

Table S4. Case studies for proposed environmental enrichment (EE) items identified in the scientific literature with reported outcomes for biological functioning, short-term hedonic positive states, sustained use and indicators of overall positive welfare balance. WS indicates Wood shaving litter; RPR indicates Recycled Paper Roll litter; RH indicates Rice hull litter; FC indicates Farrowing crate; LWL indicates Large White × Landrace cross; LMP indicates Landrace x mini pigs; DMP indicates Duroc x mini pigs; Landrace x large whiteBC indicates British continental crossbreed; B indicates British breed; JB indicates Japanese Black; C indicates Charolais cross. – indicates that the factor was no reported or unclear.

Species	Proposed EE	Details of EE	Age/ Duration	Breed	EE density	Baseline housing	Short term assessment		Long-term assessment		Citation	Framework classification based on available information
							Biological functioning	Hedonic positive affect	Sustained use	Positive mood/stress resilience		
Meat chicken	Sand	17.8cm sand bedding	0–50d	Ross308	2cm deep bedding	Pen; WS; RPR; RH	↔ <sup>1</sup>	↑ <sup>2</sup>	↓ <sup>†</sup>	Toghyani et al. (2010)	<i>Psuedoenrichment*</i>	
		2 x sand trays	0–37d	Ross308	1×(67×46×4cm)/40 head 1×(37×36×4cm)/40 head	Pen; WS		↑ <sup>2</sup>	↓ <sup>†</sup>	Arnould et al. (2004)		
		Sand pit	0-42d	Cobb500	3.8 × 8.9 cm pit with sand 2.5cm deep	Pen; WS		↑ <sup>2</sup>	↓ <sup>†</sup>	Shields et al. (2005)		
Sows prior to parturition	Hessian sack	Hessian sacks	Multiparous	LWL	2 × hessian sacks fixed to bars	FC	↔ <sup>3,4,5</sup>			(Plush et al., 2011)	<i>Psuedoenrichment*</i>	
Sows prior to parturition	Straw	Chopped straw	Multiparous	LWL	2 kg straw refreshed daily until farrowing	FC	↑ <sup>3,4,5</sup>			(Plush et al., 2011)	<i>Enrichment for meeting basic needs</i>	
		Deep straw and additional space	Multiparous	LWL	3.4 m <sup>2</sup> /sow	Pen	↑ <sup>3,1</sup>			(Merlot et al., 2017)		
		Deep straw	Primiparous/ Multiparous	Landrace x Large white	3.4 m <sup>2</sup> /sow	Pen	↑ <sup>3,1</sup>			(Merlot et al., 2019)		
		Straw in box	Multiparous	DanBred	Replenished as needed	FC	↑ <sup>4</sup>			(Martins et al., 2021)		
		Long barely straw and chain	Primiparous/ Multiparous	PIC Camborough	1.5 kg straw each morning	Pen & feeding stall	↔ <sup>3</sup>			(Spooler et al., 1996)		
		Hay straw	-	TopGen Afrodite	Replaced daily	Pen	↔ <sup>3</sup>			(Tatemoto et al., 2019)		
		Straw	Multiparous	LMP; DMP; LWL	3.5 kg daily	FC	↑ <sup>3,6</sup>	↑ <sup>7</sup>		(Wang et al., 2020)		
		Loose straw	Multiparous	Swedish Landrace x Yorkshire	15 – 20 kg 2 days before farrowing & 2 kg daily 5 d post farrowing then 0.5-1 kg daily	Pen	↑ <sup>4</sup>		(Westin et al., 2015)			
Beef cattle	Brush	L shaped brush	64d	B, BC	1/27 head	Feedlot			↑	Meneses et al. (2019)	<i>Enrichment for meeting basic needs</i>	
		A horizontal and vertical attached brush	178d	JB	2 (50×10×110cm) /4 head	Feedlot	↑ <sup>8</sup>		↑	Ninomiya (2019)		
		L shaped brush	64d	B	5m <sup>2</sup> /head	Feedlot	↔ <sup>2,9</sup>		↑	(Park et al., 2020)		
		Brush	256d	B	1/18head	Feedlot	↔ <sup>9</sup>		↑	(Park et al., 2019)		

		Arched moveable brush	22d	C	2×(1.5m H)/10 head	Feedlot & scent devices		↑ <sup>2</sup>	(Wilson et al., 2002)	
Layer hen	Perch	Rounded metal perches 32mm diameter	Pullet	White Leghorn	3.2 – 10.2 cm/hen	Conventional cage	↔ <sup>10,9</sup>		Enneking et al. (2012)	<b>Enrichment for pleasure</b>
		Rounded wood 30mm diameter	Adult	Hyline	-	Conventional cage	↔ <sup>3</sup>		Barnett et al. (2009)	
		Rounded hardwood 40 mm diameter	Adult	White Lomann	22cm/hen	Conventional cage	↔ <sup>4</sup>		Frediani et al. (2019)	
		Round metal 32 mm diameter	Adult	Hy-Line	16.9cm/hen	Conventional cage	↔ <sup>4</sup>		Hester et al. (2013)	
		Round metal perch (3.18 cm diameter)	Adult	White Lomann	15 cm/hen	Commerical aviary		↑ <sup>11</sup>	Campbell et al. (2016)	
		1 m wide, 23 and 43cm high	Adult	Lohmann leghorn	-	Pen, tested in cages		↑†	Olsson and Keeling (2002)	
Meat chicken	Sand & complexity	Sand filled dust bath, PECK stone, 3 × PVC pipe perches and novel objects	0–50d	Ross708	Dust bath: 180×91×10cm Perches: 183×31×9cm; 1.9cm diameter	Pen & WS		↑ <sup>12†</sup> ↑ <sup>13†</sup>	Anderson et al. (2021a) Anderson et al. (2021b)	<b>Enrichment for positive welfare balance</b>

<sup>1</sup> Immunefunction, Antibody titre response, spleen and bursa of fabricius weight

<sup>2</sup> Preference

<sup>3</sup> Glucocorticoid concentrations

<sup>4</sup> Reproduction, litter size, stillborn, weaned

<sup>5</sup> Immunefunction colostrum IgG

<sup>6</sup> Prolactin

<sup>7</sup> Oxytocin

<sup>8</sup> Prevalence of visceral disease

<sup>9</sup> Body weight

<sup>10</sup> Adrenal gland weight

<sup>11</sup> Behavioural demand

<sup>12</sup> Attention bias test

<sup>13</sup> Stress resilience; startle reflex & autonomic response to aversive stimuli

† End of production cycle/life assessment