*, 2011). The indicators were chosen based on several criteria, especially data availability and sensitivity to differences in practices (Lairez *et al.*, 2017). The indicators, expressed in several units (e.g. €, %, d), were transformed into scores to aggregate them by objective (maximum score: 50) and then by pillar of sustainability (maximum score: 100) based on the principles of Lairez *et al.* (2017). The sustainability of six ORF farms and 69 conventional rabbit farms was estimated and compared (Fortun-Lamothe *et al.*, 2013). For the economic pillar, the net margin was calculated from the main expenses (e.g. feed, health care, depreciation, consumables), as the other expenses (e.g. energy, water) were combined with other types of production on the farm. For the social pillar, work organisation and resting-day indexes were assessed per year and per production cycle, but the latter concept does not exist in ORF.

The economic sustainability of ORF farms (71/100) was much higher than that of conventional rabbit farms (48/100) (Table 5), perhaps due to slightly higher profitability, but mainly to a better response to flexible objectives of the types of production on the farm (multi-functionality score: 8.7/10 *vs.* 3.3/10, respectively), the low dependence on inputs and financial self-sufficiency (score 9.8/10 *vs.* 5.6/10, respectively). Environmental sustainability of ORF farms (57/100) was slightly higher than that of conventional farms (47/100) due to better economic use of certain resources (score for this sub-objective: 30/50 *vs.* 23/50, respectively; ORF-specific energy costs: 3.4 *vs.*

Table 5: Sustainability scores for organic (n=6) and conventional (n=69) rabbit farms (Fortun-Lamothe *et al.*, 2013).

Pillars and objectives of sustainability	Organic farms	Conventional farms
Economic (max score: 100)	71	48
profitability (max score: 50)	*27*	*21*
flexibility-adaptability (max score: 50)	*44*	*27*
Environmental (max score: 100)	57	47
resource use (max score: 50)	*30*	*23*
ecosystem protection (max score: 50)	*27*	*24*
Social (max score: 100)	50	38
consideration of farmer demands (max score: 50)	*25*	*24*
consideration of consumers demands (max score: 50)	*25*	*14*

5.3 €/doe/yr, respectively; fuel costs: 3.9 *vs* 6.5 €/doe/yr, respectively) and a slightly better response to the ecosystem protection objective (27/50 *vs.* 24/50, respectively), especially due to better preservation of biodiversity (score 7.7/10 *vs.* 0.7/10, respectively, due to using local breeds). Nevertheless, certain aspects were penalised, such as higher water consumption of ORF farms than of conventional farms (22 *vs.* 11 €/doe/yr, respectively) and less rigorous hygiene.

Social sustainability of ORF farms (50/100) was also higher than that of conventional farms (38/100), due to greater consideration of consumer demands (25/50 *vs.* 14/50, respectively) related to the short distance between production and selling, non-agricultural services provided by the farms, and practices more considerate of animal welfare (e.g. lower reproduction rate, lower animal density, natural mating). Scores for the farmer's living and working conditions were similar for ORF farms (25/50) and conventional farms (24/50), as the responses were sometimes more positive for the former (number of weeks off: 2.3 *vs.* 0.9, respectively) and sometimes for the latter (net margin/number of full-time equivalents times the minimum annual salary: 0.5 *vs.* 0.8, respectively).

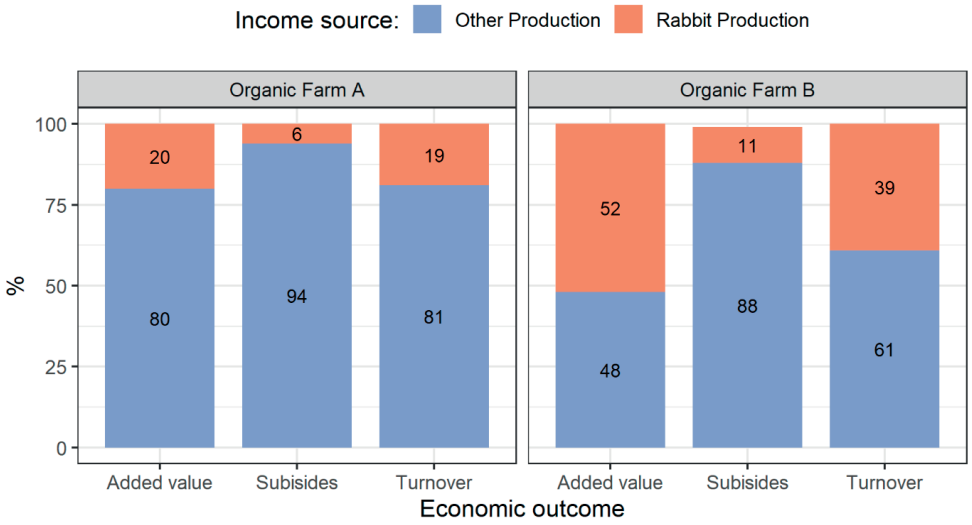

Figure 6: Contribution of rabbit production to overall economic results of two organic farms (Fortun-Lamothe *et al.*, 2013).

The contribution of rabbit production to the overall functioning of the farm was calculated for two of the organic farms by comparing the land use and economic results of rabbit production to those of other types of production (Figure 6).

Farm A, which had been organic since 2006, had 80 does and 50 dairy cows, and employed two full-time workers on 70 ha of usable agricultural area (UAA), of which 8.5 ha were used for ORF. Temporary pasture (i.e. white clover, lucerne, ryegrass, and cocksfoot) was grazed by the rabbits or used to grow a mixture of cereals (i.e., triticale, barley, oats and rye). Rabbit production provided 19% of the farm's income and 20% of its added value on 10% of its UAA and received 6% of its total subsidies. Farm B, established in 2000, had 70 does, 25 ewes and 15 dairy cows, and employed 2.2 full-time workers on 30 ha of UAA, of which 7.5 ha were pastures (i.e. 0.5 ha permanent and 7 ha temporary) grazed alternately by rabbits and cows, while other fields were used to grow cereals (i.e. triticale, barley, and oats) and peas for rabbit feed. Rabbit production provided 39% of the farm's income and 52% of its added value on 23% of its UAA and received 11% of its total subsidies.

An ORF with 80 does (i.e., 1200-1400 rabbits sold per year) can provide a minimum salary for one worker if the rabbits are sold through short distribution channels. However, the amount of time spent only on rabbit production is difficult to estimate, as many other activities occur on a farm. Nevertheless, due to rabbit physiology work can be planned precisely to avoid work peaks, except for growing crops for rabbit feed. Work constraints depend on the type of housing chosen and include moving movable cages (if used) and watering each day. Although the main type of production differed between the two organic farms (cattle *vs* sheep), their ORF systems depended less on subsidies and provided three times as much added value per ha than the main type of production, which demonstrates that ORF is a useful way to diversify farm production while keeping land requirements relatively low.

Rearing rabbits on pasture: current research on alternatives to indoor conventional systems

As an alternative to indoor rabbit farming in France, INRAE recently developed an experimental model of a rabbit farming system with access to pasture that is consistent with societal concerns about animal welfare. Fetiveau *et al* (2021) studied two group sizes (25 or 50 rabbits) with or without access to a 23 m^2 grazing area (i.e. 0.92 or 0.46 m^2/rabbit), based on a light, movable 30 m^2 building equipped with eight indoor pens (2 m^2 each). With a growth rate of 26.7 g/d and an overall mortality rate of 7.3%, the production results were similar to those obtained in an Italian study without access to pasture (D'Agata *et al*., 2009) and those observed for French ORF under the most favourable grassland conditions (Legendre *et al*., 2019). The grazing behaviour and performances of growing rabbits were studied recently for several pasture areas (Fetiveau *et al*., 2023a, 2023b, 2023c), with growth rates that reached 44.3 g/day. Studies on integrating arboriculture and rabbit farming are in progress (Savietto *et al*., 2023), focusing on the services that rabbits provide to apple orchards (e.g. grazing between the trees, soil fertilisation and possible prophylactic effects on the orchard). Preliminary results are encouraging and indicate that rabbits may contribute to alternative grass-management strategies for a variety of fruit crops. Rabbit farming associated with other types of production is the subject of multiple studies.

CONCLUSIONS AND PERSPECTIVES

The technical limitations that hinder rabbit farming on pasture require specific studies: the low fertility of breeding rabbits in autumn and winter due to the short day length; managing the risk of parasitism through rotational grazing; the nutritional values of pastures for rabbits, which remain largely unknown; and metabolic diseases of young rabbits caused by consuming too much fresh grass. In addition, available land remains a major limitation for farmers with rabbit grazing systems, at least in France. These farmers must also know how to grow pasture and cereals. Some French organic rabbit farmers prefer to sell rabbits on-farm or in a short distribution channel to earn enough income. Thus, having multiple skills is likely the key to success in organic or pastured rabbit systems.

Although France has the most organic rabbit farms in Europe, ORF remains uncommon. However, this situation could change as consumer demand outstrips supply and ORF has a positive public image. Constructing technical benchmarks, creating new digital tools and developing a network of professionals could support its development and

address several challenges by helping to streamline production techniques, using collaborative work tools to manage distances between individuals better, increasing the size of the sector to improve its structure and maintaining or decreasing production costs.

The new EU regulations on ORF, which require less surface area and access to pasture than the previous French regulation, could change how current ORF operates and thus increase the risk of parasitism due to higher animal density and the lack of rotational grazing. If badly managed, these practices could worsen animal health and welfare, decrease the economic viability of ORF and consequently damage this sector's image.

Authors contributions: Gidenne T.: conceptualization, writing – original draft and writing – review & editing. Fortun-Lamothe L.: conceptualization and writing – original draft. Huang Y.: conceptualization and writing – original draft. Savietto D.: conceptualization and writing – original draft.

Note: this review is adapted from the article: Gidenne T., Savietto D., Fortun-Lamothe L., Huang Y. 2022. Cuniculture au pâturage et sous certification Agriculture Biologique en France: fonctionnement des systèmes, performances et règlementation. *INRAE Productions Animales, 35*: 201-216.

REFERENCES

Bolet G., Brun, J.M., Lechevestrier S., Lopez, M, Boucher S. 2004. Evaluation of the reproductive performance of eight rabbit breeds on experimental farms. *Anim. Res., 53: 59-65. https://doi.org/10.1051/animres:2003043*

C.A.B. 2020. Guide éleveur.se.s: Elever des lapins Bio. *Coordination Agricole Biologique (CAB) des Pays de la Loire Editions. Accessible at www.bio.paysdelaloire.fr. Accessed May 2024.*

Cheeke P.R. 1987. Rabbit feeding and nutrition. *Academic Press.*

D'Agata M., Preziuso G. Russo C., Dalle-Zotte A., Mourvaki E., Pacia G. 2009. Effect of an outdoor rearing system on the welfare, growth performance, carcass and meat quality of a slow-growing rabbit population. *Meat Sci., 83: 691-696. https://doi.org/10.1016/j.meatsci.2009.08.005*

Duprat A., Goby J.P., Roinsard A., Van Der Horst F., Le Stum J., Legendre H., Descombes M., Theau J.P., Martin G., Gidenne T. 2016. Pasture finishing of organic rabbit: grass intake and growth - first results. *In Proc.: 11th World Rabbit Congress, Qin Y., Li F., Gidenne T. (Eds.). 16-18 June, Qingdao, China, Chinese Association of Animal Science and Veterinary Medicine publ., 931-934.*

Fanatico A., Green C. 2012. Small-Scale Sustainable Rabbit Production. *National Sustainable Agricultural Information Service (www.attra.ncat.org). National Center for Appropriate Technology, IP445.*

Fernández-Carmona J., Cervera C., Moya J., Pascual J.J. 2001. Feeding ryegrass hay to growing rabbits, a note. *World Rabbit Sc., 9: 95-99. https://doi.org/10.4995/wrs.2001.451*

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*

Fetiveau M., Savietto D., Bannelier C., Fillon V., Despeyroux M., Pujol S., Fortun-Lamothe L. 2023a. Effect of outdoor grazing-area size and genotype on space and pasture use, behaviour, health and growth traits of weaned rabbits. *Anim. Open Space, https://doi.org/10.1016/j.anopes.2023.100038.*

Fetiveau M., Savietto D., Fillon V., Bannelier C., Pujol S., Fortun-Lamothe L. 2023b. Effect of outdoor grazing-area access time and enrichment on space and pasture use, behaviour, health and growth traits of weaned rabbits. *Animal, 17: 100724. https://doi.org/10.1016/j.animal.2023.100724*

Fetiveau M., Savietto D., Janczak A.M., Bannelier C., Plagnet A.S, Tauveron M., Fortun-Lamothe L. 2023c. Time budget of two rabbit genotypes having access to different-sized pasture areas. *Appl. Anim. Behav. Sci., 260: 105872. https://doi.org/10.1016/j.applanim.2023.105872*

Fortun-Lamothe L., Coutelet G., Litt J., Dejean S., Gourlain S., Chabbert E., Gidenne T., Combes S. 2011. Evaluation de la durabilité des élevages cunicoles français : méthodologie et premiers résultats, *In Proc.: 13ème J. Rech. Cunicoles, Bolet G. (Ed.) 22-23 november 2011, Le Mans, France, ITAVI, Paris., 135-138.*

Fortun-Lamothe L., Gidenne T., Roinsard A. 2013. Lapin bio: du râble, vous avez dit durable? *Alter Agri, 120: 25-28.*

García J., Pérez-Alba J., Álvarez C., Rocha R., Ramos M., De Blas C. 1995. Prediction of the nutritive value of lucerne hay in diets for growing rabbits. *Anim. Feed Sci. Technol., 54: 33-44. https://doi.org/10.1016/0377-8401(94)00759-3*

Gidenne T. 2018. Diversité des filières cunicoles. *Innovations Agronomiques, 68: 217-225.*

Gidenne T., Lebas F., Savietto D., Dorchies P., Duperray J., Davoust C., Fortun-Lamothe L. 2015. Nutrition et alimentation. *In: Le lapin. De la biologie à l'élevage. Gidenne T. (Ed.), Quae éditions, pp. 152-196.*

Gidenne T., Lebas F., Fortun-Lamothe L. 2020a. Feeding behaviour of rabbits, *In: De Blas C., Wiseman J. (Eds.), Nutrition of the rabbit, 3rd edition, CABI; Wallingford; UK, pp. 254-274. https://doi.org/10.1079/9781789241273.0254*

Gidenne T., Savietto D., Goby J.P., Fortun-Lamothe L., Roinsard A. 2020b. A referencing system to analyse performances of French organic rabbit farms. *Organic Agriculture, 10: 125-129. https://doi.org/10.1007/s13165-020-00315-1*

Gidenne T., Savietto D., Fortun-Lamothe L., Huang Y. 2022. Cuniculture au pâturage et sous certification Agriculture Biologique en France: fonctionnement des systèmes, performances et règlementation. *Inrae Productions Animales, 35:201-216.https://doi.org/10.20870/productions-animales.2022.35.3.7257*

Goby J.P., Huck C., Fortun-Lamothe L., Gidenne T. 2013. Intake growth and digestion of the growing rabbit fed alfalfa hay or green whole carrot: first results. *In Proc.: 3rd ARPA conference, Raharjo Y. (Ed.) 27-29 august, Denpasar, Bali, Indonesia, 76.*

Goby J.P., Coullet S., Huck C., Bannelier C., Gidenne T. 2017. Ingestion et digestion de fourrages secs et verts pour le lapin - première approche pour la luzerne et la carotte entière. *In Proc.: 17 èmes Journ. Rech. Cunicoles, INRA (Ed.) 21-22 nov., Le Mans, France, ITAVI publ., 189-192.*

Goby J.P., Bannelier C., Gidenne T. 2021. Nutritive value of cabbage and pelleted complete feed in free-ranged organic growing rabbit. *In Proc.: 72th Annual conference of the European Federation of Animal Production, Davos Swiss. p. 411.*

Huang Y., Gigou M., Goby J.P., Roinsard A., Savietto D., Gidenne T. 2021. Digital breeding and assisted management in organic rabbit farming: the first results. *In Proc.: 12th World Rabbit Congress, Gidenne T. (Ed.), 3-5th November Nantes, France. INRAE-ASFC publ., comm. F-06.*

Joly L., Goby J.P., Duprat A., Legendre H., Savietto D., Gidenne T., Martin G. 2018. PASTRAB - a model for simulating intake regulation and growth of rabbits raised on pastures. *Animal, 12: 1642-1651. https://doi.org/10.1017/S1751731117002993*

JORF (Official Journal of the French Republic) 2000. "CC-REPAB-F "-Cahier des Charges concernant le mode de production et de préparation biologique des animaux et des produits animaux définissant les modalités d'application du règlement CEE, N° 2092/91 modifié du Conseil et/ou complétant les dispositions du règlement CEE n° 2092/91 modifié du Conseil.

JORF (Official Journal of the French Republic) 2010. Cahier des charges concernant le mode de production biologique d'animaux d'élevage et complétant les dispositions des règlements (CE) n° 834/2007 modifié du Conseil et (CE) n° 889/2008 modifié de la Commission.

Lairez J., Feschet P., Botereau R., Bockstaller C., Fortun-Lamothe L., Bouvarel I., Aubin J. 2017. The multicriteria assessment of livestock systems to support their evolution: issues, challenges and interrogations. *INRA Prod. Anim., 30: 255-268. https://doi.org/10.20870/productions-animales.2017.30.3.2254*

Lebas F., Lebreton L., Martin T. 2002. Lapins Bio sur prairie: des résultats chiffrés. *Cuniculture, 29: 74-80.*

Legendre H., Goby J.P., Duprat A., Gidenne T., Martin G. 2019. Herbage intake and growth of rabbits under different pasture type, herbage allowance and quality conditions in organic production. *Animal, 13: 495-501. https://doi.org/10.1017/S1751731118001775*

Licois D., Marlier D. 2008. Pathologies infectieuses du lapin en élevage rationnel. *INRA Prod. Anim., 21: 257-268. https://doi.org/10.20870/productions-animales.2008.21.3.3400*

Martin G., Duprat A., Goby J.P., Theau J.P., Roinsard A., Descombes M., Legendre H., Gidenne T. 2016. Herbage intake regulation and growth of rabbits raised on grasslands: back to basics and looking forward. *Animal, 10: 1609-1618. https://doi.org/10.1017/S1751731116000598*

Plagnet A.S, Bannelier C., Fillon V., Savietto D. 2023. Estimation of grass biomass consumed by rabbits housed in movable paddocks. *World Rabbit Sci., 31: 21-34. https://doi.org/10.4995/wrs.2023.18243*

Roinsard A., Van der Horst F., Fortun-Lamothe L., Cabaret J., Boucher S., Roland L., Gidenne T. 2016. Lapin Bio: développer une production cunicole durable en agriculture biologique. *Innovation Agronomiques, 49: 231-245.*

Savietto D., Debrusse A.M., Bonnemere J.M., Labatut D., Aymard P., Combes S., Fortun-Lamothe L., Gunia M. 2021. Reproductive performance of a maternal rabbit cross: Fauve-de-Bourgogne,×INRA 1777. *In Proc.: 12th World Rabbit Congress, Gidenne T. (Ed.) 3-5 Nov., Nantes, France, INRAE Occitanie Toulouse publ.*

Savietto D., Fillon V., Temple-Boyer-Dury A., Derbez F., Aymard A., Pujol S., Rodriguez A., Borne S., Simon S., Grillot M., Lhoste E., Dufils A., Drusch S., Fortun-Lamothe L. 2023. Design of a functional organic agroforestry system associating rabbits and apple trees. *Anim. Open Space, 2. https://doi.org/10.1016/j.anopes.2023.100051*

Wu L.P., Lukefahr S.D. 2021. Rabbit meat trade of major countries: regional patterns and influencing factors. *In Proc.: 12th World Rabbit Congress, Gidenne T. (Ed.) 3-5 Nov., Nantes, France, INRAE Occitanie Toulouse.*