Assessment of environmental and socio-economic impacts of increased animal welfare standards

TRANSITIONING TOWARDS CAGE-FREE FARMING IN THE EU

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Corresponding authors: Elisa Kollenda & David Baldock

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Main office
Rue Joseph II 36-38,
1000 Brussels, Belgium
Tel: +32 (0) 2738 7482
Fax: +32 (0) 2732 4004

London office
11 Belgrave Road
IEEP Offices, Floor 3
London, SW1V 1RB
Tel: +44 (0) 20 7799 2244
Fax: +44 (0) 20 7799 2600

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1. Executive summary

Despite the growing support in European society for improvements in farm animal welfare, as evidenced in Eurobarometer surveys, the pathways and prospects of moving forward tend to be considered separately from the wider debate about attaining greater levels of environmental and social sustainability for food systems as a whole. The recent Farm to Fork Strategy for the EU does signal the need to review and improve legislation on farm animal welfare alongside many other steps to improve the sustainability of both production and consumption. However, the linkages between the two sets of goals and potential consequences of advancing them together require further development.

This report aims to address the linkages as well as to explore the challenges and consequences of ending the use of cages in the production of hens, pigs and rabbits, which is still widespread in Europe. This would be a substantial step forward in welfare terms and is one of the measures commanding the greatest support amongst civil society organisations most active on welfare issues in the EU. Doing so in the right way could bring about positive changes in the environmental footprint of animal farming, whilst benefiting animal welfare.

Caged housing systems are a common practice amongst EU farmers keeping laying hens, rabbits and pigs (more specifically sows, being used to varying degrees before and after farrowing). These systems are characterised by both high stocking densities and high levels of animal confinement and often are utilised within large-scale operations. These characteristics of livestock housing, together with the associated management practices, have direct and indirect impacts not only on the health and welfare of the animals but also on the farms' environmental footprint and economic and social performance. Addressing the full suite of sustainability concerns alongside welfare improvements would be a significant step forward in policy terms, building on a growing understanding of the synergies and trade-offs which are encountered here as well as in nearly all other forms of production.

Of the three sectors, rabbits are the animals most commonly housed in cages, with ~85% in barren cages and ~9% in enriched cages (DG Health and Food Safety, 2017). Approximately half of all laying hens in the EU were housed in enriched cages in 2019, with percentages being much higher in most eastern, central and southern EU Member States. In the pig sector, the large majority of sows are caged during certain stages of their reproductive cycle.

Although caged housing systems are still common practice across the EU, recent developments point towards a decline. Particularly in north-western Europe, there has been a continued growth in demand for non-caged products, especially for eggs from laying hens. European consumers are also showing a greater interest in pig and rabbit welfare and their housing conditions, although concern and awareness are not as high as with laying hens. Particularly with regard to rabbits, for which there is an absence of EU species-specific animal husbandry legislation, knowledge about housing systems, welfare and farming practices is considerably lower compared to other species.

There is no one single step involved in the elimination of cages in the three different branches of farming and the many conditions found on individual farms. There are different options in terms of housing, husbandry, wider management, use of specialised equipment, access to outside space, choice of breeds, the lifetime of animals, feeding systems, the management of wastes etc. Some farms would need to take major steps to go cage-free, others could restrict themselves to narrower, more limited changes. Costs of change will vary as well, from the substantial to the rather modest. Some examples of these options are given in the report, illustrated by case studies of farms and other segments of the food chain.

A proportion of farmers may go further than removing cages and adopt a new approach entirely for example by moving to organic production approaches or converting to an entirely outdoor system.

Some of the changes in housing and management associated with a transition to cage-free production would have consequences for the environmental footprint of the farms concerned. Their character and significance would depend on parameters such as animal numbers, their health and welfare, any changes in yield (of feed production) and feed conversion efficiency, alterations in feed sourcing and composition, the changes in the volume of wastes and the skill with which they are managed and the impacts of moving animals outdoors, which can vary, not least because of the need to find appropriate sites, manage stocking densities correctly etc. There is likely to be an environmental cost in the form of increased emissions of greenhouse gasses per unit of output but other factors are much more variable. There are potential benefits from installing modern waste management systems for example as well as from following explicitly environmental pathways, such as converting to organic production. The Farm to Fork Strategy anticipates a very substantial increase in the organically farmed area and if this is accompanied by more organic livestock production this could be expected to benefit both welfare and the environment.

A transition to cage-free production would involve additional investment and the time required for good management generally would be greater. If the share of organic production rose, yields would be reduced and prices expected to be higher and there might be significant changes in demand. On the assumption that the market adjusts to higher prices where necessary, without lowering demand, there is potential for more employment and added value at the farm level. The full socio-economic consequences of different scenarios are difficult to forecast but would include consumer impacts and the likely need for time-limited financial support from agricultural or other public sector funds to aid aspects of transition.

There would be greater implications for almost all aspects of sustainability if the cage-free transition were accompanied by more far-reaching changes in the scale of consumption and production of livestock products from this sector and if there is a major departure from the current large-scale use of concentrated feeds, including imported proteins.

In order to explore these impacts, three different possible scenarios are sketched out, all using the adoption of cage-free livestock farming systems as a baseline requirement. The narratives vary in the extent of the changes made and the degree to which the consumption of the relevant livestock products declines in the EU. In the more ambitious scenarios, involving significant falls in consumption, reduced protein imports and large-scale organic conversion, greater environmental and social impacts are expected. Scenarios leading to a decline in consumption in combination with reduced regional animal densities provide the most pronounced environmental benefits, reducing the carbon and wider environmental footprint of food production.

Different means of achieving cage-free farming in Europe while realising wider environmental and socio-economic benefits were proposed by stakeholders in the course of interviews. These have been brought together and augmented with suggestions arising in the literature to offer a brief compendium of such recommendations in the final chapter. Amongst the key measures that have been put forward are changes in mandatory standards at EU level, better enforcement of standards, a range of labelling initiatives, action by retailers and processors to promote higher welfare, a focus on increasing the share of organic animal farming and time-limited aid for farmers making the transition from the CAP and other sources. Several sources emphasise the great importance of the EU creating a level playing field for animal welfare legislation in the EU market, covering all farmed species. While the EU has addressed the welfare of pigs and laying hens in species-specific regulations, there is currently no EU regulation addressing specifically the welfare of farmed rabbits[1].

Above and beyond the necessity for farm level and other sectoral actions in order to move beyond caged systems, there is a requirement for wider stakeholder cooperation across the value chain (including consumers) to work together to achieve animal-welfare benefits in an environmentally and economically sustainable way. Policymakers can help to foster such synergies as part of the new focus on sustainability within and beyond the food system.

[1] Although Directive 98/58/EC on the protection of farmed animals covers all species bred or kept for farming purposes, including rabbits, laying down some minimum standards.

2. Introduction

The majority of European citizens consider the protection of farm animal welfare as important or very important and think that it needs to improve compared to the current situation (European Commission, 2016). As part of the European Citizens' Initiative (ECI) 'End the Cage Age', well over one million Europeans have opted for improved animal welfare standards in EU farming. The initiative aims to phase out the use of cages for laying hens, rabbits, pullets, broiler breeders, layer breeders, quail, ducks and geese, farrowing crates for sows, sow stalls and individual calf pens (where not already prohibited).

Whilst the animal welfare benefits of banning caged farming are widely recognised, the wider environmental and socio-economic costs and benefits are less well researched and discussed as part of the public debate. As the coordinator of this Citizens' Initiative, Compassion in World Farming (CIWF) commissioned the Institute for European Environmental Policy (IEEP) to collect evidence and thinking on how higher animal welfare can support a much-needed sustainability transition in the livestock sector while delivering net positive benefits to society as a whole.

In light of the recently published Farm to Fork and Biodiversity strategies, the EU agriculture sector has received a strong policy signal to transition towards more sustainability. Active encouragement of a healthier diet with a potential decline in consumption of animal products in Europe, an organic production target, and a new legislative framework for sustainable food systems offer a clear direction forward. Alongside this, there is also a commitment to review and improve EU farm animal welfare legislation. These different strands of strategy are clearly related and need to be taken forward together.

This report examines the contribution which cage-free farming in Europe can make to the delivery of wider EU sustainability objectives, including the Sustainable Development Goals (SDGs) that the EU is committed to meet by 2030. It explores the benefits and some costs that a transition to cage-free farming entails, beyond animal welfare considerations, including both environmental and socio-economic aspects. It looks at some key challenges and trade-offs that can be expected to come out of such a transition.

To this end, a desk-based literature review, focusing on the EU as a whole as well as individual Member States, was complemented by 16 stakeholder interviews, covering producers, manufacturers, retailers, and experts with relevant technical knowledge from different parts of Europe. The interviews also were the foundation for a number of short **case studies**, showcasing the experience of value chain actors who have made successful steps towards implementing higher animal welfare standards. Many of these examples, included as boxes in the report, refer to understandable producer concerns about a major transition to non-cage systems and the investment required to achieve it, but show how progress has been made at different scales from the local to the global scale. In many cases, stakeholders were able to achieve socio-economic and environmental achievements in synergy with animal welfare improvements.

The report focuses specifically on laying hens, rabbits and sows, all sectors where the use of cages is prevalent but the legal, animal welfare, consumer, economic and environmental issues vary. **Chapters 3 & 4** give an overview of the three sectors, covering the scale at which cages are used, a general description of the most widely used housing systems and a general policy overview, primarily at EU level. There is a variety of alternatives to the current use of housing systems and some of these are described in **Chapter 5**, with a particular focus on their socio-economic and environmental performance as well as their welfare implications.

Building on this evidence and material from the stakeholder interviews, **Chapter 6** addresses the extent to which three different illustrative transition scenarios to cage-free farming throughout Europe could help the EU to deliver on its international commitments to the SDGs. The 'scenarios' developed for this purpose are narrative descriptions of plausible visions for cage-free farming over the next decade or so, differing significantly in terms of wider ambition level. While the three scenarios all assume the adoption of cage-free livestock housing systems, they vary in the extent to which major additional changes are made to farming systems, feed composition, and the consumption of livestock products.

Lastly, in **Chapter 7**, the report presents a repertoire of some of the most promising policy tools and stakeholder actions to take forward a transition to a cage-free EU. These have been compiled through stakeholder consultations and a review of commonly proposed recommendations in the literature.

3. Overview of laying hen, pig and rabbit housing types and legislation

3.1. The EU laying hen sector

Around 365 million laying hens were farmed in the EU in 2019 (excluding the UK)[2] and are currently raised in four different systems: 'enriched' cages[3], barns[4] (including

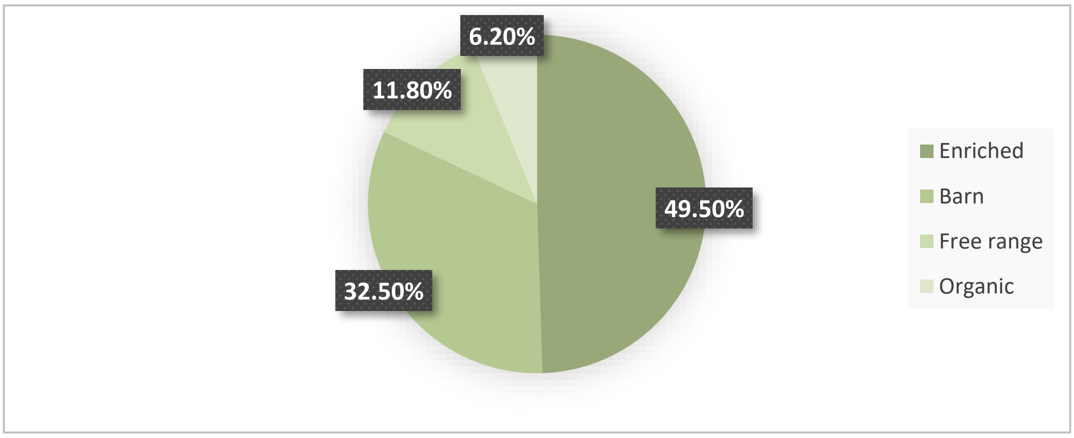
[2] The following data descriptions (Figure 1 - 3) on laying hens in the EU are based on 2019 data, excluding the UK

[3] A type of cage used for laying hens, designed to overcome several welfare concerns of battery cages, with slightly higher space requirements and access to species-specific enrichment materials (see further explanation on page 3)

[4] An indoor cage-free group housing system (see further explanation below in the chapter)

aviaries), free-range and organic systems. In 2019, approximately 49.5% of laying hens were housed in cages and 50.5% in alternative housing systems (as seen in Figure 1).

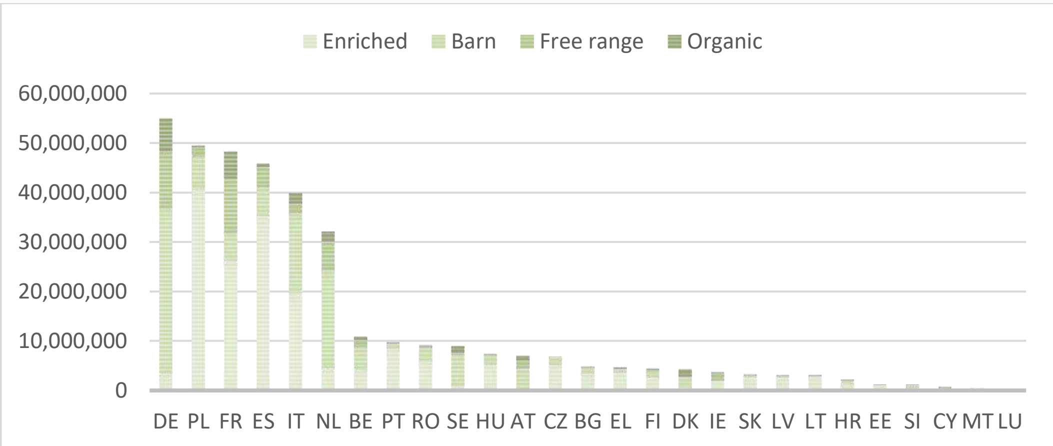
Figure 1: Share of laying hens in the EU by housing system, in 2019 (without the UK)



Source: European Commission, Eggs Market Situation Dashboard, 2020

Approximately 55% of laying hens are concentrated in just four EU Member States (Germany, Poland, France and Spain). Figure 2 shows a wide variability in the mix of housing systems used across the EU, ranging from 99.4% of housing in enriched cages in Malta to 1.9% in Austria and none in Luxembourg. Enriched cages are still dominant in most eastern, central and southern EU Member States but have been reduced to a small fraction of overall numbers in a limited group of North-West European countries.

Figure 2: Number of laying hens in different rearing systems by Member State (without the UK), 2019

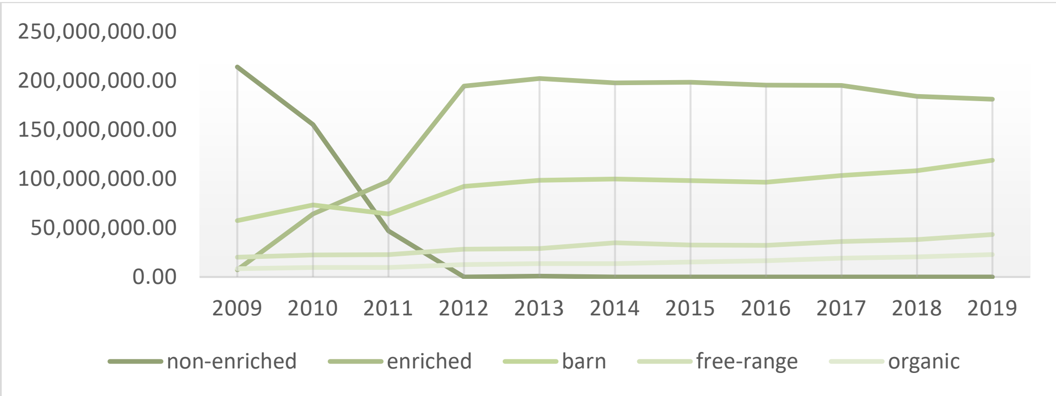


Source: European Commission, Eggs Market Situation Dashboard, 2020

From 2012, the previously dominant barren or 'conventional cage' (non-enriched in the Figure below) has been banned in the EU and only 'enriched' cages or alternative housing systems are allowed *(*Directive 1999/74/EC*)*. The ban explains the steep downward trend in numbers of non-enriched cages leading up to 2012 and the increase in enriched cages, as well as alternative rearing systems in recent years (Figure 3).

Initially, non-compliance with the 2012 standards was a serious concern in some Member States. Since 2012, the European Commission has launched an extensive series of infringement procedures against several countries. These procedures were reportedly successful in achieving compliance with the rules. The 2018 European Court of Auditors report *Animal welfare in the EU: closing the gap between ambitious goals and practical implementation* states that good progress has been achieved in certain areas of animal welfare and that the ban on unenriched cages for laying hens "was implemented effectively by the Member States".

Figure 3: Trends in rearing systems in the EU without the UK (2009 - 2019), by number of laying hens



Source: CIRCABC Database, 2020

Enriched cages are still widely used today – around 180 million hens (~49.5% of all laying hens) were kept in enriched cages in 2019. According to Directive 1999/74/EC, the minimum space required per laying hen is 750 cm^2 (of which 600 cm^2 must be usable) which is slightly larger than an A4 sheet of paper and results in a high density of animals. The cages can be stacked many tiers high.

As a minimum requirement for all housing systems, hens must have access to nests, perching space, litter to allow pecking and scratching and unrestricted access to feed. Whilst an improvement compared to conventional cages, enriched cages have been criticised for nonetheless limiting natural and essential animal behaviours such as exercising, flying and dustbathing.

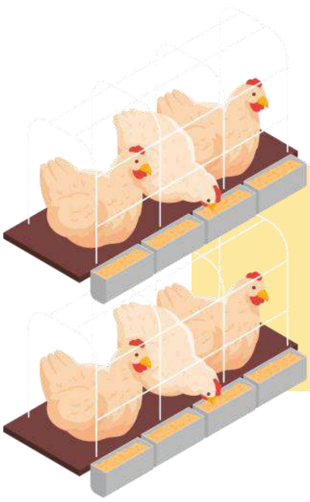
Criteria for **alternative systems** (other than enriched cages) are defined in Directive 1999/74/EC with a stocking density that does not exceed 9 laying hens per m^2 usable area, with at least one nest for every 7 hens and adequate perches. **Barns** and **aviaries** are indoor group housing systems, which are regulated under this Directive.

In **free-range systems**, hens are also housed in barns (with identical indoor conditions to barn systems), but during daylight hours they also have access to an area of outdoor pasture of at least $4m^2$ per hen (Regulation 589/2008 — marketing standards for eggs). Open-air runs must be mainly covered with vegetation and not used for "other purposes other than orchards, woodland or livestock grazing".

Organic systems are a specific form of free-range systems. Legal requirements are set out under the livestock rules of the EU organic Regulation. Under Regulation 834/2007 (primary legislation) and Regulation 889/2008 (secondary legislation*)* hens also have outdoor access but live in smaller flocks and have more space indoors. A maximum of 3,000 laying hens is housed per compartment and at densities of no more than 6 non-beak-trimmed hens per m^2.

In addition, the hens receive feed produced according to organic standards: the ingredients are grown without synthetic fertilizers or free amino acids, and genetically modified soya is not permitted. A new Regulation 2018/848 (repealing existing legislation) will be enforced from 2021 onwards (with a potential delay until 2022).[5]

Minimum requirements for different housing types are clearly defined in the EU. However, there are gaps in the legislation, which currently does not cover flocks with less than 350 hens, pullets, breeding flocks and other species of poultry. This is an important gap which the European Commission should consider in proposing any new legislation.



Enriched cages: Banned or not?

Luxembourg and Austria: *banned*

Germany: *banned from 2025*

Wallonia, Belgium: *banned from 2028*

A few Member States have advanced beyond the standards set out at the EU level: enriched cages are prohibited in **Luxembourg** and **Austria** (in Austria the transitional period for already existing enriched cages ended in January 2020 (Bundestierschutzgesetz, 2008). In **Germany,** a ban on enriched cages will come into force from 2025 onwards and in exceptional cases from 2028 (TierSchNutztV, 2006) and in **Wallonia (Belgium)** a ban on cages for egg-laying hens will come into effect by 2028 (Region of Wallonia - Le Code Wallon Du Bien-Être Animal, 2018). Additionally, in

[5] The new Regulation continues the maximum number of 3 000 laying hens per compartment of a poultry house, 30 % of the feed shall come from the farm itself or the region, and birds must have outdoor access for 1/3 of their lifetime

September 2020, the lower house of the Parliament of Czechia voted to ban cages for laying hens from 2027 and in Slovakia, the government and industry bodies have signed a memorandum to end the use of cages for hens by 2030.

EU pollution control legislation also has some influence on the development and siting of larger chicken farms. The **Nitrates Directive**, adopted in 1991, aims to control pollution by preventing nitrates from agricultural sources from contaminating ground and surface waters and by promoting good farming practices. It is now an integral part of the Water Framework Directive. As chicken manure is rich in nitrogen, phosphorus, potassium and other nutrients, it is potentially a major source of air, soil and water pollution. This is particularly the case with intensive systems, which have large volumes of waste to handle in a concentrated area. It must be properly managed to prevent negative impacts on human health.

Unlike most forms of agriculture, large intensive poultry and pig units are subject to pollution control legislation aimed mainly at industrial plants. Most relevant is Implementing Decision 2017/302 establishing the best available technique (BAT) conclusions, under Directive 2010/75/EU (the '**Industrial Emissions Directive'**) for the intensive rearing of poultry or pigs.

Intensive livestock farms with more than 40,000 places for poultry must have an operating permit that describes the whole environmental performance of the farm, taking into account pollution of air, water and land, waste production and resource utilisation (including water consumption and energy efficiency). The operating permit is only given if the farmer demonstrates the appropriate use of "best available technologies not entailing excessive costs".

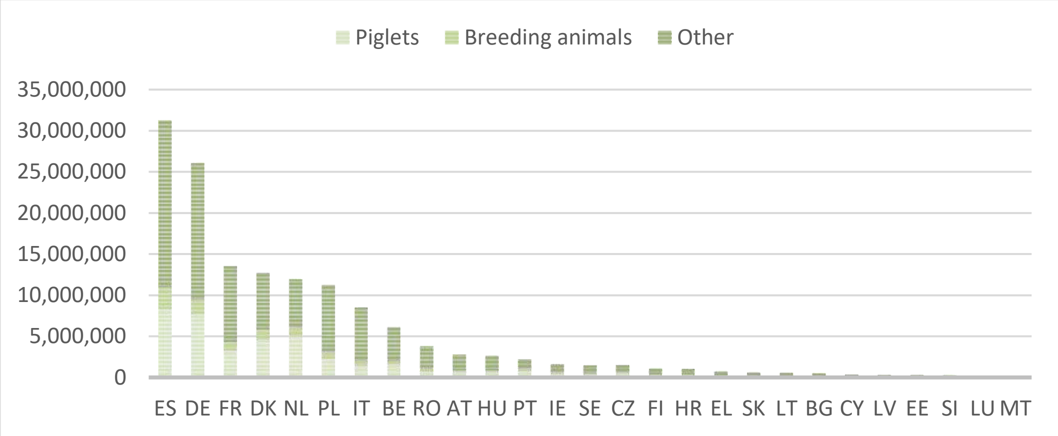
3.2. The EU pig sector

In December 2019, approximately 143 million pigs were farmed in the EU (Eurostat, 2020), which the EU Farm Structure Survey classifies in three different categories:

- 39.82 million piglets (up to 20 kg)
- 11.46 million breeding animals (11.32 million sows, 0.14 million boars)
- 91.78 million other animals (32.36 young pigs, 59.42 fattening and 'cull' pigs)

Pig production has been increasingly concentrated in a handful of Member States, with farms being increasingly specialised and intensive. The EU's leading pig producers are Spain and Germany.

Figure 4: Number of pigs and breeding sows in the EU 27 in 2019 (excluding the UK)



Source: Eurostat, 2020

This section focuses on current minimum requirements and common housing practices with regard to **breeding sows**[6]. Most sows in the EU are currently caged during large parts of their reproductive cycle.

The majority of EU breeding sows are confined in narrow **sow stalls** for around 5 weeks where they are inseminated. They must then be released into a group (non-caged) housing with other sows. The confinement in sow stalls for the whole pregnancy of 16 weeks has been prohibited since 2013 (Directive 2008/120/EC).

When they are due to farrow, most sows are confined in individual **farrowing crates** with metal bars. The farrowing crate severely restricts movement and natural behaviour. Sows can stand up but are unable to turn around and are limited in direct interaction with their piglets, separated by the bars of the crate (Baxter et al., 2011; Grimberg-Henrici, 2018). Common measurements of the crates are 200 x 60 cm (see for example Cornou et al., 2011), with the average sow measuring 171 x 40 cm (Compassion in World Farming, 2018). The crate is placed within a pen area (with a total surface area of approximately 3.5m^2) in which the piglets have their nest within solid sidewalls (Vosough Ahmadi et al., 2011).

Currently, approximately 3.5 million sows are kept in **alternative systems during the reproductive cycle** (Compassion in World Farming, 2018). Alternative farrowing systems often abolish crates completely, instead housing sows in individual pens or group systems. This method gives the animals space to turn around and move more

[6] female pigs after their first time of farrowing (giving birth to piglets)

freely. Some producers use a type of pen which provides more space and nest-building opportunities but have the option to confine the animal for up to 4 days after birth (Hales et.al., 2016) (see example case study 1).

Case study 1: Krannestrup farm & the Sow Welfare and Piglet protection pen (DK)

Niels Aage Arve took over the family pig farm and today works with innovative farrowing systems, housing 1,350 pigs on the Krannestrup farm in Denmark.

To address the issue of piglet crushing in loose farrowing systems, Krannestrup farm collaborates with researchers from the SEGES Danish Pig Research Centre which aims to benefit the animals, farmers and the environment. Krannestrup implemented the SEGES constructed SWAP (Sow Welfare And Piglet protection) pen, with the option to temporarily confine the sow for a maximum of four days after the piglets are born. It provides more space than a conventional farrowing crate and the sow is able to nest-build.

Krannestrup farm observed positive changes compared to the farrowing crates used previously: the newly implemented system reduces piglet crushing compared to entirely loose farrowing, and staff can easily enter the pen in the critical first days.

Additionally, the sows are in better condition (muscles, health) at the time of weaning, and achieve good breeding results, higher than the Danish average in traditional systems.

Directive 2008/120/EC defines minimum requirements of **indoor group housing**. Sows must be kept in groups starting from four weeks after the service to one week before the expected time of farrowing. The group pen must have sides greater than 2.8 m in length (or 2.4 m length for groups of fewer than six pigs). The ground used in group housing pens is mostly solid and should be enriched with straw or other bedding materials (wood shavings, peat and branches). The total unobstructed floor area available to each sow must be at least 2.25 m^2.

In the absence of a legal definition of 'free-range pork' in the EU, **outdoor housing** of sows can take a different form. Generally, sows housed outdoors have the greatest range of movement while also being able to form their own separated areas. Huts are used to give shelter and warmth (FiBL and Bio Suisse, 2019). This form of housing is used mainly in Denmark, Italy and the UK. Often pigs are housed outdoors all year round, in all stages of the reproductive cycle. In some cases, sows are housed indoors for the lactation period (Früh et al., 2013).

Organic production involves some additional rules designed to ensure that animals live a healthy life and to enable species-specific behaviour, as defined in Regulation 834/2007 and Regulation 889/2008. According to the current organic Regulation, sows must be housed in groups, except in the last stages of pregnancy and during the suckling period. Each farrowing sow, together with her piglets (up to 40 days), must have a minimum of 7.5 m^2 indoor and at least 2.5 m^2 of outdoor area available (10 m^2 in total) (Regulation 834/2007).

The new EU organic Regulation (2018/848), which is yet to come into force, also provides that sows are housed in groups except in the last stages of pregnancy and during the suckling period and further adds that during this time "the sow must be able to move freely in her pen and her movement shall only be restricted for short periods". Additionally, sows must be provided with a sufficient amount of straw[7] a few days before the expected farrowing, which allows them to build nests.

Additionally, the **prohibition on routine tail-docking** of pigs required by Directive 91/630/EEC is a key piece of legislation, which had to be transposed into national law by 1994. The Directive made clear that to prevent tail biting, enrichment materials such as straw or other suitable materials should be provided to satisfy the behavioural needs of pigs. Directive 91/630/EEC was updated by Directive 120/2008/EC, the 'Pigs Directive', which also provided for the partial ban on sow stalls from 1 Jan 2013.

An independent report by the Court of Auditors (2018) reviewed EU actions to improve farm animal welfare, suggesting that they were successful in some areas but challenges remain. Legislation has been successful in enforcing the partial ban of sow stalls. However, according to the report, low compliance with minimum standards remains for some issues, such as tail docking.

Several Member States have passed more ambitious legislation, going beyond the baseline set at EU level, for example:

Sweden banned sow stalls and farrowing crates entirely in 1994. The ban has been reinforced in the recently updated Swedish animal welfare legislation (Animal Welfare Act 2018:1192 and its Ordinance 2019:66).

The Netherlands has restricted housing in sow stalls to four days after insemination since 2013.

[7] or other suitable natural material

Germany will phase out the use of sow stalls by 2030 and limit the time sows are allowed to spend in the farrowing crate to 5 days starting in 2035

In terms of environmental policy, both the Nitrate Directive and the Industrial emission Directive are of relevance to larger pig units:

- The units subject to control are intensive livestock farms (currently those with more than 2,000 places for production pigs weighing over 30kg; or with more than 750 places for sows); these must have an operating permit that describes the whole environmental performance of the farm.
- As described above, this permit must cover the pollution of air, water and land, waste production and resource utilisation (including water consumption and energy efficiency).

3.3. The EU rabbit sector

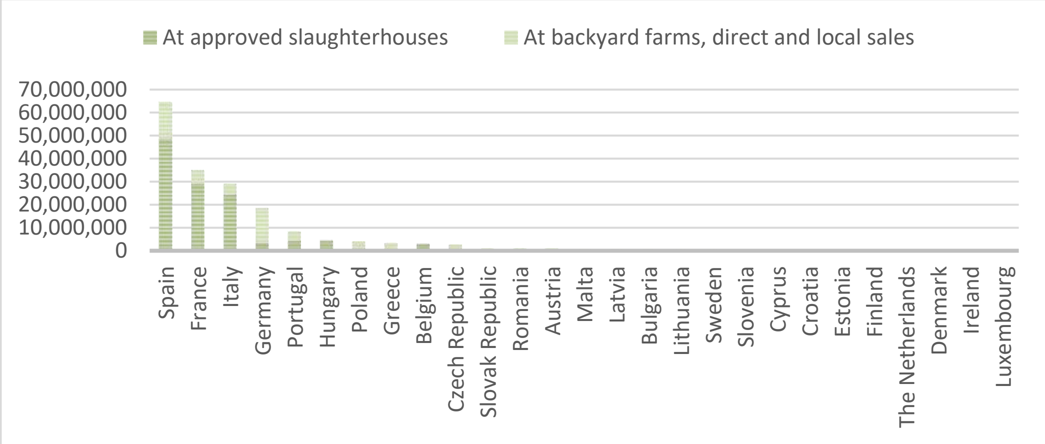
There are approximately 170 million[8] rabbits farmed for meat in the European Union (EU-28), out of which a relatively large share (~one third) is reared on backyard farms as opposed to large commercial producers.

Production is concentrated in a few Member States, primarily in Spain, France and Italy (which together are responsible for 83% of total EU production (EFSA, 2020). Other Member States with relatively high production levels include Germany, Portugal, Hungary, Poland, Greece and Belgium (as seen in Figure 5, based on the number of slaughtered animals). Rabbits are often classified into three categories (e.g. DG Health and Food Safety, 2017):

(i) *Breeding does:* reproductive females from first kindling (giving birth) till culling
(ii) *Kits:* newborns, from birth to weaning
(iii) *Growing rabbits:* from weaning to slaughter age

[8] The number of farmed rabbits in the EU is between 160 and 180 million depending on the source.

Figure 5: Number of slaughtered rabbits, by Member State in 2016 (excl.UK)



Source: DG Health and Food Safety, 2017

There is currently **no EU Regulation addressing specifically the welfare of farmed rabbits**, although Directive 98/58/EC on the protection of farmed animals covers all species bred or kept for farming purposes, including rabbits, laying down some minimum standards.[9]

The lack of regulation addressing rabbits specifically risks only minimum standards being followed and does not allow consumers a clear choice of high animal welfare products. A common standard is urgently needed, while leaving flexibility for different regional climatic conditions, to provide clarity to consumers.

In 2017, the European Parliament voted in favour of a non-legislative resolution to phase out rabbit cages in the EU Member States and for species-specific guidelines and legislation to be drawn up, which is yet to happen (European Parliament, 2017). The Council of Europe has drafted recommendations addressing the welfare of farmed rabbits, which however have never been published (Szendro et al., 2019).

Furthermore, research is lacking objective data of welfare implications in different systems and basic data is missing, also due to rabbit meat not being included in the European Meat Market Observatory. Research is urgently required to create models for housing and management systems which improve both welfare and health of rabbits in commercial farming.

[9] Other applicable EU Regulations covering farmed animals in more general include Council Regulation (EC) No 1/2005 of 22 December 2004 on the transport of animals as well as Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.

Six types of housing systems exist for rabbits: conventional cages, structurally enriched cages, elevated pens, floor pens, outdoor/partially outdoor systems and organic systems (EFSA, 2020). The majority of commercially farmed rabbits are housed in cages.[10]

Conventional barren cages, which account for approximately 85% of total EU production, are the most prevalent form of housing in which animals are kept either individually (common for does) or in small groups (common for fatteners) without bedding and with limited space for movement (DG Health and Food Safety, 2017).

According to EFSA opinion (2005), breeding rabbits towards the end of their pregnancy are recommended to have a minimum size of surface within the housing of 3,500 cm^2 (excluding nest dimensions), while for fatteners it is 625 cm^2 per animal (EFSA, 2005).

To illustrate what this means in practice, 625 cm^2 is the size of a sheet of A4 paper, while 3,500 cm^2 is as big as an open Wall Street Journal. These non-binding recommendations are however not always met. For example, in Spain, the average size of the surface provided to individual animals remains below 500 cm^2, and it is only slightly higher in France and Belgium (Trocino & Xiccato, 2006).

Compared to the conventional barren cages, **enriched cages**, accounting for around 9% of total EU production (DG Health and Food Safety, 2017), provide more space to the animals and need to incorporate some gnawing materials such as wooden sticks, which allows rabbits to express some normal behaviour. However, the space allowances and technical features of enriched cages differ as there are no EU-wide legal requirements for enriched cages.

In **park (or pen) housing,** rabbits are kept in larger groups (e.g. 20 or above) either indoors or outdoors. Housing rabbits in groups allows social contact between the animals, which is an essential part of their natural behaviour (except for breeding does in certain periods). Parks are open-top and they provide more space to the animals compared to (enriched) cages; i.e. ranging between 180-200 cm in length, 100 cm wide and with no height restrictions (DG Health and Food Safety, 2017).

In addition, these systems are equipped with platforms (more functional areas for the rabbits to move within) and more enrichment to better meet their behavioural needs. Despite the higher animal welfare benefits, park housing is less suitable for breeding

[10] There is no information available about the housing systems used on back-yard farms, although most probably use cages (pers. comm)

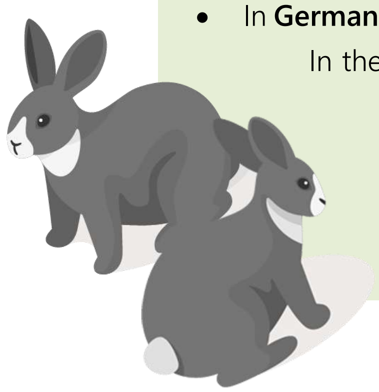
does, especially during parturition and feeding because of the higher risk of aggression in these periods. Therefore veterinarians suggest part-time group housing for does provided that issues around aggression can be resolved (FVE, 2017).

At the moment, **organic rabbit production** is based on national production protocols, such as Label Rouge in France. However, in the new EU organic farming Regulation (Regulation 2018/848), which is yet to come into force, rabbits will be included. All rabbits will be required to be kept in non-slatted floor group housing and have access to pasture when climatic conditions allow. At least 70 % of the feed will have to come from the farm itself or produced using material from the region and at least 60% of the diet must consist of forage.

In some Member States farmed rabbits are better protected by national law than the basic EU standards:

- Barren cages are banned in **Austria**, **Germany** and the **Netherlands**.
- **Belgium** has banned all cages for growing rabbits.
- In **Germany** rabbits must have a platform, gnawing material and roughage. In the **Netherlands** fattening rabbits must be housed in pairs with a platform and gnawing material (Dorning and Harris, 2017).

Nevertheless, in **Spain**, **France** and **Italy** where EU production is concentrated, conventional cages remain the most prevalent form of housing.



4. Market and trade dynamics

Consumer awareness of animal housing issues has increased continuously over the last years. The strong concern for farm animals is clearly shown by a major recent European animal welfare petition, the "End the Cage Age" ECI, which gathered well over the one million validated signatures required for a successful ECI.

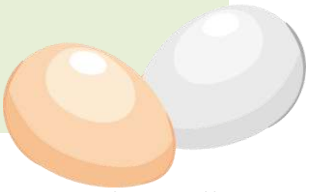
4.1. The EU laying hen sector

In north-western Europe, there has been continued growth in demand for non-caged laying hen eggs in recent years. The evolution of EU egg production systems has been strongly influenced by consumer choices and expectations, as well as legislative developments (Magdelaine, 2011).

Additionally, it has been supported by retailer-led product differentiation (see example case study 2) and brand-led initiatives (see example case study 3). In some Member States, consumer awareness has been particularly important in raising the market share of the non-caged segment. Examples from different Member States (and the UK) are:

What kind of eggs do Germans consume?

48.8% from barn housing
30.5% from free-range systems
14.3% from organic production
0.8% from caged housing



- In Germany in 2018, private households consumed a negligible share of eggs from caged housing (0.8%), 48.8 % from barn housing, 30.5 % from free-range chickens and 14.3% from organic production (5.6% were not identifiable) (BMEL, 2019).
- UK free-range egg sales have risen strongly from a 32% market share in 2014 to 67% of retail sales in 2019 (including approximately 2% organic). The large majority of growth occurred in retail consumption (Kantar, 2020)
- Organic eggs have the highest market shares in Denmark (33%), France (30%) and Austria (22%) (European Commission, 2019).

Case study 2: REWE International AG (AT)

REWE International AG is headquartered in Austria (Wiener Neudorf) and part of the REWE Group. The market leader in Austria owns several supermarket brands and private labels, such as BILLA, MERKUR, PENNY, BIPA and ADEG. Since 2013, it has been committed to 100% cage-free egg sourcing for processed products, such as pasta or baked goods, for its in-house brands. The business works with several local brands. For example, in 2019 it acquired the local free-range egg brand "Tonis Freilandeier", which has banned chick shredding and produces on local farms with an average size of 2,000 hens.

The REWE International Ag brand BILLA AG was a first-mover in the cage-free movement. The retailer committed to exclusive marketing of cage-free eggs as early as 1994. The decision was a success, due to its popularity with customers. BILLA´s early decision to go cage-free has been cited as a milestone for Austria's nationwide ban of barren cages in 2010. The cooperation between forward-looking Austrian entities engaged in animal welfare, agriculture, retail and politics made the change possible. As a pioneer country, which banned battery cages early on, Austria has seen economic benefits from the transition. Awareness among consumers is continuously growing and the demand for high-value products that prioritise animal welfare increasing.

Egg consumption plays a significant role in EU diets. On average a European citizen consumes 4.6 eggs per week, with variations among countries (Magdelaine, 2011). According to 2014 data, the biggest per-capita consumers are Austria, Germany, Sweden, Hungary and France (International Egg Commission, 2015).

Some suggest that the role livestock products, including eggs, in diets will decline in the future, as part of a protein transition which arguably is inevitable from an environmental and climate perspective (e.g. Buckwell and Nadeu, 2018). The European Commission's EU Agriculture Outlook publication draws up a protein transition scenario to 2030 where fish and egg consumption decreases by 103 grams per person in a weekly diet (DG Agriculture and Rural Development, 2019). However, the actual trajectory may not follow this course and will depend on a variety of factors.

The EU is almost self-sufficient in its egg production. In 2019, 7.07 million tonnes of eggs were produced domestically (total use: 6.84 million tonnes), 19 thousand tonnes were imported and 248 thousand tonnes exported (DG Agriculture and Rural Development, 2019).

Imports mostly originate from Ukraine, the US, Argentina and Albania (DG Agriculture and Rural Development, 2020). In 2017, primary egg production costs in Ukraine were considerably lower (22%) compared to the average level within the EU (van Horne et al., 2019). There is no legislation on animal welfare in Ukraine and laying hens are housed in conventional cages with a space allowance of approximately 300 to 400 cm^2 per hen (idem) – around half an A4 sheet of paper. The EU-Ukraine Association Agreement, which became operational in 2016, provides for Ukraine to approximate its animal welfare legislation to that of the EU. However, concerns about the continuous use of barren cages and lower production costs have repeatedly been raised by various EU stakeholders in the sector.

Other trade agreements also have a welfare element. According to the Mercosur trade agreement, which is yet to come into force, eggs imported from Brazil, Argentina, Paraguay and Uruguay to the EU will only be duty-free if hens are kept in line with EU standards.

Case study 3: Unilever/Hellman's (International)

Unilever is a multinational consumer goods company, with more than 400 brands sold across 190 countries. The brands produce food and refreshments, personal and home care products, of which some contain animal-derived ingredients (such as ice cream, bouillon and soups). As one of the first global companies to do so, in 2009 Unilever achieved 100% sourcing of cage-free eggs for all brands manufacturing in Europe.

The cage-free commitment began in 2007 as a brand-led initiative from Hellmann's, a Unilever-owned mayonnaise brand. Hellmann's move to cage-free egg sourcing was inspired by consumer demand, their commitment to sustainable sourcing and supported through collaboration with animal welfare organisations (Unilever, 2017). Other European Unilever brands using egg products followed suit, with all achieving 100% cage-free production in 2009. These types of brand-led initiatives have been shown to be impactful within the whole sector because they demonstrate firm purchase commitments to drive higher standards of animal welfare throughout the value chain.

4.2. The EU pig sector

Europeans have an interest in pig welfare and their housing conditions, however, consumer awareness is not as high as with laying hens. The concept of cage-free pig meat is not as established or as easy to understand and a lack of data on cage-free pig market shares is evident. Greater consumer understanding on the environmental, socio-economic and animal welfare implications of production conditions is needed if the position is to be changed.

Pig meat is the meat most commonly eaten by Europeans[11], followed by poultry and bovine meat, and therefore plays a key role in EU diets (DG Agriculture and Rural Development, 2018). Despite growing consumer demand for organic products, the share of organically farmed pigs in the EU was estimated at less than 1% in 2016 (idem). Producing to organic standards is seen as challenging by some, for example, because of the need to provide and manage the outdoor access requirements (idem).

The EU produced 24.19 million tonnes of pig meat in 2019 (DG Agriculture and Rural Development, 2019). Further pig meat was imported from countries such as Switzerland and Serbia, a total of 16 thousand tonnes (idem). At the same time, the EU is the leading exporters in this sector, with an increase from 3.9 million to 4.7 million (in tonnes carcase weight) from 2017-2019[12](European Commission, 2020). The main export markets for the EU are China, Japan and South Korea (idem).

In Switzerland, animal welfare standards are higher than elsewhere, based on regulations such as an upper limit on the number of pigs on one farm (250 pigs), an early ban on farrowing crates and the availability of a payment by the government for farmers meeting certain housing standards (DG Health and Food Safety, 2016). Serbia

[11] According to 2018 data, EU citizens consumed 32.9 kg of pigmeat, 24.1 kg of poultry and 11 kg of beef

[12] Numbers are including the UK here

has seen some improvements in this sector, with younger farmers adopting new techniques and technologies. However farrowing crates are still in widespread use and no obligation for group housing is in place. Therefore, Serbia's industry does not meet EU pig production standards.

4.3. The EU rabbit sector

In the absence of EU species-specific animal husbandry legislation for rabbits, consumer knowledge about housing systems, welfare and farming practices is less developed compared to other species. Also, overall rabbit meat consumption is relatively low compared to other types of meat: on average, EU citizens consume 0.5 kg in a year (DG Health and Food Safety, 2017). There has been a continuous decline in the consumption of rabbit meat, which is mainly linked to dietary changes towards convenience foods, the increased perception of the rabbit as a pet animal, as well as price competition with other meat. Compared to other livestock, a substantial volume (34%) of production occurs in backyard farms, marketed through direct and local sales (e.g. farmers' markets) (idem). In 16 EU countries, this is the main selling channel for rabbit meat.

5. The environmental and socio-economic performance of housing systems

Caged farming systems are almost always found on farms with high numbers of animals, deploying large-scale production methods and some of the most intensive forms of farming found in the EU. There is a close relationship between the use of this housing system and the overall size of the farm (Caspari et al., 2010). This is particularly true for pigs and poultry: often there are more than 100,000 birds on the larger units.

By contrast, cage-free farming takes a range of different forms. When moving away from caged housing, some of the systems used instead incorporate only the minimum changes necessary to conventional, generally intensive, livestock production methods in order to eliminate the use of cages (or reduce their use in the case of pig farms where confinement of sows after insemination and again after farrowing continues to take place). Other systems represent a much greater departure from established intensive norms and involve much more spacious forms of housing, greater access to outdoor foraging or wholly outdoor production in some cases. Very often cage-free producers farm at a smaller scale than conventional more industrial farms but this is not invariably the pattern. In a few cases, there is a clear set of rules defining what is permitted within the system, as in the case of organic production, but many systems are not subject to such codification.

Given this variety, the impacts of the production systems themselves on the welfare of the animals concerned as well as the wider environmental and socio-economic consequences are also diverse. Furthermore, they depend considerably on the specific conditions arising on the farm and in its vicinity, the key production choices, such as the source of compound feed, and the skill with which management choices are made and executed. The characteristics of individual farming practice, as well as of generic systems are of significance. In the light of this, as well as the major differences between pig, poultry and rabbit production systems, this section aims to explore some of the direct and indirect implications of utilising significantly different housing systems, distinguishing particularly between caged indoor, alternative indoor, and outdoor and organic systems, noting too the influence of scale.

Greater environmental and social impacts tend to arise when new cage-free housing systems make a significant difference to the scale of the operation or the density at which animals are housed. On the other hand, moving to a cage-free system with little change to the overall density of animals housing may have more limited wider environmental or socio-economic impacts, for example, if sows are moved from farrowing crates to loose farrowing indoor systems. Whilst scale also can affect welfare, other variables, such as the ratio between animal numbers and the numbers of the farm workforce, may be more critical.

This section begins with some of the key variables which significantly impact the environmental and then the socio-economic performance of different housing systems and concludes with brief considerations of welfare aspects.

5.1. Key variables influencing the wider environmental impact of housing systems

The particular characteristics of livestock housing and management systems, such as the level of animal confinement, density of animals, housing design, and the scale of operations have direct impacts on the environmental footprint of the operation, together with other factors, such as the type, age and health of the animals concerned, the composition and sources of feed, the disposal of wastes, the capacity to control airborne pollutants etc. Some impacts are local, others more distant or indirect and to some extent, the intensity of the environmental pressures can be altered by appropriate management measures. Given the number of factors involved, the aim here is to signpost some key issues.

The following housing and management variables are associated with some of the most significant environmental impacts in relation to laying hens, pigs, and rabbits:

- The scale and **concentration of wastes and nutrients arising**. The generation of livestock wastes on any scale results in various environmental pressures, including water and air pollution, damage to ecosystems from ammonia deposition, unpleasant odours, and potential impacts on human health as well. Concentrating livestock numbers in a small area increases the load of wastes and nutrients, creating management challenges and risks of severe pollution incidents, such as large spills of slurry into water bodies. Smaller-scale production reduces the intensity of wastes and the scale of the disposal problem in a particular location, but the challenge of waste management remains. Some technologies for reducing emissions may not be practical or cost-effective on a small scale. In fully outdoor systems there are also challenges (such as nitrogen losses and risks of more diffuse water pollution) and good management remains critical.

- **Use of litter and bedding material.** The choice and management of this material have impacts on the emissions produced in indoor housing. Poor management of litter (for laying hens) can further increase ammonia emissions or lead to pollution of surface waters with nitrogen and phosphorus, soils with heavy metals, and groundwater contamination with antimicrobial residues (Augère-Granier, 2019). In indoor pig housing, for example, bedding material conditions strongly influence nitrous oxide emissions (FAO, 2018).

- **Energy use and efficiency, especially from heating and lighting in livestock production**. This directly affects the carbon footprint of the housing system. Intensive poultry farming, for example, requires large quantities of energy for heating, ventilation and air conditioning. The number of animals and stocking density clearly affects the scale of energy and other input requirements but so too does the management system. There is evidence that suggests that the scale of energy use usually depends more on the housing design than the intensity of the production (Augère-Granier, 2019).

- **The immediate land requirements** for indoor housing as well as any associated pasture may be relatively small in intensive systems but nonetheless may result in negative impacts on the surroundings, including the industrialisation of the landscape, construction of roads and hard surfaces, noise and light pollution, generation of new and heavier traffic etc. Moving to less intensive systems without reducing the numbers of animals farmed usually will require additional land taken from other uses. The net impact of moving to less intensive systems will depend on the difference between the new and previous conditions, including the availability of suitable land, proximity of sensitive water bodies and other habitats, potential to change sources of feed, including use of more local sources, the potential for replacing previous buildings with lower impact ones etc. Outdoors there may be both risks e.g. soil damage from poor management of outdoor pigs and also may be opportunities e.g. increased biodiversity from more complex habitats displacing intensively fertilised grassland.

- **Feed conversion** ratios vary between systems and will affect the environmental footprint of each animal as well as the system as a whole. Higher feed conversion efficiencies generally are associated with lower environmental impacts, such as GHG emissions per unit of meat produced. Housing systems that permit more locomotive activity for animals can be expected to result in lower feed conversion efficiency and so greater GHG emissions.

Beyond these more direct impacts at the farm level, the indirect environmental implications of the extended supply chain for the farm play an important role, chiefly through the quantity and composition of bought-in feed. Currently, EU pig and poultry production consumes large amounts of processed feed, including vegetable proteins, even though monogastric species have a digestive system that enables them to thrive on food waste (which would need to be appropriately treated for food safety reasons), and historically wastes were an important part of their diet (Westendorf, 2000). The use of concentrate feed (mostly for monogastrics but also for rabbits) in industrial production leads to indirect supply chain impacts, such as:

- **Transport and energy consumption requirements** and associated GHG emissions, including from feed sourced from within Europe as well as from the rest of the world. The quantity of feed and the scale of imports, the distance and the transport type are important parameters.

- **Land use requirements** for growing animal feed, including cereals and proteins of various forms including oilseed cake. Much of this is sourced from outside Europe, mainly from North and South America. Some of these crops are grown on land that has been converted (legally or illegally) from more natural and biodiverse vegetation, such as forest and grassland, to crop production like maize and soya. All crop production has impacts on local habitats, biodiversity loss and the carbon cycle and this is especially so when more natural habitats have been displaced.

- **External input requirements**, such as mineral fertilisers for production of proteins, maize and other concentrates, have their own carbon footprint and for example, lead to increased nitrous oxide (N_2O) emissions.

Differentiation between systems

The concentration of farmed animals in small spaces is strongly related to altered **nitrogen and phosphorus flows** in their geographical surroundings and large-scale waste management challenges. Such farms produce increased amounts of manure, releasing nitrogen, phosphorus, potassium and other nutrients, which create serious management challenges (Augère-Granier, 2019). Water pollution from the disposal of slurry and manure on farmland and ammonia emissions to the air are key environmental concerns for these systems (Roffeis et al., 2015). Odour is also a problem in some regions, for example in the Netherlands. Small areas of land cannot absorb all the manure/slurry arising on large units and responsible management can be extremely challenging.

Outdoor and grass-based production avoids some of the pressures associated with intensive indoor systems with their high concentrations of emissions but is associated with nitrogen losses and more diffuse water pollution in the field, particularly where animal stocking densities are high. In outdoor systems, nutrients are mostly deposited directly to the land rather than being treated in a manure management system. While outdoor housing systems are often found to have an overall lower eutrophication potential than indoor systems per kg of output (see for example Dourmad et al., 2014), careful management is required outdoors to lower the impact of nitrogen losses (Halberg et.al. 2010). It is important to locate housing correctly, with sufficient distance away from surface water and well catchments for example. To lower the impact of N-losses from pigs, different approaches are possible: for example, tents located on a deep litter area, designed to reduce the risk of N leaching have been suggested (idem). Furthermore, to minimise the risk of over-fertilisation and overgrazing, outdoor housing should regularly be moved to a new area of land (FiBL and BioSuisse, 2019).

Organic systems reduce the risk of N-losses and are subject to rules setting out the maximum herd/flock size, low stocking density requirements (EU organic Regulation 834/2007 and secondary Regulation 889/2008). The area and quality of outdoor space in organic pig production in Europe is however highly variable, and therefore environmental impacts may differ. Pigs may be kept wholly outdoors in paddocks on pasture, as in most UK and Italian farms, or indoors, with access to a limited concrete outside run, as in many farms in Germany and Austria (Rudolph et al., 2018).

In intensive pig and poultry production, including the caged systems, **feed supply** often comes largely or wholly from off the farm. Compound feed[13] is mainly consumed by poultry and rather less by pigs. Approximately 55% of compound feed, by value, in 2018 was purchased by the EU poultry sector, 35% by the pig and 10% by the cattle sector (FEFAC, 2018). The wider land-use footprint is externalised and may extend well beyond the vicinity of the farm and often to other countries. Additionally, such protein is generally produced in high-yielding and large-scale arable systems, which are often compromised in biodiversity terms and may have other negative environmental impacts. Imported rather than locally grown protein feed impacts land use worldwide and creates additional emissions during transport (Halberg et al., 2010, Godfray et al., 2010). The ways in which rabbit farms affect the environment are not

[13] Compound feed is defined as "a mixture of at least two feed materials, whether or not containing feed additives, for oral animal-feeding in the form of complete or complementary feed" in Regulation (EC) No767/2009

dissimilar but arise on a smaller scale given their more limited production in the EU. For rabbits, feed-related impacts are among the most significant (Cesari et al., 2018).

A number of papers in the literature have assessed the **environmental efficiency, measured per unit of output, of several different housing systems**. The use of the lowest amounts of inputs for any given output represents high efficiency on this metric. Looking only at these important but limited criteria, the higher welfare systems tend to score less well on efficiency and the related environmental parameters (e.g. Asselt et al., 2015; Leinonen et al., 2012). However, such findings need to be treated carefully. This result comes from the high levels of efficiency in feed conversion and lower energy use per unit of output. The measurement does not take into account the concentrated and high overall environmental externalities of large intensive holdings.

For example, one life cycle assessment of housing systems, which sought to quantify the environmental impacts per kg of laying hen eggs in barns and aviaries in the Netherlands, shows a higher global warming potential, land use, energy use, fossil P use and acidification potential in both (aviaries and barns) compared to caged systems (Dekker et al., 2011). When comparing all alternative housing systems (barn, free-range and organic systems), indoor barns have the highest energy use (Dekker et al., 2011; Leinonen et al., 2012). Of all the loose housing systems, organic laying hen systems show low environmental impact values in the categories of global warming potential, energy use, fossil phosphorus use, and nitrogen and phosphorus surplus (Dekker et al., 2011).

There has also been research comparing pig housing systems (conventional, indoor with slatted floors; adapted conventional mix of slatted floors and straw bedding; and organic systems) with regard to their environmental impact expressed per kg live weight. It was found that the energy demand and land occupation was lowest in conventional, higher in adapted conventional, and highest in organic pig housing. Generally, the eutrophication potential is slightly higher and acidification potential slightly lower in indoor systems compared to organic systems (Dourmad et al., 2014). However, intensively reared pigs are likely to have a high protein conversion efficiency and lower GHG emissions than their extensive counterparts.

When laying hens are entirely free-range, they can **improve the soil structure,** as they are constantly moving while searching for the most fertile foraging materials. In some instances, there are benefits from the manure spreading that takes place. As outdoor animals roam freely, they turn and blend soil and manure as they search for insects and worms, thereby increasing organic matter (Berton and Mudd, 2009). Similarly, well-managed pigs in outdoor grazing systems on pasture can improve soil health and the inclusion of pigs in the crop rotation can be highly beneficial for overall soil health (Früh et al., 2013).

5.2. Key socio-economic variables influencing the wider impact of housing systems

Livestock housing system characteristics have direct impacts on farm costs, revenues, labour and capital requirements as well as overall profitability. Key socio-economic variables that typically are affected by a change towards less confined and cage-free housing systems are:

- **Labour requirements**, which are likely to increase in alternative housing systems (assuming no change in stock numbers). Generally, more time is required for supervising and maintaining larger areas, both indoors and outdoors. This may lead to higher costs or more time spent by members of farming families. This in turn may have an impact on the overall profitability of the farm, depending on whether these costs can be recouped either through the market or increased access to public sector support. At the same time, increased employment and wage bills can contribute greater added socio-economic value to the wider rural community in which the farm is located.

- Higher **running costs and investment needs for buildings and land**. Changes in running costs will relate to expenditure on energy, feed, veterinary expenses, land management, certification costs for organic producers etc. Where buildings need to be altered, new structures created, and perhaps additional land acquired or rented, there are likely to be capital requirements that will increase costs. Any sort of transition, for example from cages to indoor group housing, requires an initial investment, increasing overall production costs, with consequences for profitability, although the consequences may be short-term.

- **Output levels in the form of meat or eggs** are highly variable across different housing systems. Output quantities are often lower when animals have more space and the freedom to move around. Additionally, slaughter dates may be later in non-caged systems while alternative systems may use slower-growing, more robust breeds.

- Different housing systems vary with respect to the **average mortality per animal** arising, with impacts on output and the profitability of the business. For example, specific attention must be paid to preventing piglet crushing in loose farrowing systems, which can be addressed by appropriate space and design, and good management. Loose housing systems can increase harmful aggressive behaviour among animals in certain conditions and good standards of husbandry are required to limit this.

- **Market prices** are an important determinant of farm revenue and profitability. Premiums are often available for products from non-caged systems. They vary greatly and can be sensitive to local market conditions but generally are highest for organic and outdoor systems. Clearly, the balance between premiums and additional costs is critical.

Aside from the economic health of the farm, moving to non-caged housing systems can have wider societal benefits. These can include:

- Reductions in the **use of antibiotics on the farm**: excessive use increases risks for human health.

- **Nutrition and health effects, which** may arise since the characteristics and overall nutritional quality of the eventual product can vary between the products of different housing systems. The nutritional properties of products may be different and the quality preferred due to a changed feed composition for animals, for example through the introduction of grazing widening their diets. (Rakonjac et al., 2014; Castellini et al., 2006).

Differentiation between systems

The **demands on labour** in terms of time, tasks required and skills vary among different housing systems and different species. Routine surveillance work by the staff of indoor pig pens remains straightforward and safe (Früh et al., 2013). Some additional time is required however for cleaning the larger area that is available to the animals indoors and outdoors (Bussemas et al., 2011). For rabbits, similarly, several studies and reports have pointed towards additional time and effort by farmers being needed in alternative systems. If plastic flooring is used, some farmers have reported increased effort and difficulties in cleaning, leading to a higher probability of gastro-intestinal diseases (FVE, 2017; Dorning and Harris, 2017). Additionally, when fattening rabbits are removed from the doe, put in mixed litters and start reaching maturity, there is a risk of increased fighting, requiring careful management (DG Health and Food Safety, 2017).

In general, the **management** of outdoor housing requires higher effort and expertise. Free-range and organic hen management for example requires greater skills than management of hens kept inside (Weerd et al., 2009). Likewise, for rabbits kept outdoors, additional costs stem from the more demanding management needed (training to observe behaviour sufficiently thoroughly in these conditions, clinical signs, feed and water) and the measures required to manage climatic conditions (investment in fans, trees, humidifiers) (EFSA, 2020). Labour costs for pigs are overall greater in an outdoor system. The pigs have to be checked upon on a daily basis, particularly in the farrowing period (Halberg et al. 2010; FiBL and BioSuisse, 2019). Free-range or outdoor systems are generally easier to implement for pregnant sows and pigs, but the prerequisites are more complex in the farrowing and weaning period (FiBL and BioSuisse, 2019).

Transiting to alternative indoor housing systems can require a significant **initial investment**, as noted above. Transforming a conventional indoor pig system to create new facilities with indoor pens, for example, involves new capital expenditure as well as higher running costs (Guy et. al., 2012, Halberg et al., 2010). With many pig farms working with small margins, moving away from crates can influence financial stability (Guy et al., 2012; Harvey et. al., 2013). However, in the long-term, labour costs and time requirements are estimated not to vary greatly from conventional systems with farrowing cages (Guy et al., 2012).

Compared to other housing systems, **production costs** are comparatively low in caged systems. In EU egg production systems, this has been found to relate to the feed required to produce eggs (Leinonen et al., 2012 & Leenstra et al., 2014) and lower management requirements (Weerd et al., 2009). Caged pig systems are seen as a cost-efficient option for producers. The argument extends to both labour and building costs (Willgert, 2011, Guy *et al*., 2012). Organic pig farming systems on the other hand generally have higher production costs and lower productivity (Sundrum et al., 2011). Within rabbit farming, in terms of productivity and labour efficiency, intensive systems seem to be more economically viable than extensive ones, which is linked to the larger number of annual reproductive cycles (Theau-Clement et al., 2016).

In outdoor and grass-based production systems, **feed consumption** may increase. This is true for laying hens in both organic and free-range systems as a consequence of extra physical activity and thermoregulation at lower temperatures, due to the birds having outside access, and the lower density of hens in the house in organic systems (Leenstra et al., 2014). The literature suggests that the number of birds and feed required to produce 1 kg of eggs is highest in the organic and lowest in the cage system (Leinonen et al., 2012). Also for pigs housed outdoors in winter, higher costs for feed are normal (FiBL and BioSuisse, 2019).

In moving to alternative housing systems, changes in both the **quantity and quality of the meat/eggs produced** can be expected but it is difficult to establish the full significance of this with so many different options and variability in results. Product quantity and quality have been assessed for eggs in the literature and it is reported that caged hens deliver a higher yield of eggs, but their qualitative aspects (Haugh index and yolk colour) were not optimal (Castellini et al., 2006). The egg quality in furnished cages was found to be largely dependent on cage design – for example when nest-boxes or perches were not functional, quality can be negatively affected (EFSA, 2005). A reduction in the growth and fat content of carcasses has been observed for alternative systems for rabbits (Chodova et. al., 2014; Pinheiro et. al., 2012) as greater freedom of movement generally leads to a lower weight at slaughter due to more locomotive activity. Rabbits housed in alternative systems have a 13% lower live weight, except for their hind parts and hind leg muscle. Additionally, the colour of the meat might be affected, although to a degree hardly visible to consumers (Xiccato et al., 2013).

When it comes to **overall net farm income**, the evidence suggests that free-range laying hen systems are the most profitable, followed by organic systems (Dekker et al. 2011). In contrast, Asselt et al. (2015) find that both production costs and related market prices are the highest for organic farms, followed by free-range systems, barns and lastly, enriched cages. Organic products generally have a competitive advantage on the market, due to the high quality of products (Rahmann 2011). The overall market for organic pigs remains relatively small in Europe which presents a market opportunity for producers wishing to provide higher welfare conditions for their animals.

Farmers and workers can be negatively affected by the **air quality** in intensive indoor systems. Workers may for example be exposed to high levels of CO_2, endotoxin and inhalable and respirable swine confinement dust above the recommended health threshold limit (Anthony et al., 2014). While emissions of air pollutants arising from rabbit farms remain below the occupational threshold, potential impacts on human health are not always well understood, calling for a cautious approach (Calvet et al., 2012; Adell et al., 2012). Here, the evidence suggests that airborne pollution levels may not be improved relative to more intensive systems associated with cages.

Litter use requirements have an impact on airborne concentrations of particulate matter (PM) and ammonia emission levels. For the laying hen sector, evidence suggests that barns and aviaries have higher concentrations of suspended dust than enriched cages where birds have only a little access to litter. The higher dust levels in aviaries and barns also relate to increased bird activity and movement (David et al., 2015). Similarly, when indoor pig farms use a bedded floor - which is vital for animal welfare - overall higher CO_2 equivalent emissions may occur (Philippe and Nick, 2015; Cabaraux et. al., 2009). The increased emission levels mostly arise from nitrous oxide emissions, as bedding materials in barns have been cited to create a favourable environment for the formation of N_2O[14] (Nimmermark et al., 2012). In pig housing, bedding materials often consist of straw, sawdust, wood shavings or peat (Nicks, 2004). Particularly, sawdust has been found to create high nitrous oxide levels (Cabaraux et al., 2009).

The **risk of contact with wild animals and disease transmission** is also a notable issue. For example, a recent study has found influenza viruses with pandemic potential all year round on European pig farms (Henritzi et al., 2020). While in indoor systems, the risk of disease transmission within the farm is higher, outdoor access may provide additional sources of infection. It has been noted that intensive pig farms can increase the risk of disease transmission, especially at high stocking densities where

[14] N_2O is produced during the nitrification and denitrification processes which normally convert NH_3 into inert N_2 gas. Nitrification requires aerobic conditions and denitrification requires anaerobic conditions (Monteny et al., 2006). Both conditions can be found in deep litter.

control over disease is more difficult. Outdoors, animals face additional threats. Laying hens, for example, are exposed to wild bird diseases (Bhanja et al., 2018). Farmers must additionally be careful about disease originating from the contact with faeces in outdoor production more than in other systems.

The **use of antimicrobials** is more likely in intensive systems, with possible long-term consequences for human resistance to antibiotics and other drugs. Endemic diseases are more easily spread in a dense environment and control relies on replacing animals or a vaccination system (Sørensen et al., 2006).

5.3. Key variables influencing animal welfare in housing systems

Clearly, the design and management of livestock housing systems have important consequences for both animal health and animal welfare. This is a large and specialist subject but amongst the key variables are:

- **Housing systems with sufficient space to enable natural behaviours**. Natural behaviour can be defined as the "behaviour an animal normally presents when exposed to conditions similar to its natural habitat" (Bracke and Hopster, 2006). For poultry, for example, it is natural for birds to spend 15 % of their time being active. Sufficient space is important for animals to avoid each other, giving rise to fewer injuries. For rabbits, for example, it is important to offer the possibility to demonstrate submission to others (Doring and Harris, 2017). Greater floor space is one aspect but there are others too. Elevated platforms allow for vertical movement and provide space to retreat from social interactions.

- **Species-specific design and appropriate choice of materials** are important factors in providing housing that is closer to farmed animals' natural environment. The laying hen is a forest bird, while domesticated rabbits are related to the wild rabbit whose natural habitat is grassland with sufficient shelter (such as scrub) for cover. Domesticated pigs are relatives of the wild boar which favour mixed forests, marshes and meadows. Therefore, for pigs, for example, an appropriate choice of nesting materials can be important in improving interactions between sow and piglets (Baxter et al., 2012; Vosough Ahmadi et al., 2011).

- **The provision of sufficient shelter and protection from external threats** is important to shield animals from certain weather conditions, such as the sun, excessive heat, cold, rain and wind, as well as from wild predators.

- Higher welfare systems need to ensure sufficient **dietary sources** of nutrients, protein, and vitamins, given their importance for animal welfare and health as well as the quality of the output. If animals are grassland-based for example, the vegetation and soil should provide vitamins and minerals otherwise not found in their conventional diet.

Differentiation between systems

According to the World Organisation for Animal Health (OIE), animal welfare is defined as: "how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well-nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear and distress." Animal welfare is consequently a broader term than just animal health. When evaluating different housing systems, the restrictions on natural behaviour play an important role.

In caged systems, all three species are restricted in exercising their **natural behaviours**. A hen in an enriched cage for example still has very little opportunity to exercise and is prevented from flying. Since laying hens are originally forest birds, their behavioural needs and preferences include perching, nesting, foraging and dustbathing (Weeks and Nicol, 2006), as well as comfort behaviours such as wing stretching. The high stocking density of birds hinders wing-flapping, which leads to frustration and harmful behaviour such as pecking. Farmers use practices such as beak trimming which worsen animal wellbeing in other ways (Akaichi and Revoredo-Giha, 2016).

The lack of ability to exercise can lead to physical problems such as bone weakness (Augère-Granier, 2019). Hens in enriched cages at times show tonic immobility and the status of their plumage is very poor (Castellini et al., 2006). On the other hand, hens have access to the nesting box, perches, scratch areas and a dust-bathing area, which allows for the expression of several natural behaviours (Blatchford et al., 2016). Scratching and dust bathing opportunities may be restricted, however, as litter inside the cages can be quickly depleted and this causes stress to the hens who are excluded from dust-bathing by more dominant animals.[15]

Indoor alternative housing provides better opportunities for animals to exercise natural locomotive behaviours compared to caged systems. In aviary housing systems for laying hens, the opportunity to forage in litter is crucial to reduce the incidence of cannibalism and feather pecking (Greene and Cowan, 2014). On the other hand, injuries can occur when animals climb on perches (Bhanja et al., 2018). Organic systems achieve the best welfare status and the additional space allows for high levels of natural behaviour.

[15] Additionally, the cages supposedly provide scratching areas, but the law doesn't specify how large these should be, which raises the question whether sufficient space is provided in all cases.

Case study 4: Kipster farm (NL)

Ruud Zander grew up on his parents' intensive poultry farm, which produced eggs from laying hens in cages. After the farm went bankrupt in 2007, a new approach to poultry farming was developed. Since 2017, laying hens are housed in an indoor garden at the first Kipster building.

Together with Wageningen University, the Kipster farmers developed a science-based approach to animal welfare, which aims to put animal welfare and the environmental impacts of farming at its centre. The cage-free transition started in 2013 when Ruud and his partners moved away from large-scale production.

The innovative Kipster glassed indoor housing design provides daylight, protection from rain and predators, and imitates the natural environment of chicken as forest birds, with wooded elements. Hens have additional access to a free-range area around the farm. Male chicks are raised on a partner organic farm for meat production. The farm takes a different approach than organic certification but strives for circularity and carbon-neutrality. Kipster eggs can be produced with a lower carbon footprint than eggs from other systems (cage, barn, free-range and organic) due to use of residual waste (such as left-over products from bakeries) as feed, instead of cereals from arable land. Kipster produces CO_2-neutral eggs and low-carbon egg boxes. On-site solar energy production enables exclusive use of renewable energy on the farm. Products are marked by Lidl, which provides a fair price to the farmers, and these eggs are highly popular with its consumers.

As discussed above, caged pig systems mostly relate to sows during certain stages of their reproductive cycle. In farrowing crates and sow stalls, animals cannot follow natural behaviour patterns such as nest-building, and overall they are less calm during the farrowing period if housed in cages (Weber et al., 2007, Vosough Ahmadi et al., 2011, Baxter et al., 2011). Physical pain from the restricted space adds to this. Stress is created by the lack of exercise and the solid substrate they have to stand on, without the option to root. Pens offer more space and therefore better possibilities for natural behaviour. So-called "Design pens" offer even better results as they are equipped with designated areas for dunging, which are separated from lying areas. They additionally provide enrichment material, separate nesting sites and solid floors and are rated as the best alternative in indoor pig systems (Baxter et al., 2012; Vosough Ahmadi et al., 2011). However, despite an overall lower stocking density in operations using such pens with an outdoor area, the stocking density can still lead to a higher risk of illness, compared to outdoor or mixed production systems which have lower densities (Früh et al., 2013). Outdoor pig production can provide the closest to a natural environment and associated behaviour (FiBL and BioSuisse, 2019; Früh et al., 2013). Outdoor housing systems should provide space for natural hierarchies and the possibility for individuals to avoid each other, creating fewer injuries than indoor production.

Conventional rabbit cages have been found to restrict movement, lead to the inability to gnaw, resting problems as well as social behaviour, heat stress and hunger (EFSA, 2020). According to the 2020 EFSA assessment report, "The main welfare consequences in conventional cages are directly related to the size of the cage (restriction of movement, resting and social behaviour)" and therefore it recommends an increased cage size and additional structures, such as elevated platforms, to allow for more efficient use of the cage. Similarly, for enriched cages, the report confirms that restriction of movement still occurs in in a majority of conventional cages, and elevated pens or enriched cages do not eliminate this key welfare issue. Other literature on this topic is rather consistent with these conclusions (Theau-Clement et al., 2016; Szendro et al., 2019; Ribikauskas et al., 2010; Sommerville et al., 2016). In general, enrichment objects improve animal welfare. However, care should be taken in terms of the type of enrichment and number of objects to avoid competition leading potentially to increased mortality (Somerville et al., 2016). Evidence suggests that rabbits kept in group outdoor systems enjoy the pasture. Those rabbits housed in open-air parks instead of indoors show a decreased level of corticosterone concentration (compared to cage and park systems), possibly meaning a lower stress level (Pinheiro et al., 2012). Organic rabbit farming generally shows good welfare outcomes, even though there are wide variations in the organic systems being used (EFSA, 2020).

The literature presents conflicting views on whether the **mortality and injury occurrence** of animals is increased in cages or not. Some reports find a relationship between raised levels of laying hen mortality and furnished cages for example (e.g. Stadig et al., 2016). Others, however, report that caged systems decrease animal mortality (e.g. Asselt et al., 2015, Weeks et al., 2016). In confined spaces, hens peck at each other's feathers, which can lead to injuries and even cannibalism[16]. Female chicks will usually have their beaks trimmed to avoid feather pecking, a very common welfare issue. Beak trimming may cause the animal pain due to tissue and nerve damage (Cheng, 2006). Generally, it must be noted that in commercial farms, hens are usually killed when egg production slows down (around the age of 72 weeks) although their life expectancy is otherwise six years on average (Augère-Granier, 2019).

There are several different reasons for piglet mortality in caged and alternative systems. In crates, the occurrence of starvation and stillbirth is higher, while in loose farrowing the main cause of death is piglet crushing. Modern sows have been bred to be larger and have larger litters than their wild ancestors, with increased numbers

[16] Weitzenburger et al. (2005) state that cannibalism accounted for as much as 65.5% of mortality in furnished cages.

of smaller and weaker piglets, which increase the risk of piglet mortality (Rutherford et al., 2013). As piglet survival is closely linked to maternal behaviour, cage-free farrowing systems are highly beneficial where sows show fewer signs of stress and injuries compared to caged systems (Grimberg-Henrici, 2016). Sows may be calmer out of the confines (idem) and they are more likely to recognise piglet screaming, compared to caged housing (Weber et al., 2007). In crates, communication between sows and piglets is restricted. Pregnant sows in organic production are found to have a lower average prevalence of lameness than in conventional production (March et al., 2015) and sows have less swelling in their legs due to softer lying areas (Leeb et. al., 2019).

Mortality of rabbit kits decreases with greater separation between mother and kits, which is only achievable in alternative housing. Alternative housing systems offer better results with regard to preventing the occurrence of injury compared to caged systems. The plastic flooring used for rabbits in alternative systems for example contributes to improved welfare by removing the painful wire mesh. However, to maintain animal health, enhanced flooring must be cleaned regularly to avoid the build-up of faeces and soiling (Szendro et al., 2019).

The welfare of rabbits, laying hens and pigs is additionally influenced by the extent to which they are permitted to exhibit natural behaviour as **social animals**. The Federation of Veterinarians of Europe has made it clear that rabbits for example prefer living in groups during most parts of the reproductive cycle. Behavioural traits that must be catered for to achieve high welfare standards include gnawing, hopping and social interaction (FVE, 2017). Nevertheless, 'park' rabbit systems can create tension due to competitiveness between animals and aggression, which can lead to more injuries in the group (Jekkel et. al., 2008; Szendro et al., 2019). In some conditions, the space available may not be enough for rabbits to demonstrate submission to others (Doring and Harris, 2017), in which case the numbers of animals must be reduced and the space redesigned. Elevated platforms are important to allow for vertical movement and provide space to retract from social interactions. Moreover, it has been demonstrated that the provision of gnawing sticks can help to achieve a significant decrease in injuries (Princz et al., 2008).

Case study 5: Bauer Kaninchen (DE)

The family Bauer has bred and marketed rabbits for over 30-years in the south of Germany. The business started its transition to group housing in 2008 and today farms around 18,000 rabbits in indoor pens, on five different family-owned holdings. In 2008, the family co-developed a new label for group housing in partnership with the retailer Kaufland. They jointly developed criteria for certification: today these apply to all of Kaufland's rabbit meat suppliers.

In 2016, the Bauer family founded an EU-funded European Innovation Partnership (EIP-Agri Kaninchen), together with five other partners along the value chain. The objective of the multi-stakeholder group was to develop and test a new rabbit housing system. The new system was developed to be in accordance with a 2014 regulation in Germany (TierSchuNutzV), and to better meet rabbits' needs while improving farm profitability. As no housing system existed at the time that was in line with the new requirements, the group had to fill an important gap on the market. The new housing system was co-designed in partnership with Kaufland, the University of Giessen, the Italian equipment producer Meneghin, the feed producer Mifuma and the Farmarts veterinary practice.

Bauer Kaninchen was one of the first rabbit meat producers in Germany to offer animals from group housing. There was a first-mover advantage in transitioning to group housing offering the possibility of entering a new market for high-quality products. The cooperation with the retailer led to a long-term and partnership-based collaboration and improved the conditions for keeping rabbits sustainably without receiving government subsidies. In the newly developed housing system, rabbits have significantly more space and can exercise a wider range of their natural behaviours. The plastic floor, multiple-layers and species-appropriate equipment provide higher comfort than traditional metal barren cages and the joint group housing reduces stress in animals.

Pigs also show distinct patterns of social behaviour and their interactions are regulated by hierarchy. In relation to the piglets' behaviour, caged systems on commercial farms present a very limited opportunity for piglets to learn the natural behaviour of pigs (Oostindjer et al., 2011). Commercial production employs very early weaning so the separation from the mother occurs earlier than in organic production (and weeks earlier than in natural conditions). The effect can be low feed intake, welfare and health problems in the period post-weaning. In a study conducted by Chidgey et al. (2016), observed maternal behaviour, such as nursing vocalisation and physical contact with piglets from sows, was overall more prevalent in alternative systems of pens and low or impossible in farrowing crates. Strong maternal bonds cannot be formed in caged systems (Grimberg-Henrici, 2016). In an alternative system, sows are mostly not confined in a metal crate and the piglets can build a bond with the mother. When no barriers separate the mother sow from the piglets, they can develop social behaviour and bonds (Oostindjer et al., 2011). In organic pig production, the sow-piglet relationship has more time to develop as the weaning period is longer than in conventional production (40 days in organic production) (Simantke et al., 2015).

As noted above, greater access to the vegetation and soil in outdoor systems helps to provide **vitamins and minerals** otherwise not found in the diet of intensively farmed animals. Particularly for pregnant sows, forage can provide a large part of these nutrients (Sundrum et al., 2005). Outdoor housing of laying hens allows the birds to forage on pasture, which provides dietary sources of nutrients, protein, and vitamins, and can also reduce the consumption of feed. As well as grass, birds feed on a wide range of macroinvertebrates living in the soil surface (Mugnai et al., 2014).

6. Scenarios towards cage-free farming

Looking ahead to the future of agriculture and related food systems in Europe, the potential adoption of cage-free and higher welfare farming systems can be seen as part of a wider transition to a more sustainable model. Increasingly this transition is understood as involving a reduced environmental footprint both inside and outside Europe, a progression to healthier diets, rewarding jobs, and prosperous rural areas as well as the end of hunger.

In this chapter the place of higher welfare farming systems within a holistic transformation of this kind is explored, using three different scenarios to illustrate some of the central issues and relationships in play on the road to sustainability. The three scenarios all assume the adoption of cage-free livestock farming systems but vary in the extent to which major additional changes are made to farming systems and the extent to which the consumption of the relevant livestock products declines in the EU. It is assumed that some degree of decline in consumption is the direction of travel both because of the aim of reducing the carbon and wider environmental footprint of food production and the need to tackle obesity and other health problems within the EU, as set out in the Farm to Fork Strategy.

The three scenarios are set out in the context of the UN Sustainable Development Goals (the SDGs), a set of 17 targets to which the EU has made a firm commitment, giving them a particular authority and relevance in the decade to 2030, the date by which they should be met. This end date has been chosen for the scenarios as well.

6.1. Transition scenarios to 2030 for cage-free farming in the EU

Scenario 1: Transition but limited structural changes

In this scenario, cages are banned across Europe, being displaced by both indoor and outdoor alternative systems. This could arise from an EU-wide ban on cages or more voluntary approaches. Substantial improvements are made in welfare standards on farms, but there are no assumptions about other significant changes in the structure of livestock production, unlike in the other two scenarios. This is the critical difference.

Meat and egg consumption somewhat decreases (up to 10%) in this scenario, as might be expected in a society more aware of welfare issues. The reduction in pig and egg production might be greater than in the case of rabbits, a sector where demand is already declining. As a large share of the farm animals that we are considering currently is housed in cages, an EU-wide ban would have far-reaching implications:

- In 2019, approximately 365 million laying hens were farmed in the EU-27 of which approximately 49.5% were kept in enriched cages, 33% in barns, 12% in free-range and 6% in organic farms (DG Agriculture and Rural Development, 2020). With cages being banned, space requirements will need to increase and investments made in a large share of the laying hen sector.

- For rabbits, conventional barren and enriched cages are the most prevalent form of housing. A ban covering both conventional and enriched cages would require a large effort from the sector, especially in countries like France, Spain and Italy.

- While most pigs in the EU are kept in group housing, the majority of sows are caged for a part of their life span, namely the reproductive stages of farrowing and lactation. Alternative farrowing systems often abolish crates completely, instead housing sows in much more spacious individual sow pens or in group systems. Another option is temporary crating systems, which are designed for free farrowing but give farmers the option of maintaining confinement for a short time period. When transitioning away from conventional crates, investments need to be made and management practices adjusted for the safety of personnel and efficient time management as well as the health and welfare of animals.

The rise in alternative housing systems will entail costs but in our scenarios is assumed to result in higher farm gate prices to compensate for this. If demand is unchanged it can be expected to create added value in the sector and potentially better livelihoods for farmers. For laying hens, for example, free-range and organic systems have generated the highest overall farm incomes in the past, relative to other systems (Dekker et al., 2011; Asselt et al., 2015). A move away from caged systems will also lead to higher workforce requirements due to an increase in the area in use and frequency of supervision.

Animal welfare implications will be positive but special attention needs to be paid to managing aggressive behaviour (including hens and rabbits) and preventing additional animal mortality (e.g. through the crushing of piglets). In environmental terms, many alternative systems will show a lower efficiency in feed conversion per output unit (for all species), due to the increased freedom and motor activity. However, there are some environmental benefits for example from the greater extent of organic systems.

Scenario 2: Major increase in organic production scenario

In this scenario, cages are banned across Europe and at the same time, the three sectors adopt outdoor systems on a large scale, including a significantly increased level of organic production, so that 25% of all EU farmland becomes organic by 2030. This corresponds to the target proposed in the Farm to Fork Strategy. EU meat and egg consumption decreases more in this scenario, by up to 20%. The decrease occurs partly as a consequence of decreased productivity and higher prices in organic systems. Feed imports are more restricted than currently in this scenario, with a ban on imported feed from deforested areas. This represents a deeper set of changes in livestock production than Scenario 1. Currently, the proportion of livestock being farmed organically is relatively low, ranging from about 5% of the cattle herd and 6% of sheep and goats down to poultry and pigs, which stand at 3% and less than 1% respectively (in 2017, Eurostat). Lifting the share of organic pigs and poultry anywhere near 25% would be a transformational change (and goes beyond the current F2F proposal).

In 2018, the organic area made up 7.5% of the total EU agricultural land (UAA). However, the share of organic land varies between different uses for farmland, being highest for permanent crops (12.35 %), and lower for permanent grassland (9.62%) and arable cropland (5.81%) (own calculation based on Eurostat, 2020). The permanent grassland and arable cropland category, which includes cereal production and green fodder, are the two most relevant for livestock feed production. If 25 per cent of all the area used to grow animal feed (including both arable cropland and permanent grassland) is farmed organically, which would be a very sizable change from the current situation, then significant environmental, socio-economic and animal welfare benefits can be expected. Our assumption is that 25 per cent of the UAA used to produce animal feed, specifically pigs and poultry, will be farmed organically in this scenario. Yields of feed crops in the EU would be lower following organic conversion but with a reduced output of livestock products and hence demand for feed, this may avoid the need to increase the area of land under such crops. If the proportion of poultry, pigs and rabbits produced organically rose very significantly, many environmental benefits would be gained from following the organic rules applying to pigs and laying hens. Amongst other things, they cover the maximum permitted herd/flock size, (lower) stocking densities, a minimum proportion of feed to be derived from the farm or region and the organic production of feed. As a consequence, N and P surpluses are lower in organic compared to conventional systems (Dekker et al., 2011).

In terms of animal welfare, the literature generally finds that organic systems achieve good results, chiefly due to the larger space requirements per animal, permitting higher levels of natural behaviour. This is true for rabbits as well as pigs and poultry. Although there are wide variations in organic housing systems for rabbits, including for example movable cages or individual paddocks (EFSA, 2020), generally good welfare outcomes are reported due to some overarching requirements, such as for access to pasture.

Because of the higher level of organic feed production and the ban on those feed imports causing deforestation, considerable climate, biodiversity and land use benefits can be expected on this scenario. The EU is highly dependent on imported animal feed, particularly soy. In 2019/2020, 97% of soybean feed consumed in the EU was imported from third countries (EU Feed Protein Balance Sheet, 2020). This has contributed to large areas of land overseas being devoted to providing feed for EU livestock. Some of this production is linked to deforestation, biodiversity loss and displacement of local communities in South America. For example, 18 to 22% of all soy exported from Brazil to the EU has been estimated to be linked to illegal deforestation (Rajão et al., 2020). Soy feed imported by the EU is heavily utilised by the large and intensive producers in the pig and poultry sectors, which are the main consumers of compound feed in the EU.

Scenario 3: EU livestock production limited by sustainability commitments

In addition to the system and supply chain changes set out in the previous scenario (expansion of organic production and ban on feed imports related to deforestation), this scenario introduces limits on the total sizes of the relevant livestock populations in the EU. Their number would be aligned with the (limited) volume of EU domestic resources available for animal feed (grassland and European production of cereals), under a strong future sustainability scenario that includes the principle of phasing out nearly all EU protein imports. Short and local supply chains receive strong support and EU meat and egg consumption decreases strongly. The literature provides some benchmark values for the scale of decrease that might be required under a low carbon and enhanced sustainability policy regime. For example, Buckwell and Nadeu (2018) indicate a decrease of 21% in direct livestock emissions being needed by 2030 and 74% by 2050. If this were applied across the board equally to all types of farm animal in the EU there would be a major reduction in pig and poultry numbers (making the simplifying assumption that emissions are in large part correlated with livestock numbers).

Of the total agricultural land in the EU, 61.41 million hectares of permanent grassland and the majority of the 105.02 million hectares of arable land are dedicated to fodder production (Eurostat, 2018). The amount of processed feed consumed per animal species differs across the EU and is mostly consumed by the pig and poultry sectors (FEFAC, 2018). To reduce this footprint and free land for other purposes, a large reduction in livestock numbers could be envisaged. There also are arguments for favouring types of farm animals that can thrive on a large proportion of residues and fodder rather than concentrate feed if it can be assured that the feed is safe and also can provide the nutrients that animals require.

Several research modelling exercises have tried to establish sustainable livestock populations based on the use of solely EU domestic resources of animal feed (generally assuming grassland and European production of cereals). This would allow for the near phasing-out of protein imports. For example, the TYFA scenario (Poux & Aubert, 2018), attempts to model protein self-sufficiency, halting EU imports of protein crops, whilst also phasing out pesticides and synthetic nitrogen in the EU by 2050. One of the main conclusions of the exercise is the need for all livestock production, including pig and poultry to be reduced by approximately 40%[17] between 2010 and 2050. It also assumes a more plant-based diet and finds that only 92% of the UAA (including 52 million ha of natural grasslands and 10 million ha of farmland under agroecological management) would be required to meet the needs of European consumers (idem). A shift towards more grass-fed ruminant production reduces the use of protein crops (imported and locally grown).

According to the European Commission, 10.3% of EU GHG emissions originate from agricultural activities, of which close to 70% can be directly linked to livestock production (especially manure management and enteric fermentation) (European Commission, 2020). Additionally, a large share of agricultural soil emissions is associated with feed production. According to Buckwell and Nadeu (2018), an upper boundary for climate protection requires respectively 21%, 47% and 74% reductions in the amount of direct livestock emissions by the dates of 2030, 2040 and 2050. In order to stay within the upper boundary for nutrient flows, regions with the highest N inputs and surpluses, which have been found to be those with the highest livestock density, such as Brittany (France), the Po valley (Italy), large parts of Denmark, Belgium, Germany and the Netherlands, need to see a reduction in livestock headage and densities. The report further suggests that the range in necessary nitrogen fixation[18] reductions, which are largely related to livestock but also crop production, for the individual Member States ranges from 35% for the Netherlands to 90% for Ireland (Buckwell and Nadeu, 2018).

A pivot to a smaller and more locally focussed pig and poultry sector might precipitate structural changes as well as fewer livestock numbers in many regions, with more small-scale farms. This could challenge the current pattern of egg production, for example, which is increasingly concentrated, with large companies sometimes keeping more than a million laying hens in cage systems on a single site.

6.2. Wider impacts of the transition and SDG considerations

There are several different pathways to establishing cage-free and higher welfare systems for farm animals in Europe, beyond the simple banning of certain practices, such

[17] In terms of tonnage and calories
[18] calculated as the sum of fertiliser consumption and biological fixation

as farrowing crates. Some of these potentially involve extensive further changes to livestock production, including changes in scale, feed use, approach to land management and adoption of new certified systems (notably organic methods) and modified diets relative to the status quo in Europe. Production is currently dominated by large intensive units, particularly for poultry and pigs in most regions but it is possible to consider futures where this is no longer the case. The three scenarios, outlined above, spell out different routes and scales of change. They are used here to illustrate the relationship between changes in production methods and the attainment of the much broader set of SDGs, to which the EU is strongly committed.

From the outset it is worth stressing that the case for improving farm animal welfare and for moving to cage-free systems as part of this, does not depend on its contribution to sustainable development, however this is measured: it is entirely justifiable in its own right.

The SDGs do not cover animal welfare as an explicit topic and so they do not include any targets for improving welfare. However, many of the targets in the fields of ending hunger, managing resources and the environment, improving human health, economic wellbeing etc. do seek goals relevant to improved animal welfare.

In a recent study which involved a small group of independent academics, 66 of the total 169 SDG targets were considered relevant to animal welfare (Keeling et al., 2019). One of the conclusions of the expert group was that "there is no conflict between achieving an SDG and improving animal welfare; rather creating the one actually helps achieving the other" (idem). For a number of the SDGs, the academic experts judged that there is a two-way relationship between the accomplishment of the SDG and the improvement of animal welfare. There was considered to be a "high mutual enabling of the SDG on animal welfare and of improved animal welfare enabling the SDG" with respect to seven SDGs:

- 1. No Poverty
- 2. Zero hunger
- 3. Good health, wellbeing
- 8. Decent work and economic growth
- 12. Responsible consumption and production
- 14. Life below water
- 15. Life on land.

All these SDGs have relevance to the welfare of farmed animals and fish. In addition, aspects of SDG 6 (clean water and sanitation) and SDG 13 (Climate change) also are relevant to the concerns of this report. It is evident that there is a wide potential interface between improved farm animal welfare and the SDGs even without any single SDG addressing the topic directly.

6.3. SDGs and progress towards higher farm animal welfare

Many of the connections between improved farm animal welfare and the SDGs arise from the environmental, social and health benefits of making changes to farming systems as a whole in the direction of greater sustainability. The more the transition to cage-free systems is embedded in a wider transition to farming systems and food chains that are sustainable on a global scale, the stronger the connection to SDGs. In testing this relationship, some of the scenarios considered here do envisage relatively ambitious steps to greater farm and food chain sustainability and significant departures from the status quo in the EU. This seems appropriate given the challenge set out in the SDGs and the message in the Farm to Fork Strategy that major changes are needed on both the production and consumption sides in Europe.

Some changes in farm practice that are necessary to improve animal welfare could be introduced without major changes to current production structures and so would make relatively little difference to the social or environmental footprint of the farms concerned or to the cost of production, especially if any investment was sufficiently modest or phased over time. Consumption levels would not necessarily change, even if there were a modest price increase, especially if consumers were aware that they were buying a more ethical product. In this respect, a set of welfare improvements would be both desirable in their own right, irrespective of wider policy objectives and entirely compatible with progress under many SDGs, particularly 2, 3 and 12. Political and cultural perspectives on these topics vary within Europe but such a step could be understood (in most parts of Europe at least) as part of an overall transition to more sustainable agriculture and potentially improved dietary health.

The question of SDGs becomes much more significant once larger changes in farm practices and structures are considered, with a more significant impact on footprints, costs, employment and consumption. The most important positive synergies between the SDGs and improved and cage-free welfare for pigs, poultry and rabbits seem to be:

Regarding **Good Health and Well-being (SDG 3)**, there is the potential to reduce the risks to humans that arise from livestock production, particularly where healthier animals kept in less confined conditions at a lower density and with less genetic uniformity have increased immune-competence and greater resistance to zoonotic diseases. The risks of transfer to humans has been highlighted by Covid-19 and needs to be reduced. Furthermore, there is increased recognition of the importance of protecting humanity from the risks of increased antibiotic resistance and therefore the need to reduce the use of antimicrobials in the treatment of farm animals. This is underlined in the recent EU Farm to Fork Strategy, which was accompanied by the announcement of a "Fitness Check" review of all EU legislation relating to animal welfare. Welfare advances that result in fewer, animals of more robust breeds, in less confined conditions, would help to bring down the use of antimicrobials significantly.

This is linked closely to **Responsible Production and Consumption (SDG 12)**, with improved welfare and lower densities allowing a reduced use of antimicrobials, now understood as an integral part of responsible production. A higher proportion of organic farming in Europe, accompanied by a rising share of organic livestock products (rather than those from more intensive systems) in the diet, would represent a further step towards responsible production and consumption, as confirmed in the Farm to Fork Strategy. Higher welfare standards are a substantial element of the rules that need to be followed by all organic producers. Scenarios in which improved welfare practices are accompanied by a significant shift towards less intensive and more organic production therefore offer a substantive contribution to meeting the goals of SDG 12.

Beyond this, there is the potential to reduce the consumption of imported proteins and of cereal crops for pigs and poultry by keeping them in more extensive systems in which their diet is more varied (e.g. including food waste), particularly where there is an overall drop in the scale of production. The scale of change is important here. Lower density outdoor systems generally are associated with a lower feed conversion efficiency and only with accompanying falls in animal numbers and excellent animal husbandry can the potential for reduced consumption of concentrated feed be realised. Reduced consumption of these feeds has multiple benefits in terms of increased resource efficiency, less competition for land between animal and human food and reduced pressure on ecosystems threatened by conversion to commercial soya production for example in parts of South America.

Finally, an absolute fall in consumption of livestock products, which could arise from increased awareness of welfare issues and perhaps from the higher cost of organic and other higher welfare foods, would also contribute to sustainable consumption, not least with respect to reducing the carbon and biodiversity footprint of the European diet.

Case study 6: The City of Vienna

The City of Vienna in Austria procures 100,000 meals daily in public institutions such as schools, kindergartens, hospitals, and care homes. Other products, such as cleaning and office materials, also are purchased in large quantities by the city. All of these purchases fall under an ambitious public procurement scheme, which has been in place for over 20 years.

In January 2020, the city's procurement standards were reviewed and improved with the help of a stakeholder process, working on synergies covering both animal welfare and environmental solutions. A plan was established as part of a roundtable with representatives from all areas of the supply chain, who shared motivations and experiences. The regional parliament of Vienna took a unanimous decision to implement the resulting Food Action Plan („Wien isst G.U.T"), summarising the current initiatives and further building on them with a comprehensive strategy.

The well-established eco-purchase (ÖkoKauf) programme already had set a 30% organic quota for food and cleaning products in 1998. The newly established plan extends the public procurement standards and aims holistically at healthy, environmentally sustainable food with high animal welfare standards. As part of the strategy, minimum criteria apply to suppliers covering farming, transport and slaughter. One key aspect, for example, is the exclusive use of organic and free-range eggs in processed products. The co-development of the new action plan with stakeholders was an important step in order to understand the motivation and framework conditions of the other actors – and to find joint solutions.

The links to **SDG2 Zero Hunger** are mainly in the developing world but relevant to Europe too. A more sustainable pattern of pig and poultry production with reduced risks of zoonoses and less reliance on large-scale use of land to produce feed crops for affluent countries would increase the long-term security of food supplies on a global basis and potentially help to make more resources available to combat hunger. More localised and short-supply-chain oriented systems would be more transferable to developing countries which could benefit directly from research and innovation in this area, carried out in the EU. A reduction in the consumption of pig and poultry meat in the EU also would diminish the land area required to feed European people, freeing resources for other uses, including alternative food for human consumption. However, to reduce hunger globally, the world needs to tackle the issues of poverty and equitable and secure access to food, rather than maintaining production levels in Europe.

The need for **Clean Water and Sanitation, SDG 6,** is also greatest in the developing world. In Europe, livestock farming is a major source of water pollution in rural areas and the disposal of slurry from pig and poultry farms is a major challenge when it is produced in large quantities in concentrated areas. All livestock farms potentially create a pollution load and the challenges in alternative housing systems are not to be underestimated: the load and options for managing it depend on the specific methods and conditions, as noted above. However, some systems offer advantages and if production is on a smaller scale and more dispersed in the countryside, some of the management problems linked to concentration are reduced. Scaling back production would also reduce the overall volume of wastes and the potential pollution load (as suggested in the literature (e.g. Buckwell and Nadeu, 2018).

For **SDG 13, covering Climate Action,** many of the considerations are the same. Livestock farming, including pigs and poultry, is a significant source of GHG emissions in the EU and the carbon footprint of this sector stretches well beyond the farm itself to include the upstream supplies of feed, energy and other materials. This footprint can be reduced by increasing the efficiency of feed conversion in farmed animals (whilst safeguarding animal welfare and health) - and other steps to increase energy efficiency in the supply chain. More humane forms of pig and poultry production often will increase the quantity of feed needed to produce one kilo of meat or eggs and often will increase emissions for this reason. However, it is also possible to change the diets of animals in ways that reduce the use of imported proteins and other imported feeds (e.g. through the use of food waste). More local feed supplies often will have a smaller carbon footprint. Following a change in the system, there may be a net reduction in the energy required on the farm itself e.g. for heating, cooling and running machinery, so the net impact on total emissions will depend on a variety of different factors. More use of farm-level assessments will help to clarify the picture. As with water pollution, it can be forecasted that emissions will be lower with a reduction in consumption of pig and poultry meat, as long as the consumption of other, higher carbon foods does not increase. Less production in Europe only contributes to emission reductions if it is not replaced by a growth in output elsewhere. This underlines the importance of consumption patterns from the perspective of climate mitigation and the necessity to address absolute rather than relevant (per unit) emissions.

For **SDG 15, Life on Land**, supply chain issues also are important. The impoverishment of biodiversity in Europe needs to be reversed, as emphasised in the recently published EU Biodiversity Strategy. Some of the pressures on biodiversity associated with highly intensive indoor pig and poultry systems include ammonia emissions and their subsequent deposition on surrounding habitats, the additional nutrient load created by the large quantities of slurry and other material needing to be managed and the impact of feed production from beyond the farm. As referenced in Scenario 2, a proportion of this feed comes from areas of considerable environmental sensitivity, including from South American farms where illegal deforestation has taken place. The impacts of outdoor systems on biodiversity will vary but there are examples of good management, some of them in traditional systems, like the dehesas in southern Spain. Some specific measures, such as ceasing to import feed associated with deforestation, could make a significant contribution to reducing the impact of meat production on biodiversity and an overall cut in consumption also would cut pressures in a more general sense.

The goal of **Decent Work and Economic Growth, SDG 8,** also has several different facets. A successful transition to cage-free systems will depend on farms being able to recover the costs that are usually incurred in alternative systems and to generate sufficient incomes and profit to be viable and able to invest over time. In most cases, this seems likely to involve higher price levels at the farm-gate and probably at the retail level, although it may be possible to secure a greater proportion of the final price for farmers, for example via more direct marketing. This points to more value-added on farms (but perhaps less in upstream industries) and potentially more employment, especially as additional management is required in many alternative systems.

Higher prices may also contribute to some scaling back in demand, a trend that is expected for other reasons as well, as noted in the scenarios. The net impacts of a series of related adjustments in both production and consumption on employment and the level of economic activity are difficult to forecast. This exercise becomes more difficult still if the economic impacts on consumers and potential gains from healthier diets are taken into account as well. However, it is not unreasonable to expect some gain in employment at the farm level or to anticipate a greater level of job satisfaction on farms taking a pride in an enhanced level of welfare.

Standing back and considering **the three scenarios** in the light of what they might offer in helping (or hindering) **the EU in meeting the SDGs** it appears that the second and third scenarios, incorporating more radical sets of change, are likely to have the greater impacts on SDGs as well. This is not surprising given that the scale of departure from the status quo is so much greater.

It is also clear from the analysis in the previous chapter that the relationship between a less intensive and cage-free pig and poultry sector and a range of environmental scenarios is rather complex. There are several respects in which cage-free systems have a lower environmental footprint and there are clear environmental benefits from changes in feed sources and supply chains. At the same time, there are environmental costs in the form of lower feed conversion efficiency and consequently increased feed consumption and GHG emissions, that would need to be compensated by reduced production and consumption of the relevant products. Those developments that make a significant contribution to the environmental SDGs include organic conversion, reductions in the level of concentrated feed consumption, measures to eliminate the most damaging forms of feed (e.g. with direct links to deforestation) and outright reductions in consumption. These are taken much further in the more radical scenarios.

There appear to be opportunities to increase farm employment and make it more satisfying with the switch to cage-free systems, although this would require sufficient demand and willingness to pay potentially higher prices. It is interesting to ask whether employment in the EU economy as a whole would increase once the various economic adjustments had fed through but difficult to assemble the evidence to answer multi-faceted socio-economic questions of this kind. However, in those more radical scenarios that incorporate significant reductions in pig and poultry numbers, reduced feed imports and lower consumption it seems more likely that employment in the sector within Europe would fall, although there would be new opportunities in the production of other foods. As in other sectors, there are trade-offs between the pursuits of different goals.

7. Bringing together policy recommendations for advancing cage-free farming

As part of this review, we conducted a series of interviews with stakeholders involved in the three sectors of farming covered here and other links in the food supply chain, including processors and retailers. As well as compiling evidence for the report and the case studies we asked them to put forward their ideas for promoting a cage-free future for the three sectors covered in the review. They were encouraged to suggest proposals for policy change at EU level as part of this exercise so that different proposals could be brought together in one place, synthesised and presented as a complete set.

The recommendations below are drawn from these interview results as well as from other sources within the literature (e.g. BMEL, 2015; European Court of Auditors, 2018) and from within IEEP as well. This set of recommendations compiles a repertoire of policy options and steps to be taken by the industry. They are intended to highlight both the scope of possible initiatives to bring about a transition to cage-free systems and the depth of ideas in the sector, including topics not covered in his review. A comprehensive assessment of these options is outside the scope of this report. Not all recommendations here necessarily reflect the view of IEEP.

7.1. Supporting the cage-free transition through legal standards & guidelines

Progress in Europe towards higher standards typically is achieved by building a strong case for EU level action covering all Member States and then negotiating a legal text that lays down binding requirements. Generally, this takes the form of a minimum set of standards required throughout the EU, allowing more ambitious Member States to go further if they wish. It has been the means of advancing several aspects of animal welfare in the past and remains the mechanism favoured by most supporters of higher standards and by experts in the literature. There is a widely supported view that new binding legislation laying down stricter standards for farm animal welfare, including specific requirements for rabbit housing, is a fundamental requirement if the EU is to move towards achieving greater animal welfare outcomes in all EU Member States. The Farm to Fork Strategy proposes a review and improvement to current legislation and this commitment must be acted upon.

However, the enforcement of standards within the EU often falls below the necessary level, especially in the initial years of implementation, so both supplementary efforts and special attention to ensuring compliance are required. The following specific recommendations are supported by many in the stakeholder community:

- The EU should create a **level playing field for farm animal welfare legislation** in the single market, covering all relevant species (including the development of specific legislation at the EU level for the welfare of farmed rabbits).

- The EU and Member States should ensure more robust **implementation and enforcement** of existing EU farm animal welfare legislation. The 2018 Court of Auditors special report on "Animal Welfare in the EU" concludes that "EU actions to improve animal welfare were successful in some areas, but there are still some weaknesses in compliance with minimum standards". This could include the establishment of a specialised European Observatory for example.

- The EU, together with Member States and regions, should define minimum **green and public procurement** criteria for sustainable food procurement to promote healthy and sustainable diets, including organic products. As part of the F2F Strategy, the European Commission is yet to determine the best way of setting minimum mandatory criteria for sustainable food procurement. As part of a science-based definition of health and sustainable diets, a reduction of animal-based products can be expected – which may facilitate a move towards cage-free systems.

7.2. Supporting the cage-free transition through producer, processor & retailer commitments

Retailers, brands and processors (especially larger ones) committing to cage-free products need to play an important role in both educating consumers and creating a market with fair prices if a transition is to succeed. They can give security to producers and smaller processors through different means including purchase guarantees, fixed prices, or support with marketing strategies. In addition to this:

- **Voluntary industry commitments** for cage-free products are prevalent in the laying hen sector and should be learned from and **extended to the pig and rabbit meat value chain**.

- There should be increased support for the welfare transition from **public catering bodies** through their procurement procedures.

- Beyond this, retailers should be embarking on the necessary action to support cage-free products and changes in purchasing habits to achieve healthier diets, including reduced consumption of animal products, using appropriate labelling, marketing and pricing tools.

7.3. Supporting the cage-free transition through financial incentives

An exclusive focus on raising minimum standards by law is not sufficient to bring about wholly sustainable production and consumption patterns across the EU. It places the financial burden disproportionately on producers, at least in the first instance, although over time most additional costs are likely to be passed on down the food chain and to fall on consumers. Legal requirements, such as requiring group housing with sows, tend to necessitate larger investments on farms and may lead in some cases to smallholders going out of business. Producers need to get sufficiently high prices in the market to remain viable and they may need support from the public sector as well to assist with transition costs, the more so if the timetable is ambitious.

Public sector support (e.g. from the CAP) already is used to reward concrete societal benefits arising from agricultural "services", especially where these involve meeting standards going beyond the legal minimum e.g. adopting cage-free systems earlier than required by law or to a higher standard. The following specific recommendations are made in this regard:

- **Financial support for a transition to higher standards entailing higher costs for producers** is likely to be needed at least on some farms for a time-limited period to provide a secure financial basis to allow them to embark on a major change in production methods. This should be made available where justified to supplement rather than replace the role of retailers and the private sector. Suitable funding schemes would need to be updated and where necessary supplemented by national and regional authorities, with the support from the CAP (primarily rural development programmes). Some farms with high standards would qualify for longer-term support from a public goods-focussed CAP.

- Within the CAP framework, the Member States could make more use of the support mechanisms for improving farm animal welfare in **rural development policy** (such as aid for housing methods with lower stocking densities, allowing animals more space and outdoor access).

- Criteria addressing **animal welfare and health should be integrated into the EU Finance Taxonomy** at the earliest possible date, expanding the scope of the environmental goals of the taxonomy

7.4. Supporting the cage-free transition through trade measures

While the share of imported products in the three sectors is small, the production methods used in countries outside the EU raise concerns since their producers may gain a competitive advantage from lower standards which are prevalent in many exporting countries. The severity of this competition for domestic producers will grow with higher EU standards. The recommendation is:

- The EU should ensure that imports of farm animal products into the Union have to meet the same standards of farm animal welfare as apply to producers within the EU. Within the **WTO the EU should seek to clarify the rules relating to the treatment of production methods, including farm animal welfare-related aspects, confirming that defence of domestic producers is legitimate** under clearly and strictly defined rules. An alliance with the UK may be possible here. Similarly, the F2F Strategy calls for EU trade policy "to contribute to enhance cooperation with and to obtain ambitious commitments from third countries" in the animal welfare area, among other areas.

7.5. Supporting the cage-free transition through labels and other consumer choice initiatives

Currently, there is a divide between the reality of most commercial agricultural animal husbandry and changing social expectations. Except for retailers and a few brand manufacturers, suppliers and their different production methods in the livestock value chain are largely unknown to consumers. The recommendations to address this are:

- The Farm to Fork Strategy has the ambition of "ensuring that food price campaigns do not undermine citizens' perception of the value of food". The price of animal products should reflect the true costs of production. Therefore, policy in this area should follow the principle that the externalities of intensive animal farming (including animal welfare) should be included in the price at the point of sale.

- The EU should introduce and subsequently enforce a **mandatory "method of production" labelling system for meat from pigs, poultry and rabbits**, which shows clearly and objectively the rearing method used. This has been a legal requirement for shell eggs and is a meaningful mechanism by which the EU and Member States are able to increase consumer understanding of animal farming production processes and impacts.

- Value chain stakeholders may find commercial advantages by jointly developing **private labels** (e.g. producers together with retailers) that are nimble and sufficiently sensitive to varying regional conditions within Europe to promote the establishment of new markets and provide more detailed information on animal welfare to consumers.

- Member States should promote greater **transparency in the whole supply chain, including the deployment of appropriate labels for processed food** and for products by **the foodservice and hospitality industry**.

- The EU and Member States should **work together to develop appropriate and measurable indicators** beyond those covering farm production and management systems (e.g. space availability for animals or breeding characteristics) to capture farm **animal welfare parameters in a meaningful way** e.g. with respect to animal health and animal behaviour (e.g. proportion of lame animals on a farm)

7.6. Research, knowledge transfer & advice: priorities for realising the transition

Research and innovation (R&I) has the potential to foster technical and institutional innovations, including those that create synergies or reduce trade-offs, which are plentiful in the livestock sector. EU-funded agricultural research should increase the priority given to animal welfare objectives, as it currently has a strong focus on the productivity-environment nexus. Alongside this, the training of those working in farm animal husbandry is a key aspect of achieving better animal welfare (while also achieving competitiveness and environmental objectives). Scientific evidence shows significant animal welfare discrepancies between similar housing types, based on management measures. Currently, the level of education, availability and quality of advice and training is heterogeneous across sectors and Member States (DG Health and Food Safety, 2016). The recommendations are:

- The EU and Member States should increase levels of support for EU-funded research designed to increase **understanding of the trade-offs and benefits** of cage-free farming in relation to environment and climate objectives and productivity levels.
- The EU should invest in more R&I on **appropriate housing and floor systems**. Understanding of this is particularly lacking for rabbits.
- National or regional authorities should put in place mandatory regular **training on key management measures** (such as air ventilation and hygiene measures).
- The EU should launch a new **EU-wide assessment of animal welfare on farms** based on scientifically validated, result-based evidence, with appropriate indicators. This could be conducted as part of the review of welfare legislation announced in the Farm to Fork Strategy.

Drawing on CAP support where appropriate, Member States should support stronger **advisory services** that link farm animal welfare aspects more centrally to other management and business objectives on farms. Tailored advice designed to improve the husbandry of all farmed animal species needs to be available (there is currently a gap for rabbits). Specific training and advice (from government bodies or other independent bodies) should be required for farmers wanting to enter the market.

8. References

Adell, E., Calvet, S., Torres, A. G., & Cambra-López, M. (2012). Particulate matter concentrations and emissions in rabbit farms. *World Rabbit Science*, *20*(1), 1-12.

Akaichi, F., & Revoredo-Giha, C. (2016). Consumers demand for products with animal welfare attributes. *British Food Journal*.

Alleweldt et al. (2009). Feasibility study on animal welfare labelling and establishing a Community Reference Centre for Animal Protection and Welfare.

Anthony, T. R., Altmaier, R., Park, J. H., & Peters, T. M. (2014). Modeled effectiveness of ventilation with contaminant control devices on indoor air quality in a swine farrowing facility. *Journal of occupational and environmental hygiene*, *11*(7), 434-449.

Augère-Granier (2019). The EU Poultry Meat and Egg Sector: Main Features, Challenges and Prospects. Retrieved from: https://epthinktank.eu/2019/12/17/the-eu-poultry-meat-and-egg-sector-main-features-challenges-and-prospects-policy-podcast/

Baxter, E. M., et al. (2011). Alternative farrowing systems: design criteria for farrowing systems based on the biological needs of sows and piglets. Animal 5(4): 580-600.

Baxter, E. M., Lawrence, A. B., & Edwards, S. A. (2012). Alternative farrowing accommodation: welfare and economic aspects of existing farrowing and lactation systems for pigs. *Animal*, *6*(1), 96.

Berton, V., & Mudd, D. (2009). Profitable Poultry: Raising Birds on Pasture. *Sustainable Agricultural Network*.

Bhanja, S. K., & Bhadauria, P. (2018). Behaviour and welfare concepts in laying hens and their association with housing systems.

Blatchford, R. A., Fulton, R. M., & Mench, J. A. (2016). The utilization of the Welfare Quality® assessment for determining laying hen condition across three housing systems. *Poultry Science*, *95*(1), 154-163.

BMEL (2015). Wege zu einer gesellschaftlich akzeptierten Nutztierhaltung. Gutachten. Berlin.

BMEL (2019). Kennzahlen des deutschen Eiermarktes. Retrieved from: https://www.bmel-statistik.de/fileadmin/daten/DFB-0100200-2019.pdf

Bracke, M. B., & Hopster, H. (2006). Assessing the importance of natural behavior for animal welfare. *Journal of Agricultural and Environmental Ethics*, *19*(1), 77-89.

Buckwell, A., & Nadeu, E. (2018). What is the Safe Operating Space for EU livestock. *RISE Foundation, Brussels*.

Bussemas, R., Kocerka, C., & Weißmann, F. (2011). Einzel-versus Gruppensäugen in der ökologischen Sauenhaltung: Betrachtung von Verhalten und Leistung. *ART-Tagungsband 24. IGN-Tagung*, 28-32.

Cabaraux, J. F., Philippe, F. X., Laitat, M., Canart, B., Vandenheede, M., & Nicks, B. (2009). Gaseous emissions from weaned pigs raised on different floor systems. *Agriculture, Ecosystems & Environment*, *130*(3-4), 86-92.

Calvet, S., Cambra-López, M., Adell, E., Torres, A. G., & Estellés, F. (2012, September). Rabbit rearing and air quality: state-of-the-art and key unknowns. In *Proc. 10th World Rabbit Congress* (pp. 787-791).

Caspari et al. (2010). The Poultry and Egg Sectors: Evaluation of the current market situation and future prospects. Retrieved from: https://www.europarl.europa.eu/RegData/etudes/etudes/join/2010/438590/IPOL-AGRI_ET(2010)438590_EN.pdf

Castellini, C., Perella, F., Mugnai, C., & Dal Bosco, A. (2006). Welfare, productivity and qualitative traits of egg in laying hens reared under different rearing systems.

Cesari, V., Zucali, M., Bava, L., Gislon, G., Tamburini, A., & Toschi, I. (2018). Environmental impact of rabbit meat: The effect of production efficiency. *Meat Science*, *145*, 447-454.

Cheng, H. (2006). Morphopathological changes and pain in beak trimmed laying hens. *World's Poultry Science Journal*, *62*(1), 41-52.

Chidgey, K. L. (2016). *The productivity and behaviour of sows and piglets housed in farrowing pens with temporary crating or farrowing crates: a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Animal Science, Massey University* (Doctoral dissertation, Massey University).

Chodova, D., Tůmová, E., Martinec, M., Bízková, Z., Skřivanová, V., Volek, Z., & Zita, L. (2014). Effect of housing system and genotype on rabbit meat quality. *Czech Journal of Animal Science*, *59*(4), 190-199.

Civil dialogue group animal products (2019). Retrieved from: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/cdg-animal-products-2019-07-16-minutes_en.pdf

Compassion in World Farming (2018). End the cage age. Retrieved 15.01.20, from https://www.ciwf.org.uk/media/7434596/end-the-cage-age-why-the-eu-must-stop-caging-farm-animals.pdf.

Cornou, C., Lundbye-Christensen, S., & Kristensen, A. R. (2011). Modelling and monitoring sows' activity types in farrowing house using acceleration data. *Computers and electronics in agriculture*, *76*(2), 316-324.

David, B., Mejdell, C., Michel, V., Lund, V., & Moe, R. O. (2015). Air quality in alternative housing systems may have an impact on laying hen welfare. Part II—Ammonia. *Animals*, *5*(3), 886-896.

Dekker, S. E. M., De Boer, I. J., Vermeij, I., Aarnink, A. J., & Koerkamp, P. G. (2011). Ecological and economic evaluation of Dutch egg production systems. *Livestock Science*, *139*(1-2), 109-121.

Dourmad, J. Y., Ryschawy, J., Trousson, T., Bonneau, M., Gonzàlez, J., Houwers, H. W. J., ... & Morgensen, L. (2014). Evaluating environmental impacts of contrasting pig farming systems with life cycle assessment. *Animal: an international journal of animal bioscience*, *8*(12), 2027-2037.

Dorning, J., & Harris, S. (2017). Farmed rabbits in commercial production systems.

DG Agriculture and Rural Development (2018). EU Agricultural Outlook for markets and income 2018 - 2030. Retrieved from: https://ec.europa.eu/info/news/eu-agricultural-outlook-2018-2030-changing-consumer-choices-shaping-agricultural-markets-2018-dec-06_en

DG Agriculture and Rural Development, European Commission (2019). EU Agricultural Outlook for markets and income 2019 - 2030. Retrieved from: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2019-report_en.pdf

DG Agriculture and Rural Development, European Commission (2020). EU Market Situation for Eggs. Retrieved from: https://ec.europa.eu/info/food-farming-fisheries/animals-and-animal-products/animal-products/eggs_en

DG Health and Food Safety, European Commission (2016). Overview Report. Educating Professionals on Animal Welfare. Retrieved from: https://ec.europa.eu/

DG Health and Food Safety, European Commission (2016). Final Report of a study visit carried out in Switzerland.

DG Health and Food Safety, European Commission (2017). Overview report Commercial Rabbit Farming in the European Union. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/5029d977-387c-11e8-b5fe-01aa75ed71a1/language-en%0D%0D

EFSA Panel on Animal Health and Welfare (AHAW), (2005). The Impact of the current housing and husbandry systems on the health and welfare of farmed domestic rabbits.

EFSA Panel on Animal Health and Welfare (AHAW), Saxmose Nielsen, S., Alvarez, J., Bicout, D. J., Calistri, P., Depner, K., ... & Michel, V. (2020). Health and welfare of rabbits farmed in different production systems. *EFSA Journal*, *18*(1), e05944

EU Feed Protein Balance Sheet (2020). Retrieved from: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/eu-feed-protein-balance-sheet-2019-20_en.pdf

European Commission (2016). Special Eurobarometer 442 Report: Attitudes of Europeans towards Animal Welfare.

European Commission (2019). Organic farming in the EU - A fast growing sector. EU Agricultural Markets Briefs are available on Europa. Retrieved 15.01.20, from https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/market-brief-organic-farming-in-the-eu_mar2019_en.pdf.

European Commission (2020). Farm to Fork Strategy. Retrieved from: https://ec.europa.eu/food/farm2fork_en

European Commission (2020). Pigmeat CMO Committee 23 July 2020. Retrieved from: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/pig-market-situation_en.pdf

European Court of Auditors (2018), Special report: Animal welfare in the EU: closing the gap between ambitious goals and practical implementation. Retrieved from https://www.eca.europa.eu/Lists/ECADocuments/SR18_31/SR_ANIMAL_WELFARE_EN.pdf

European Parliament (2017), Briefing 09. 03. 2017. Retrieved from: https://www.europarl.europa.eu/news/en/agenda/briefing/2017-03-13/12/rabbits-meps-to-call-for-phasing-out-of-battery-cages

FAO (2018). Environmental performance of the pig supply chains. Retrieved from: http://www.fao.org/3/I8686EN/i8686en.pdf

FEFAC (2018). Annual Report 2018-2019. Retrieved from: https://fefac.eu/wp-content/uploads/2020/07/fefac_annual-report_2018-2019_rz.pdf

FiBL and BioSuisse (2019). Freilandhaltung von Schweinen. Merkblatt Ausgabe Schweiz(Nr. 2503).

Fortun-Lamothe, L., Combes, S., & Gidenne, T. (2009). Contribution of intensive rabbit breeding to sustainable development. A semi-quantitative analysis of the production in France. *World Rabbit Science*, *17*(2), 79-85.

Früh, B., Bochicchio, D., Edwards, S., Hegelund, L., Leeb, C., Sundrum, A., ... & Prunier, A. (2013). Description of organic pig production in Europe. *Organic Agriculture*, *4*(2), 83-92.

FVE (2017). Laguens, R., van Dobbenburgh, R., Pinter, Z., Robinson, A., & Skjoldager, A. FVE comments on farmed rabbits. Retrieved from: https://www.fve.org/cms/wp-content/uploads/rabbit_comments_fve_final.pdf

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., ... & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. *science*, *327*(5967), 812-818.

Greene, J. L., & Cowan, T. (2014). *Table Egg Production and Hen Welfare: Agreement and Legislative Proposals*. Congressional Research Service.

Grimberg-Henrici, C. G., Büttner, K., Meyer, C., & Krieter, J. (2016). Does housing influence maternal behaviour in sows?. Applied Animal Behaviour Science, 180, 26-34.

Guy, J. H., Cain, P. J., Seddon, Y. M., Baxter, E. M., & Edwards, S. A. (2012). Economic evaluation of high welfare indoor farrowing systems for pigs. *Animal Welfare-The UFAW Journal*, *21*(1), 19.

Halberg, N., Hermansen, J. E., Kristensen, I. S., Eriksen, J., Tvedegaard, N., & Petersen, B. M. (2010). Impact of organic pig production systems on CO 2 emission, C sequestration and nitrate pollution. *Agronomy for Sustainable Development*, *30*(4), 721-731.

Hales, J., Moustsen, V. A., Nielsen, M. B. F., & Hansen, C. F. (2016). The effect of temporary confinement of hyperprolific sows in Sow Welfare and Piglet protection pens on sow behaviour and salivary cortisol concentrations. *Applied Animal Behaviour Science*, *183*, 19-27.

Harvey, D., Hubbards, C., Majewski, E., & Malak-Rawlikowska, A. (2013). *Impacts of improved animal welfare standards on competitiveness of EU animal production* (No. 1021-2016-81789, pp. 251-274).

Heerkens, J. L., Delezie, E., Kempen, I., Zoons, J., Ampe, B., Rodenburg, T. B., & Tuyttens, F. A. (2015). Specific characteristics of the aviary housing system affect plumage condition, mortality and production in laying hens. *Poultry Science*, *94*(9), 2008-2017.

Henritzi, D., Petric, P. P., Lewis, N. S., Graaf, A., Pessia, A., Starick, E., ... & Schröder, C. (2020). Surveillance of European Domestic Pig Populations Identifies an Emerging Reservoir of Potentially Zoonotic Swine Influenza A Viruses. *Cell Host & Microbe*.

International Egg Commission (2015). Annual Review. Retrieved from: http://www.internationalegg.com/wp content/uploads/2015/08/AnnualReview_2015.pdf

Jekkel, G., Milisits, G., Nagy, I., & Biró-Németh, E. (2008). Analysis of the behaviour of growing rabbits housed in deep litter at different stages of rearing. In *Proceedings of the 9th World Rabbit Congress, Verona, Italy, 10-13 June 2008* (pp. 1189-1194). World Rabbit Science Association.

Keeling, L. J., Tunón, H., Olmos Antillón, G., Berg, C. L., Jones, M., Stuardo, L., ... & Blokhuis, H. (2019). Animal welfare and the United Nations sustainable development goals. *Frontiers in Veterinary Science*, *6*, 336.

Leeb, C., Rudolph, G., Bochicchio, D., Edwards, S., Früh, B., Holinger, M., ... & Rousing, T. (2019). Effects of three husbandry systems on health, welfare and productivity of organic pigs. *animal*.

Leenstra, F., Maurer, V., Galea, F., Bestman, M., Amsler-Kepalaite, Z., Visscher, J., ... & van Krimpen, M. (2014). Laying hen performance in different production systems; why do they differ and how to close the gap? Results of discussions with groups of farmers in The Netherlands, Switzerland and France, benchmarking and model calculations. *European Poultry Science*, *78*, 1-10.

Leinonen, I., Williams, A. G., Wiseman, J., Guy, J., & Kyriazakis, I. (2012). Predicting the environmental impacts of chicken systems in the United Kingdom through a life cycle assessment: Egg production systems. *Poultry Science*, *91*(1), 26-40.

Magdelaine, P. (2011). Egg and egg product production and consumption in Europe and the rest of the world. In *Improving the safety and quality of eggs and egg products* (pp. 3-16). Woodhead Publishing.

March, S., Brinkmann, J., Schwalm, A., Leeb, C., Dippel, S., Weißmann, F., & Winckler, C. (2015). Erste Ergebnisse einer Untersuchung zu Lahmheiten bei ökologisch gehaltenen Zuchtsauen in Stallhaltung mit Auslauf.

Mugnai, C., Sossidou, E. N., Dal Bosco, A., Ruggeri, S., Mattioli, S., & Castellini, C. (2014). The effects of husbandry system on the grass intake and egg nutritive characteristics of laying hens. *Journal of the Science of Food and Agriculture*, *94*(3), 459-467.

Nicks, B., Laitat, M., Farnir, F., Vandenheede, M., Desiron, A., Verhaeghe, C., & Canart, B. (2004). Gaseous emissions from deep-litter pens with straw or sawdust for fattening pigs. *Animal Science*, *78*(1), 99-107.

Nimmermark, S. A., Jeppsson, K. H., & Ngwabie, N. M. (2012). Nitrous Oxide Emissions from an Experimental Pig House with Straw Bedding. In *2012 IX International Livestock Environment Symposium (ILES IX)* (p. 3). American Society of Agricultural and Biological Engineers.

OECD (2019). Retrieved from: https://data.oecd.org/agroutput/meat-consumption.htm

Oostindjer, M., van den Brand, H., Kemp, B., & Bolhuis, J. E. (2011). Effects of environmental enrichment and loose housing of lactating sows on piglet behaviour before and after weaning. *Applied Animal Behaviour Science*, *134*(1-2), 31-41.

Philippe, F. X., & Nicks, B. (2015). Review on greenhouse gas emissions from pig houses: Production of carbon dioxide, methane and nitrous oxide by animals and manure. *Agriculture, Ecosystems & Environment*, *199*, 10-25.

Pinheiro, V., Mourão, J. L., Monteiro, D., & Silva, S. (2012). Growth performances and behavior of growing rabbits housed on cages, closed parks or open-air system. In *Proc 10th World Rabbit Congress, 3–6 September 2012, Sharm El-Sheikh, Egypt*(pp. 1097-1100).

Poux, X., & Aubert, P. M. (2018). An agroecological Europe in 2050: multifunctional agriculture for healthy eating. *Findings from the Ten Years For Agroecology (TYFA) modelling exercise, Iddri-AScA, Study*, (09/18).

Princz, Z., Dalle Zotte, A., Radnai, I., Bíró-Németh, E., Matics, Z., Gerencsér, Z., ... & Szendrő, Z. (2008). Behaviour of growing rabbits under various housing conditions. *Applied Animal Behaviour Science*, *111*(3-4), 342-356.

Rajão, R., Soares-Filho, B., Nunes, F., Börner, J., Machado, L., Assis, D., ... & Gibbs, H. (2020). The rotten apples of Brazil's agribusiness. *Science*, *369*(6501), 246-248.

Rahmann, G. (2011). Biodiversity and organic farming: what do we know?. *vTI Agriculture and Forestry Research*, *3*, 189-208.

Rakonjac, S., Bogosavljević-Bošković, S., Pavlovski, Z., Škrbić, Z., Dosković, V., Petrović, M. D., & Petričević, V. (2014). Laying hen rearing systems: A review of major production results and egg quality traits. *World's Poultry Science Journal*, *70*(1), 93-104.

Ribikauskas, V., Ribikauskienė, D., & Skurdenienė, I. (2010). Effect of housing system (wire cage versus group-housing) and in-house air quality parameters on the behaviour of fattening rabbits. *World Rabbit Science*, *18*(4), 243-250.

Roffeis, M., Muys, B., Almeida, J., Mathijs, E., Achten, W. M. J., Pastor, B., ... & Rojo, S. (2015). Pig manure treatment with housefly (Musca domestica) rearing–an environmental life cycle assessment. *Journal of Insects as Food and Feed*, *1*(3), 195-214.

Rudolph, G., Hörtenhuber, S., Bochicchio, D., Butler, G., Brandhofer, R., Dippel, S., ... & Prunier, A. (2018). Effect of three husbandry systems on environmental impact of organic pigs. *Sustainability*, *10*(10), 3796.

Rutherford, K. M. D., Baxter, E. M., D'eath, R. B., Turner, S. P., Arnott, G., Roehe, R., ... & Edwards, S. A. (2013). The welfare implications of large litter size in the domestic pig I: biological factors. *Animal Welfare*, *22*(2), 199-218.

Simantke, C., Knierim, U., Aubel, E., & Bussemas, R. (2015). Optimierung des Liegebereichs von abgesetzten Ferkeln.

Sommerville, R., Ruiz, R., & Averós, X. (2016). A meta-analysis on the effects of the housing environment on the behaviour, mortality, and performance of growing rabbits. *Anim. Welfare*, *26*, 223-238.

Stadig, L. M., Ampe, B. A., Van Gansbeke, S., Van den Bogaert, T., D'Haenens, E., Heerkens, J. L. T., & Tuyttens, F. M. (2016). Survey of egg farmers regarding the ban on conventional cages in the EU and their opinion of alternative layer housing systems in Flanders, Belgium. *Poultry Science*, *95*(3), 715-725.

Sundrum, A., & Weissmann, F. (2005). Organic pig production in free range systems. Bundesforschungsanstalt für Landwirtschaft, FAL (Federal Agricultural Research Centre).

Sundrum, A., Aragon, A., Schulze-Langenhorst, C., Bütfering, L., Henning, M., & Stalljohann, G. (2011). Effects of feeding strategies, genotypes, sex, and birth weight on carcass and meat quality traits under organic pig production conditions. *NJAS-Wageningen Journal of Life Sciences*, *58*(3-4), 163-172.

Szendrő, Z. S., McNitt, J. I., Matics, Z. S., Mikó, A., & Gerencsér, Z. S. (2016). Alternative and enriched housing systems for breeding does: a review. *World Rabbit Science*, *24*(1), 1-14.

Szendro, Z. S., Trocino, A., Hoy, S. T., Xiccato, G., Villagrá, A., & Maertens, L. (2019). A review of recent research outcomes on the housing of farmed domestic rabbits: reproducing does. *World Rabbit Science*, *27*(1), 1-14.

Theau-Clément, M. T., Guardia, S., Davoust, C., Galliot, P., Souchet, C., Bignon, L., & Fortun-Lamothe, L. (2016). Performance and sustainability of two alternative rabbit breeding systems. *World Rabbit Science*, *24*(4), 253-265.

Trocino, A., & Xiccato, G. (2006). Animal welfare in reared rabbits: a review with emphasis on housing systems. *World rabbit science*, *14*(2), 77-93.

Unilever (2018). Sustainable Agriculture Code 2017. Retrieved from: https://www.unilever.com/Images/sustainable-agriculture-code--sac---2017_tcm244-515371_en.pdf

Kantar (2020) on UK egg info Industry data. Retreived from: https://www.egginfo.co.uk/egg-facts-and-figures/industry-information/data

Van Asselt, E. D., Van Bussel, L. G. J., Van Horne, P., Van der Voet, H., Van der Heijden, G. W. A. M., & Van der Fels-Klerx, H. J. (2015). Assessing the sustainability of egg production systems in The Netherlands. *Poultry science*, *94*(8), 1742-1750.

Van de Weerd, H. A., Keatinge, R., & Roderick, S. (2009). A review of key health-related welfare issues in organic poultry production. *World's Poultry Science Journal*, *65*(4), 649-684.

Van Gelder, J., Kammeraat, K., & Kroes, H. (2008). Soy consumption for feed and fuel in the European Union.

Van Horne, P. L. M. (2019). Competitiveness the EU egg sector, base year 2017: international comparison of production costs (No. 2019-008). Wageningen Economic Research.

Vosough Ahmadi, B., Baxter, E. M., Stott, A. W., Lawrence, A., & Edwards, S. (2011). *Animal welfare and economic optimisation of farrowing systems* (No. 1336-2016-103947).

Weeks, C. A., & Nicol, C. J. (2006). Behavioural needs, priorities and preferences of laying hens. *World's Poultry Science Journal*, *62*(2), 296-307.

Weeks, C. A., Lambton, S. L., & Williams, A. G. (2016). Implications for welfare, productivity and sustainability of the variation in reported levels of mortality for laying hen flocks kept in different housing systems: a meta-analysis of ten studies. *PLoS One*, *11*(1), e0146394.

Weber, R., Keil, N. M., Fehr, M., & Horat, R. (2007). Piglet mortality on farms using farrowing systems with or without crates. *ANIMAL WELFARE-POTTERS BAR THEN WHEATHAMPSTEAD-*, *16*(2), 277.

Westendorf, M. L. (Ed.). (2000). *Food waste to animal feed*. John Wiley & Sons.

Willgert, K. (2011). The economic and welfare impact of lameness in sows in England. *London, United Kingdom*.

Xiccato, G., Trocino, A., Majolini, D., Tazzoli, M., & Zuffellato, A. (2013). Housing of growing rabbits in individual, bicellular and collective cages: growth performance,

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