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# Easier said than done! Organic farmers consider free-ranging important for laying hen welfare but outdoor areas need more shelter – important gaps between research and practice

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## ABSTRACT

1. The aim of the present study was to investigate the design and management of free-range areas and their use by birds on commercial organic laying hen farms in Sweden and to document farmers' perspectives on outdoor access for poultry.  
2. Eleven Swedish organic laying hen farms were visited. The farmers were interviewed about general farm management, bird health and behaviour and outdoor access. The free-range areas were assessed in terms of proportion covered by protective (high) vegetation and any artificial shelters provided. The numbers of hens ranging at different distances from the house were recorded twice during the day.  
3. The outdoor area within 250m from the house contained 0–5% vegetation cover on six of the farms and at least 80% pasture on seven farms. On 10 farms, no more than 13% of the flock was observed outdoors. Of the hens observed in the free-range area, the median proportion ranging within 20m from the house or veranda per observation event was 99% (IQR=55–100%), confirming reports by the farmers.  
4. Free-range access was considered important by all farmers, primarily for welfare reasons and most agreed that protective vegetation cover and/or artificial shelters were important in encouraging free-ranging. However, there was marked variation among the farmers in their suggestions on how to attract hens outside.

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Animal welfare; poultry; vegetation; artificial shelter; predation

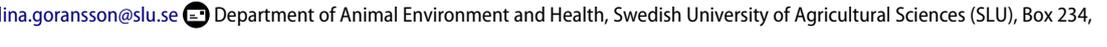
## Introduction

High animal welfare standards are fundamental in organic agriculture (IFOAM 2022). The welfare of an individual animal depends on its health and biological functioning, subjective experiences and the opportunity to perform natural behaviours (Fraser et al. 1997). With emphasis on the latter as well as on production practices that promote health, laying hens in organic egg production must be provided with *e.g.*, outdoor access, roughage, natural light and lower stocking densities, under current organic EU regulations (Regulation (EU) 2018/848).

Outdoor access, to provide an environment containing natural elements and greater opportunities to perform natural behaviours and physical exercise (Regulation (EU) 2018/848), is one of the most prominent features of organic animal farming (Vaarst and Alrøe 2012). The natural habitat of the red jungle fowl (*Gallus gallus*), the ancestor of the domestic chicken (*Gallus gallus domesticus*), includes areas of relatively dense vegetation, with shrubs and trees that offer protection against predators (Collias and Collias 1967). The colouration of the red jungle fowl's plumage largely matches the environment, making the bird difficult to detect by predators (Collias and Collias 1967). In the wild, adult red jungle fowl spend around 60% of their waking hours foraging (Dawkins 1989), but during the day they may also rest on

a branch or engage in plumage maintenance behaviour, such as preening and dust bathing (Collias and Collias 1967).

Shelter and protection is an important feature of outdoor areas in commercial poultry production, in order to encourage the hens out into the range (Chielo et al. 2016; Larsen et al. 2017; Nagle and Glatz 2012; Zeltner and Hirt 2003) despite domestication and intense genetic selection for production traits in domestic chickens, which live a different life from their ancestors. However, previous research has shown that farmers may be unwilling to plant trees or bushes to provide appropriate shelter in the free-range area, for practical or other reasons (Göransson et al. 2021; Stadig et al. 2020). When vegetation cover is limited, artificial shelters may be provided instead (Commission Implementing Regulation (EU) 2020/464), but there is limited knowledge on their form and how to distribute these for optimal effect on bird ranging in a commercial setting (Larsen and Rault 2021). Lack of sufficient shelter may limit the extent to which the outdoor area is actually used, which can have welfare implications, *e.g.*, increased risk of severe feather pecking (Bestman and Wagenaar 2003). Moreover, laying hens seem to prefer the outdoors for foraging (Thuy Diep et al. 2018), an important species-specific behaviour which they are highly motivated to perform (Weeks and Nicol 2006). Despite the potential welfare benefits associated with free-

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ranging, there are some welfare risks, such as exposure to predators (Bestman and Bikker-Ouwejan 2020) and disease transmission through contact with wild birds (Guinat et al. 2022).

At the time of the present study there were 98 commercial organic laying hen farms in Sweden representing around 16% of the total national egg production (Swedish Board of Agriculture 2022a). Approximately 69% of these organic farms are certified according to the standards of the Swedish private organic incorporated association KRAV® (Robert Dinwiddie, pers. comm., August 11, 2022). KRAV standards comply with the organic EU regulations and in some instances go further, e.g., by including specific requirements on producers to offer a stimulating and interesting outdoor environment that encourages free-ranging (KRAV 2022).

The main aim of the following study was to describe the current status on commercial organic laying hen farms in Sweden in terms of outdoor access, free-range areas and bird ranging behaviour. A further aim was to explore practicable methods to improve bird ranging, through observing current on-farm solutions and collecting information on farmers' experiences and perspectives on free-ranging.

## Materials and methods

This study did not comprise any invasive treatment involving laying hens on commercial farms, nor did it include collection of any sensitive personal data from farmers. Thus, ethical approval by an ethics committee was not required for either animal experiments (SJVFS 2019:9) or for research involving humans according to Swedish legislation (SFS 2003:460).

### Farms and flocks

Study farms were recruited through a national organic poultry advisor, who contacted Swedish organic egg producers via telephone (in no particular order). After having been informed about the project, farmers with at least one flock approaching the end of lay were invited to participate in the study, and the first 10 farmers to consent were included. The first author then contacted the farmers, who were provided with a more detailed description of the study aim and methods and informed that they could withdraw their consent at any time. During the course of the study, an additional farm was included due to one of the original farmers withdrawing consent to handle individual birds for clinical examination (Göransson et al., in preparation). The farms were visited for

one day by the first author and one assistant. Farm visits were performed in May–July 2020 (northern hemisphere spring–summer) on five farms and in September–November 2020 (autumn) on six farms.

All farms in the study ( $n = 11$ ) were KRAV-certified. There were nine flocks of Bovans White hens, one flock of Bovans Brown and one flock of Lohmann Selected Leghorn (LSL). Farm visits were performed at the end of lay in all flocks and the median (Q1–Q3) age of the observed flock at the time of visit was 74 (73–75) weeks. The median (Q1–Q3) farm size was 18 000 (13 000–40 300) and the median flock size at the time of visit was 5750 (5372–8825). In compliance with EU regulations, no more than 3000 hens were kept together in separate sections within the hen house. Unless divided by a solid wall indoors and with access to separate outdoor areas, hens from different sections were considered one flock.

### Farmer interviews

Farmer interviews were conducted according to a structured protocol (supplementary material), to obtain information about general farm structure, management and husbandry routines, housing, bird health, behaviour and production. The questions covered outdoor access and free-ranging behaviour. Farmers' responses were collated together with outdoor observations made by the research team, in order to consolidate the relevant information on each aspect. The farmers were asked about factors that in their experience encourage, discourage and potentially enhance free-ranging and the reasons why they considered this to be important or not.

### Free-range areas

Outdoor observations were performed in the free-range area available to the flock observed. Due to the large size of some flocks and consequently large free-range areas, it was impossible to assess the entire area on some farms. Thus, the assessment was limited to the free-range area within approximately 200–250 m from the house or veranda. The proportion of this part of the range covered by protective vegetation cover (defined as tall grass, bushes or trees  $\geq 50$  cm height) was rated on a scale from 0 (none) to 6 (very high), including the relative proportion of trees and bushes within the protective vegetation cover (Table 1). The proportion of the free-range area covered by pasture (i.e. short grass and grass-free soil areas) was estimated on a scale from 0 (very low) to 4 (very high)

**Table 1.** Protocol used for free-range observations (ranging behaviour and vegetation) on organic laying hen farms in Sweden. Free-range area within approximately 200–250 m from the house or veranda, not including veranda.

Observation	Description
<b>Free-ranging</b>	
Birds outdoors	Estimated total number of birds in free-ranging area
Bird dispersion	Estimated proportion (%) of total number of birds outside at $\leq 5$ , $5 \leq 20$ , $20 \leq 50$ and $>50$ m
Maximum distance	Greatest distance from the veranda to where a bird was observed ranging
<b>Free-range features</b>	
Pasture: proportion of total free-range area	0 (<20%); 1 (20 < 40%); 2 (40 < 60%); 3 (60 < 80%); 4 ( $\geq 80\%$ )
Protective vegetation cover: proportion of total free-range area <sup>a</sup>	0 (0%); 1 (<5%); 2 (5 < 10%); 3 (10 < 20%); 4 (20 < 40%); 5 (40 < 60%); 6 ( $\geq 60\%$ )
Type of vegetation cover <sup>a</sup>	Proportion (%) of total protective vegetation cover made up of bushes <100 cm, bushes $\geq 100$ cm and trees
Artificial shelter	Description and number of objects, including number of birds underneath

<sup>a</sup>Defined as tall grass, bushes or trees  $\geq 50$  cm.

(Table 1). Observations entailed recording the number and type of any artificial shelters, the type of fencing and the geographical orientation of the house and free-range area.

### Free-ranging behaviour

First and last during each farm visit, the total number of birds in the free-range area and the numbers of birds within 5, 20 and 50 m or further from the house or veranda were counted. When the number of birds outside was too high to count individuals, they were counted in increments i.e. by groups of tens to get at an estimate. The distances were 'by eye' estimates to avoid disturbing the hens prior to observations and based on previous data collection (Bestman et al. 2023), during which the hens were most often observed ranging within a few metres and rarely beyond 50 m, from the house or veranda. Observations were performed at around 09.00–14.00 and again around 14.30–17.00, depending on the season and day length. Temperature and relative humidity were recorded at ground level using a digital thermometer and hygrometer. Precipitation (mm), wind speed and direction (m/s) and time of sunrise and sunset were recorded using a meteorological software mobile telephone application (Swedish Meteorological and Hydrological Institute, SMHI).

### Data analyses

Data were compiled in Microsoft Excel 2016. The data were thoroughly explored visually to look for any patterns and possible correlations, but no formal statistical analysis was possible due to the limited number of

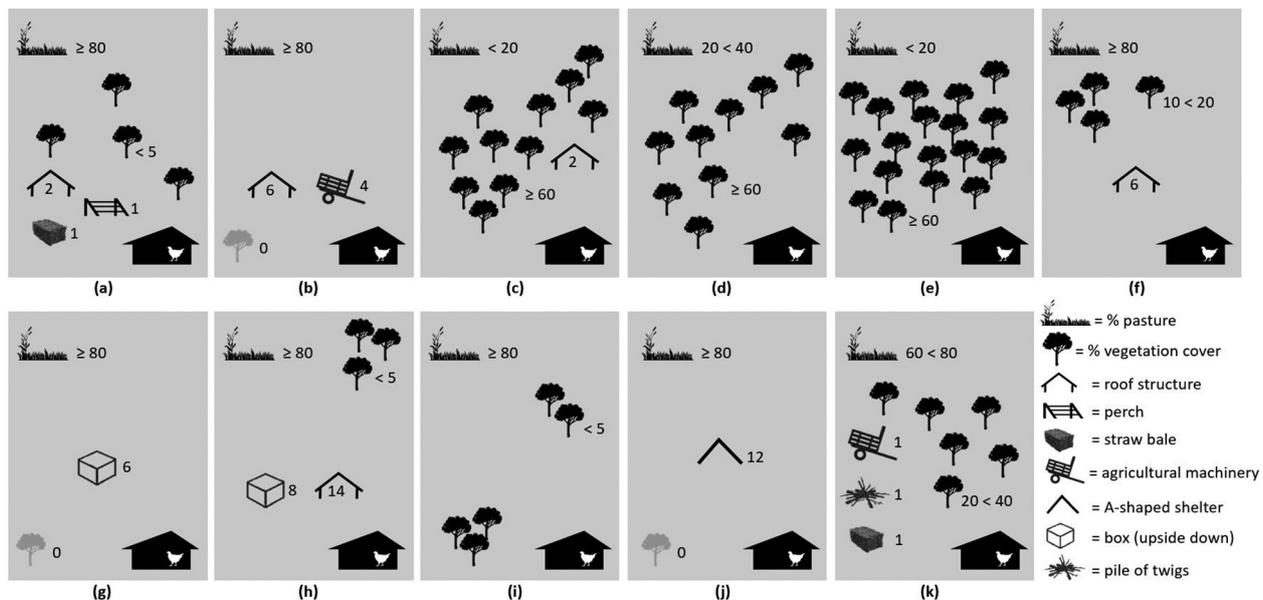
participating farms ( $n = 11$ ). As the study was descriptive rather than hypothesis-driven and relatively small-scale, summary statistics are presented. Values reported are median and lower (Q1) and upper (Q3) quartiles, unless otherwise stated.

## Results

### Farms and flocks

Pullets were placed at 15 or 16 weeks of age and in 10 flocks, they were reared without outdoor access, while in one flock they had access to a veranda (roofed platform with three walls and one wind net, littered floor and natural ventilation). All laying hen flocks included roosters (around 10–35 per 3000 hens). Birds were kept in aviary multi-tier systems on all farms. On eight farms, a veranda adjoined the pop-holes to the free-range. No birds were beak-trimmed, in accordance with national and EU regulations.

Unless pullets arrived on the laying farm during late autumn or winter, they were generally provided with free-range access as soon as the farmer considered them to have found the nests properly (at 19–24 weeks of age). The birds on 10 farms normally had free-range access from around April–May (spring) to October–November (autumn), although this was largely weather-dependent. On one farm, the hens sometimes had free-range access also during winter in favourable weather conditions. On most farms, free-range access was from around 06.00–08.00 until approximately 21.00–24.00 (11–18 h) ( $n = 7$ ). On the remaining four farms, the birds had outdoor access from 01.00 to 17.00 (16 h) ( $n = 1$ ), from 08.00–09.00 to 18.00 (9–10 h) ( $n = 1$ ), from 10.30–11.30 until around sunset (between 5 and 11 h



**Figure 1.** Schematic illustrations (note: not to scale) of vegetation dispersion and artificial shelters in free-range areas on 11 organic laying hen farms in Sweden: (a) Single trees scattered throughout the range, and corrugated iron sheet roofs on four pillars, a pile of three square straw bales and an A-shaped perch; (b) pasture only, agricultural machinery (e.g. a harrow) and corrugated iron sheets on top of concrete cylinders; (c) trees, bushes and tall grass throughout the range, and corrugated iron sheet roofs on four pillars; (d) tall grass, bushes and trees throughout the range (N.B. difficult to get an overview of the entire range); (e) dense forest throughout the range (N.B. difficult to get an overview of the entire range); (f) one single distinct area with trees (grove) approximately 60–70 m from the house, and corrugated iron sheet roofs on four pillars; (g) pasture only around house (N.B. difficult to get an overview of the entire range), upside-down stainless steel frames (for e.g. water containers ~1000 litres); (h) pasture only around house (N.B. difficult to get an overview of the entire range), wooden boxes upside down, corrugated iron sheet roofs on four pillars ( $n=11$ ) and roof structures made from tree logs ( $n=3$ ); (i) two distinct areas with trees (groves) within approximately 60–70 m from the house (N.B. difficult to get an overview of the entire range); (j) Pasture only, corrugated iron sheet A-shaped shelters; (k) trees scattered throughout the range, and a wagon, a pile of twigs and a large round straw bale.

**Table 2.** Swedish farmers' experiences of predation as a minor, moderate or severe problem on organic laying hen farms ( $n = 11$ ), including fencing and other protective measures (G: ground predators; A: aerial predators).

Farm	Free-range fully enclosed	Problems with predators	Species <sup>a</sup>	Protection (other than fence)
1	Yes	Minor (G) and severe (A)	Mink, raven, marten	Nothing
2	No	Severe	Fox, badger	Traps, shooting
3	Yes	Minor (G) and severe (A)	Hawk	Fence in tree tops
4	Yes	Minor (occasionally severe)	Fox, marten, hawk, raven	Cattle in range
5	Yes	Minor (occasionally severe)	Fox, A <sup>b</sup> , mink	Closing pop-holes
6	Yes	Severe	Fox, A <sup>b</sup> , mink, marten	Traps, shooting
7	No	Minor	Fox, buzzard, eagle owl, mink	Traps, shooting
8	Yes	Minor	Fox, A <sup>b</sup> , mink	Missing information
9	No	Moderate	Fox, badger	Traps, shooting
10	No	Moderate	Fox, A <sup>b</sup> , marten	Shooting
11	Yes	Minor-moderate	Fox, buzzard	Shooting, (traps)

<sup>a</sup>Mink (*Mustela lutreola*); raven (*Corvus corax*); marten (*Martes martes*); fox (*Vulpes vulpes*); badger (*Meles meles*); hawk (*Accipiter* spp.); buzzard (*Buteo buteo*); eagle owl (*Bubo bubo*). <sup>b</sup>Aerial predators: species not specified.

depending on season) ( $n = 1$ ) or 24 hours per day ( $n = 1$ ). Pop-holes were open for the birds to use the veranda during daylight hours year-round on the eight farms providing these. On two of these farms the birds could access the veranda 24 h per day from spring and throughout summer and autumn.

The study flocks were first provided with free-range access in March or April ( $n = 5$ ), May or June ( $n = 3$ ) and August or September ( $n = 3$ ). Seven of the flocks were 19–25 weeks of age at first free-range access and 53–71 weeks of age when they could access the free-range again following indoor housing during winter. Four of the flocks were 40–48 weeks of age at first free-range access.

### Free-range areas

The proportions of the free-range area per farm consisting of protective vegetation cover and pasture are shown in Figure 1, along with information on any artificial shelters provided. The free-range areas contained only natural vegetation, i.e. not planted ( $n = 7$ ), only planted vegetation ( $n = 1$ ) or both ( $n = 3$ ).

Planted vegetation cover included sunflowers (*Helianthus annuus*), fruit trees including apple trees (*Malus domestica*) and cherry trees (*Prunus* spp.), fruiting shrubs (currants (*Ribes* spp.)), wheat (*Triticum aestivum*), chicory (*Cichorium intybus*), willow (*Salix* spp.) and birch (*Betula* spp.). The vegetation cover in six of the eight free-range areas that contained some protective vegetation consisted of  $\geq 90\%$

trees. On the remaining two farms, bushes  $<100$  cm comprised the majority ( $\geq 50\%$ ) of the protective vegetation cover. Seven of the observed free-range areas were completely enclosed, while the remaining four ranges were fitted with a fence closest to the house only (Table 2). Some farmers considered predation to be a minor issue, while others experienced moderate to severe problems, especially with foxes (*Vulpes vulpes*) and birds of prey (Table 2).

### Free-ranging behaviour

Of the observed flocks, eight had outdoor access at the time of visit (Table 3). On five of these farms, pop-holes were closed either during the first or the second outdoor observation round, i.e. only one observation of the birds in the free-range was possible. On the remaining three farms, pop-holes were completely closed due to unfavourable weather conditions, attacks by wild predators or loose hunting dogs. In all flocks but one (in which up to 56% of the hens were observed outdoors), no more than 13% of the hens were ranging. The majority of birds ranged within 20 m from the house or veranda and only a few individuals were observed farther away than 50 m (Table 3).

### Farmers' estimates of free-range use in the observed flock

According to the participating farmers, the majority of birds in the observed flocks ranged within 15–20 m ( $n = 3$ ), 35–50 m ( $n = 5$ ) and 70–80 m ( $n = 1$ ) from the house. The maximum distance from the house to which hens (often a few

**Table 3.** Proportion of flock observed in free-range area on Swedish organic laying hen farms ( $n = 11$ ), distance from house (or veranda) and prevailing weather conditions (N: no wind; L: little wind; M: moderate wind; V: very windy).

	Farm <sup>c</sup>	Time	Month	Proportion (%) of flock and [total number of hens] in free-range <sup>e</sup>	Proportion (%) of free-ranging birds at different distances (m) from house (or veranda)				Maximum distance (m) from house (or veranda)	Temperature (°C)	Cloud cover (%)	Precipitation (yes/no)	Wind
					0 ≤ 5	>5 ≤ 20	>20 ≤ 50	>50					
First observation <sup>a</sup>	2	12.40	May	6 [273]	68	29	3	0	45	15.0	25	No	L (M)
	3	14.15	June	30 [340]	9	29	44	18	75	25.4	50	No	N
	4 <sup>d</sup>	11.00	June	missing data	na	na	na	na	na	20.3	25	No	L
	6	10.00	September	1 [100]	60	40	0	0	20	21.7	75	No	L
Second observation <sup>b</sup>	7	09.10	September	4 [250]	60	40	0	0	20	14.5	100	No	L
	1	15.30	May	missing data [300] <sup>f</sup>	60	20	17	3	60 <sup>g</sup>	15.6	50	No	M
	3	17.10	June	56 [630]	19	20	56	5	75 <sup>g</sup>	22.6	75	No	N
	6	16.00	September	2 [130]	85	15	0	0	15	21.0	25	No	N
	7	14.30	September	9 [500]	50	50	0	0	20	13.9	100	No	L
	8	14.30	October	1 [130]	77	23	0	0	20	6.1	50	No	V
	11	14.45	November	13 [750]	13	34	40	13	55 <sup>g</sup>	9.1	0	No	M

<sup>a</sup>Pop-holes closed during first observation round on farms 1, 8 and 11. <sup>b</sup>Pop-holes closed during second observation round on farms 2 and 4. <sup>c</sup>Pop-holes closed due to predators, weather conditions, hunting season on farms 5, 9 and 10. <sup>d</sup>No overview of range due to dense vegetation (approximately 400 birds within 5 m). <sup>e</sup>In free-range area within 200–250 m from the house or veranda. <sup>f</sup>Proportion could not be calculated due to uncertainties in total flock size. <sup>g</sup>To outer boundary fence.

individuals only) in the observed flocks were reported to range was 30–40 m ( $n = 2$ ), 50–60 m ( $n = 4$ ), 75–100 ( $n = 3$ ) and 120–150 ( $n = 1$ ). The maximum proportion of the observed flocks out in the range at any one time was estimated by the farmers to be less than 10% ( $n = 1$ ), 20% ( $n = 2$ ), 30–40% ( $n = 2$ ), 50% ( $n = 3$ ) and 80% ( $n = 1$ ).

### Farmers' estimates of free-range use across flocks in general

All but one farmer agreed that, in general, different flocks displayed large variations in terms of how much and how far they range. Four farmers stated that birds provided with free-range access at a relatively younger age appear to range more and farther. According to the farmers, the majority of birds across most flocks normally range within 15 m ( $n = 1$ ), 25–50 m ( $n = 5$ ), 50–60 m ( $n = 3$ ) or 70–80 m ( $n = 1$ ) from the house. The maximum distance from the house to which birds range (most often a few individuals only) was reported to be 50–55 m ( $n = 2$ ), 75–100 m ( $n = 5$ ), 150–200 ( $n = 1$ ) and 200–250 ( $n = 2$ ). The maximum proportion of the flock out on the range at any one time (e.g. before sunset during optimal weather conditions) was reported by the farmers to be less than 5% ( $n = 1$ ), 15–30% ( $n = 4$ ), 50% ( $n = 3$ ) and 60–70% ( $n = 2$ ). One farmer considered the difference between flocks too large to make any estimates. Although no formal analysis was possible due to the limited number of farms, no clear correlation could be discerned between the distance or the proportion of a flock ranging and vegetation cover in the outdoor area.

### Farmer opinions on free-ranging in laying hens

All farmers were asked about factors that in their experience encourage, discourage and could improve bird free-ranging in commercial poultry production and about whether or not and why, they felt free-ranging is important (Table 4).

### Discussion

This study investigated provision of an outdoor environment in practice on commercial organic laying hen farms in Sweden and use of free-range areas by the hens. It also charted farmers' experience-based knowledge on how to encourage outdoor use and their perspectives on free-ranging. On-farm studies generate important knowledge about the welfare of animals in a commercial production context, and provide insights into practical implementation of research findings and into farmers' knowledge and practical considerations stemming from on-farm experience.

The participating farms ( $n = 11$ ) represented approximately 11% of all organic laying hen farms in Sweden (Swedish Board of Agriculture 2022a) and about 17% of the organic farms that were KRAV-certified (Robert Dinwiddie, pers. comm., 11 August 2022). The median size of these KRAV-certified farms corresponded well with the farms included in the present study. Moreover, approximately 88% of the total number of hens in Sweden (organic and non-organic) are found on farms in the southern third of the country, where all farms included in the present study were

**Table 4.** Swedish organic farmers' ( $n = 11$ ) responses to questions about free-ranging in commercial poultry production (frequency within brackets; N.B. each farmer could give several answers to the same question).

Question	Answer
What do you think encourages/would encourage hens to range more and/or farther?	Protective cover, vegetation and/or artificial shelter (10) Pathways in vegetation (4) and straight lines to follow (1) Age (i.e. younger) at first outdoor access (2) Roosters <sup>a</sup> (ranging more and/or farther) (1) Good plumage condition (1) Grass to forage (1) and fruit trees (e.g., apples to eat) (1) Geographical orientation of house and free-range (1) Sheep <sup>b</sup> (1) Indoor lighting (relatively lighter than outside) (1) Veranda (large) (1) Anything to stimulate curiosity (1) Do not know (1)
What do you think discourages hens from ranging?	Open areas and lack of protection (4) Food, water and shelter indoors (no need to range) (2) Frequently frightened by loud sounds (1) or predators (1) Stormy weather (1) Fearfulness (fearful hybrids) (1) Indoor lighting (relatively darker than outside) (1) Protection, grass and pathways in vegetation <sup>c,d</sup> (7) Do not know (4) Less fearful hybrids (genetic material) (2) Smaller free-range areas (2) Electric and robust fences (1)
Suggestions of improvements in free-range?	Animal welfare and health (6) Only visible argument (to consumers) for organic production (2) Farther from house for better foraging opportunities (2) Farther from house to decrease stocking density (parasite load) (1) Increased number of hens close to house, rather than farther out (1) Feels good to provide them with the choice (1)
Do you think free-ranging is important for hens? Why/why not? <sup>e</sup>	Positive Not farther out; unnecessarily large area (1) Negative for production performance (1) Risk factors; parasites (1) and predators (1)

<sup>a</sup>Selling fertilised eggs for human consumption is not prohibited in Sweden and therefore inclusion of roosters in non-breeding flocks is common and specifically recommended to encourage ranging (KRAV 2022). <sup>b</sup>The incidence of Salmonella is low in Sweden, yet the risk of disease transmission between different species has to be considered. <sup>c</sup>scrubby cinquefoil (*Potentilla fruticosa*), willow (*Salix* spp.), fruit trees, sea-buckthorn (*Hippophaë rhamnoides*), elderflower (*Sambucus nigra*) and currant (*Ribes* spp.). <sup>d</sup>Of which two farmers emphasised that protection should foremost be provided closer to the house (more likely to attract larger number of birds). <sup>e</sup>All farmers ( $n = 11$ ) considered free-ranging to be positive, but some farmers ( $n = 3$ ) expressed concerns associated with outdoor access.

located (Swedish Board of Agriculture 2022b). Hence, the study farms were considered to comprise a representative sample for describing the current status on organic laying hen farms in Sweden.

The free-range area assessed (within 200–250 m from the hen house) contained no vegetation or less than 5% vegetation cover on six of the farms. The assessment was limited to the area in the vicinity of the hen house since it was impossible to get an overview of the entire range from a single viewing position on some farms. This immediate area of the range is most likely to have the greatest impact on hen ranging behaviour, as it is the area hens first encounter and must traverse in order to reach any other parts of the range.

Numerous on-farm studies have shown that natural vegetation cover, i.e. shrubs and trees, can encourage more hens onto the range and/or farther out (Bestman and Wagenaar 2003; De Koning et al. 2018; Gilani et al. 2014; Hegelund et al. 2005; Larsen et al. 2017; Nicol et al. 2003; Zeltner and Hirt 2008). On four of the farms studied, various trees had been planted in order to increase the amount of protective vegetation cover. However, the area in front of the hen house comprised at least 80% pasture on seven of the farms, although the proportion of pasture was less than 20% on two farms. In open areas, hens are exposed to predators and adverse weather conditions and have been shown to prefer areas within the free-range that provide protection and shade when foraging and dust bathing (De Koning et al. 2018; Larsen et al. 2017).

Artificial shelters, which provide protection and shade when natural vegetation cover is limited, can successfully attract birds onto and farther out into the range (Gilani et al. 2014; Nagle and Glatz 2012; Pettersson et al. 2017; Zeltner and Hirt 2003). The free-range areas which contained 0–5% vegetation cover were equipped with between 0 and 22 artificial shelters varying from small wooden boxes to large agricultural machines. In general, these structures were distributed in front of the house or veranda, no farther away than 50 m from the buildings. To move between the artificial shelters or to reach these upon leaving the house or veranda, hens were required to cross an open area, which potentially undermined the effect of the artificial shelters (Bestman et al. 2002). Thus, an otherwise open area equipped with a few structures scattered within a certain part of the range might comply with relevant regulations but may not necessarily provide the birds with proper protection. The large flocks in modern poultry production with correspondingly large free-range areas pose a challenge in terms of how to equip the outdoor areas with sufficient cover. However, there is limited research on the particular features of artificial shelters that are important to the hens (Larsen and Rault 2021; Rana et al. 2022) or on how best to distribute such structures throughout the range.

On four of the farms, the free-range area was equipped with a fence closest to the house only and three of these farmers reported ground predators to be a moderate or severe problem. From an animal welfare perspective, it is imperative to equip the range with fences to protect the hens as much as possible from predators, which is one of the main welfare concerns associated with free-range access for poultry (Bestman and Bikker-Ouwejan 2020). It should be noted that even on farms where fences enclosed the entire range, some minor to moderate issues with predators such as mink were reported. Ground predators can be kept out by

appropriate fencing, but it is more difficult to protect hens from aerial predators and these were considered a problem on several farms in this study. However, it should be noted that predator issues were defined solely in terms of farmers' perceptions and that their assessment of minor, moderate or severe depended on their subjective experience.

Of the hens observed in the free-range area, the median proportion of birds ranging within 20 m from the house or veranda per observation was 99% (55–100%) and the hens were rarely observed farther away than 50 m. Apparent reluctance to venture away from the house has been reported previously in laying hens on commercial farms (Chiello et al. 2016; Zeltner and Hirt 2003). In the present study, some observations were lacking as the hens on three farms did not have outdoor access at the time of visit and on five of the remaining eight farms the pop-holes were closed during the first or second observation round. Although limited in number, the results from the outdoor observations nevertheless corresponded well with experiences reported by the farmers in terms of ranging behaviour, in general and in the observed flocks. Future studies should investigate these issues within a commercial context, in order to find practicable solutions for farmers that are also fit for purpose and successful in providing hens with an attractive outdoor environment that encourages beneficial behaviour whilst minimising risk.

Most farmers reported large variation between flocks in terms of how often and the distance the hens ranged. The maximum proportion of a flock out in the range at any one time, as estimated by the farmers, varied from less than 5% to 80%. This wide span is in accordance with previous research findings (Bestman and Wagenaar 2003; Nicol et al. 2003; Whay et al. 2007). During farm visits, no more than 13% of the hens in a flock were observed ranging in all flocks but one (in which up to 56% of the hens were observed outdoors). In agreement with this, results from other studies on commercial laying hen farms suggest that a limited proportion of the flock range at any one time (Chiello et al. 2016; Gilani et al. 2014; Hegelund et al. 2005). However, it should be acknowledged that two observations during one day only provided limited information about hen ranging behaviour, considering that it is affected by weather and time of the day (Hegelund et al. 2005; Richards et al. 2011). Moreover, estimating the number of birds on the range at a particular point in time as a method for investigating outdoor use does not account for dynamic ranging behaviour within a flock, which has been demonstrated in studies using various individual tracking systems (Gebhardt-Henrich et al. 2014; Kolakshyapati et al. 2020; Larsen et al. 2017; Richards et al. 2011).

Free-range access was considered important, primarily for welfare reasons, by all farmers in the present study. Some farmers expressed that they found it important that hens ranged farther out and were better distributed throughout the range for improved foraging opportunities and to reduce the parasitic load in the area close to the house. All farmers except one stressed that protective vegetation cover and/or artificial shelters are important to encourage more hens onto the range and farther from the house. Some of the farmers emphasised that open areas and lack of protection discouraged hens from ranging. This is clearly in line with relevant research findings (De Koning et al. 2018; Larsen et al. 2017; Zeltner and Hirt 2008), but was generally not reflected in the actual outdoor environment provided for the hens. Although

not explored further in this study, important barriers to implementation of vegetation cover and/or artificial shelters may include capital and labour constraints (Stadig et al. 2020).

While there was consensus that protective cover was important, there was otherwise marked variation among the farmers in their views on how hens can be encouraged to range. Some of the factors mentioned were difficult, or even impossible, for the individual farmer to influence, such as flock age at first range access, geographical orientation of the house and range and genetic selection for reduced fearfulness. However, most of the factors were within the control of the farmer and had already been implemented at farm level, e.g. roosters in the flock, sheep in the outdoor area, providing sufficient foraging material, linear structures (straight lines to follow), providing an interesting environment to stimulate curiosity and protection to reduce the fear of predators. Within these suggestions regarding how to increase free-range use in a commercial context, which encompass practical considerations in terms of implementation, may lie solutions worth exploring in future research.

### Limitations of the study

Although the sample size was reasonable to represent current organic egg production in Sweden, the low number of farms impeded further data analysis and limited extrapolation of results. Due to GDPR, the recruitment of farms was challenging. Despite the limitations of the farm sampling method, the phone calls were not made in any particular order and should thus have ensured a certain level of random selection. Moreover, during the recruitment of farms, it is unknown whether any (or how many) of the farmers declined to participate when asked by the third party. Since participation was completely voluntary, the farm sample might have been somewhat biased, i.e. the participating farmers may have been more interested in free-range management and ways in which to enhance outdoor use. The farm visits were planned so that the flocks were around the same age at the time of data collection and took place during spring, summer and throughout autumn. This seasonal, and associated weather and temperature, variation could have had an effect on e.g. the outdoor observations of hens' free-ranging behaviour. This variation, as well as adjustments that had to be made to accommodate farmers e.g. time of arrival at the farm and when to begin data collection, resulted in differences in time of day for the outdoor observations, which is another factor known to affect ranging behaviour in laying hens. Considering the variation reported by the farmers, repeated observations within flocks and in more than one flock per farm would have enabled more robust conclusions to be drawn in terms of hen ranging behaviour, although this was not possible in this study due to time limitations and logistics. However, independent outdoor observations were complemented with relevant questions in interviews and showed reasonable consistency with farmers' perceptions.

### Conclusions

The farmers in this study, representing around 11% of all Swedish organic laying hen farms, considered free-ranging to be an important aspect of organic poultry production, but with challenges. Protective cover,

whether as natural vegetation or artificial shelters, was seen as important in order to attract the hens into free-range areas, but, on around half of the farms, only a limited proportion of the free-range area contained protective vegetation cover and most comprised large areas of pasture. Thus, despite free-ranging being considered to be important and being aware of the importance of protective cover, there were discrepancies between this understanding and actual provision on some farms. Many farmers considered it important to encourage the hens to range farther, but the various shelters were mainly positioned close to the house. It is important to determine the optimal features and distribution of artificial shelters on commercial farms and to identify measures to improve the outdoor environment that are practicable as well as successful in encouraging bird free-ranging.

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No potential conflict of interest was reported by the author(s).

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