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Behavioural response of crossbred (Landrace × *Desi*) pigs under different floor space allowances

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ABSTRACT

Present investigation was carried out to study the behaviour of pigs at 33 and 50% reduced floor space allowances in relation to Indian standards (IS: 3916-1966) for housing of pigs. Crossbred (Landrace × Desi*)* barrows (36) were reared with 3 different floor space allowances (n = 4 (group size) × 3 (replications) = 12 each) i.e. group T_{IS} (control) had floor space allowance as per Indian standards, while $T_{2/3}$ and $T_{1/2}$ treatment groups had 33 and 50% reduced floor space allocation per pig. Accordingly, during weaner (6–14 weeks), grower (15–22 weeks) and finisher (23–28 weeks) stages, 3 different floor spaces were provided. During each growth stage (weaner/grower/finisher), activities of each unit (consisting of 4 animals) were recorded thrice in sessions of 2 consecutive hours (an hour before (preprandial) and after (prandial and postprandial) offering of second meal in afternoon). Total time spent in agonistic activities did not differ among the groups. However, parallel pressing agonistic activity was more in $T_{1/2}$ group during grower and finisher stages at prandial and postprandial time while in T_{IS} group during weaner stage at preprandial time. Time spent resting was higher in T_{IS} group at prandial and postprandial time during weaner stage while it was higher in $T_{2/3}$ group during grower stage. Exploratory activities and social interactions were maximum in $T_{2/3}$ group during weaner and finisher stages and differed significantly from $T_{1/2}$ group. From behavioural response, it can be concluded that suitable floor space allowance should lie in between 33 to 50% reduction in relation to IS specifications.

Key words: Behaviour, Crossbred pigs, Floor area, Space allowance

Swine production is backbone for small and marginal farmers in many parts of India and other Asian countries. At global level, the fastest growth is taking place in more affordable meat sectors i.e. pig and poultry (FAO 2014). Efficient use of indoor floor space enhances economic and management benefits (Anil *et al.* 2007) in swine production. Most of the developed countries have revised floor space allowances for pigs from time to time whereas, Indian standards for housing of pigs were formulated in 1966 (IS: 3916-1966). Some studies indicated that still there is scope of reduction of floor space for pigs through environment enrichment (Marchant-Forde 2009, de Greef *et al.* 2011). Presently, as per IS guidelines, about 6 times more floor area is being recommended than most of the other countries of the world despite smaller average size of Indian pigs. Average meat yield of pigs in India is 35 kg/animal, which is about 55% less than the corresponding value of world average. Hence, this investigation was carried out to study the behaviour of pigs at 33% and 50% reduced floor space allowances in relation to Indian Standards (IS: 3916-1966) for housing of pigs.

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MATERIALS AND METHODS

*Experimental animals and management conditions: C*rossbred (Landrace × Desi (local Indian)) male piglets (36), from 14 litters of unrelated sows farrowed contemporarily, were selected randomly taking body weight and age into consideration at ICAR-Indian Veterinary Research Institute, India. Before weaning, these piglets as littermates were kept with respective dam in farrowing pen having 8 m^2 of covered area including provision of creep area. These piglets were castrated at 1 month of age, weaned at 6 weeks of age and subsequently distributed randomly into 3 equal groups (n=12 each (group size=4, replications=3)) on the basis of 3 different floor space allowances. T_{IS} (control) group was provided floor space as per Indian Standards (IS: 3916-1966) specification, while $T_{2/3}$ and $T_{1/2}$ treatment groups with 33 and 50% reduced floor space allocation per pig in comparison to IS. Indian Standards suggests covered floor area of 0.9 and 1.8 m^2/

pig for weaner and finisher pigs respectively. During weaner (6–14 weeks), grower (15–22 weeks) and finisher (23–29 weeks) stages, 3 different floor spaces (T_{IS} group (0.9, 1.35 and 1.8 m^2/pig), $T_{2/3}$ group (0.6, 0.9 and 1.2 m^2/pig) and $T_{1/2}$ group (0.45, 0.68 and 0.9 m^2/pig)) were provided.

Each pen had 2.5 m width and specified floor space was provided by fixing length of the pen using metallic grill gates. Floor was made of concrete with serrations to avoid slippage. Animals were fed twice daily in linear feeders with provision of potable water round the clock. Pigs were provided with corn-barley-soybean meal-wheat bran based diet based on formula as per growth stage. Management practices related to health and hygiene were followed as per farm's guidelines. Experiment was coincided with summer and monsoon months. During weaner, grower and finisher stages, microclimatic temperature and relative humidity (RH) ranged between 29–41ºC, 48.6–75.3%; 24.5–37ºC, 79–94.9%; and 22–34.5ºC, 75.3–90.3%. Permission of Institutional Animal Ethics Committee was taken before conduct of experiment.

Behavioural observations: Different behavioural activities (Table 1) of experimental pigs were recorded manually using camera. During each growth stage (weaner/grower/finisher), activities of each unit (consisting of 4 animals) were recorded thrice in sessions of 2 consecutive hours (an hour before and after offering of second meal i.e. afternoon). Peri-prandial session was selected as it coincides with period of resting as well as increased activities towards waiting for feed. From each recorded video, randomly one animal's behavioural activities were documented by continuous focal sampling technique (Martin and Bateson 1993). Behavioural activities were recorded by a trained observer in data sheets using codes assigned to each activity. Data sheet was prepared for 2 h session with unit cell representing time fraction of 5 sec, however key instantaneous (agonistic) activities were precisely recorded. Major categories of behavioural activities of pigs included agonistic, resting, social, exploratory, ingestive and miscellaneous. Utmost care was taken to avoid any disturbance while recording the videos. Observer entered the shed 20 min before start of each recording to avoid interference in behavioural activities of pigs. Observer recorded behaviour from a 6½ feet high bench placed at corner of the respective pen in central passage to get full visual contact of pen without influencing behaviour of pigs.

Statistical analysis: The data, thus collected during the experimental period, were subjected to the statistical analysis as per Snedecor and Cochran (1994) using the Statistical Analysis System (SAS institute Inc., Cary, NC; USA). Behavioural activities were presented as mean occurrence time in seconds out of 1 h period before and after offering of feed. Data collected for 3 treatment groups were compared using ANOVA. P value of ≤ 0.05 was considered significant in the analyses.

RESULTS AND DISCUSSION

Different behavioural activities of pigs were recorded for 1 h preprandial and 1 h prandial-cum-postprandial time. Among agonistic interactions, only parallel pressing differed among the groups (Table 2). Parallel pressing was

Table 1. Behavioural activities of pigs*

Behaviour	Definition
Agonistic behaviour (performed or received)	
Parallel pressing	Two pigs standing side-by-side in the same direction, pressing against each other's shoulder, with one throwing its head against the head or the neck of the other pig
Inverse parallel pressing	Two pigs standing side-by-side in opposite directions, pressing against each other's shoulder/croup
Head-to-head knock	A rapid thrust upward or sideways with the head or snout against the neck, head or ears of another pig
Levering	Pig puts its snout under the body of another pig from behind or from the side and lifts the other pig up into the air
Biting	Biting on any part of the body
Postures	
Lateral recumbency (cluster)	The pig lies flat on one side of its body maintaining contact with another pig
Sternal recumbency (cluster)	Lying on sternum with one or more legs tucked under the body maintaining contact with another pig
Lateral recumbency (individual)	The pig lies flat on one side of its body without contact of another pig
Sternal recumbency (individual)	Lying on sternum with one or more legs tucked under the body without contact of another pig
Sitting	Body is supported by one or two front legs
Standing	The pig is upright on all four legs
Non-social physical interactions (exploration)	Pigs nosing (rubbing snout), chewing, licking or sniffing floor or any inanimate object in the pen
Non-agonistic social interactions	Nose-to-body and nose-to-nose interactions performed and received
Feeding	Head contained within the feeder
Miscellaneous	Feeding, running, walking etc.

*Modified Anil *et al.* (2007).

Table 2. Time spent (sec) in different agonistic activities during different stages of barrows

Activity	Stage	Preprandial behaviour				Prandial and postprandial behaviour			
		T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM	T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM
PP	W*	0.44[a]	0.00[b]	0.00[b]	0.13	1.89	4.00	1.44	1.77
	G**	0.00	0.33	0.67	0.25	0.22[a]	0.00[a]	3.22[b]	0.56
	F*	0.11	0.00	0.44	0.21	1.00[ab]	0.00[a]	1.78[b]	0.44
IP	W	1.56	0.44	0.33	0.54	1.00	17.67	3.11	7.05
	G	11.33	0.56	1.33	4.97	2.00	0.56	1.78	1.37
	F	1.00	0.22	0.22	0.50	1.44	2.11	0.33	1.21
HH	W	3.22	1.56	2.11	0.68	7.11	13.67	7.89	3.45
	G	6.78	1.89	2.33	1.59	7.00	2.56	6.67	2.62
	F	2.44	0.44	1.33	0.87	5.00	2.56	2.00	1.23
L	W	0.00	0.00	0.00	0.00	0.22	0.67	0.56	0.33
	G	0.11	0.00	0.22	0.14	0.11	0.00	0.22	0.11
	F	0.00	0.00	0.22	0.09	0.22	0.00	0.00	0.09
B	W	3.78	1.33	3.22	1.87	0.67	3.00	0.44	0.92
	G	0.22	0.89	2.44	0.61	1.11	0.67	0.89	0.57
	F	1.00	0.22	1.44	0.63	0.67	0.67	1.33	0.50
Total	W	9.00 (0.25)	3.33 (0.09)	5.67 (0.16)	2.22	10.89 (0.30)	39.00 (1.08)	13.44 (0.37)	12.04
	G	18.44 (0.51)	3.67 (0.10)	7.00 (0.19)	6.34	10.44 (0.29)	3.78 (0.11)	12.78 (0.36)	3.77
	F	4.56 (0.13)	0.89 (0.03)	3.67 (0.10)	1.48	8.33 (0.23)	5.33 (0.15)	5.44 (0.15)	2.77

PP, parallel pressing; IP, inverse parallel pressing; HH, head to head knock; L, levering; B, biting; Total, total agonistic interactions; W, weaner; G, grower; F, finisher; SEM, standard error of means. Means in a row with different superscripts differ significantly at **P<0.01, *P<0.05; values in parenthesis indicates % of total observed time.

observed only in T_{IS} group (P<0.05) before offering of feed during weaner stage. Whereas, prandial-cum-postprandial parallel pressing was performed more in $T_{1/2}$ group during grower (P<0.01) and finisher (P<0.05) stages though time spent was too tiny. Overall, agonistic interactions did not differ among the groups. Among agonistic interactions most of the activities did not differ between the groups except parallel pressing which showed varying pattern during different stages. Economic analysis of pigs reared with different space allowances too has been studied (Kaswan *et al.* 2018). Earlier studies (Weng *et al.* 1998) suggested that crowding causes increased aggression. When pigs are housed in space restricted environments, the dominance hierarchy becomes less stable (Jensen 1982). Aggressive behaviour by growing and finishing pigs is significantly increased when space allowance is reduced (Weng *et al.* 1998, Anil *et al.* 2007). Increased aggression has been reported at stocking of 100 kg/m^2 (Kyriazakis and Whittemore 2006) and 110 kg/m^2 or more (Moinard *et al.* 2003). Increased tail biting with space restriction was also reported by Jensen *et al.* (2010). Although, few studies reported no association between stocking density and the incidence of tail biting (Kritas and Morrison 2004, Seguin *et al.* 2006). There was no difference in biting incidences between different floor space allowance groups.

Resting was predominant activity during preprandial period in all the groups (Table 3) which was replaced by feeding activity during prandial-cum-postprandial period. During prandial-cum-postprandial time, barrows of T_{IS} group spent relatively more time (P<0.01) in resting followed by $T_{2/3}$ and $T_{1/2}$ groups during weaner stage while during grower stage $T_{2/3}$ and T_{IS} groups showed more resting time (P<0.05) than $T_{1/2}$ group indicating more competitiveness for feeding at higher stocking densities. Group/cluster lying behaviour did not differ between the groups during all the stages, however, individual sternal recumbency was shown for more (P<0.01) time in T_{IS} group than $T_{2/3}$ and $T_{1/2}$ groups during postprandial time in weaners. Individual lateral recumbency was shown for more (P<0.05) time in T_{IS} group than $T_{1/2}$ group during weaner stage. Finisher pigs of T_{IS} group spent more (P<0.01) time standing than $T_{2/3}$ group during preprandial period. As per Averos *et al.* (2010), non-linear relationship between space allowance per pig and time spent in sitting and lying occurs. In present study, especially during weaner and grower stages, pigs of T_{IS} group spent more time lying than $T_{1/2}$ group after offering of feed while during pre-prandial period this difference was not significant. Young pigs are reported to spend 40–60% of their time lying (Blackshaw 1981) as also found during pre-prandial period in this study. From 25 kg to heavier body weights, pigs lie together most of the day (Cho and Kim 2011). However, such difference was not clearly noted in this study probably due to proportionate increase in space allowance as per growth stage. Pigs showed greater proportion of time spent lying in sternal rather than lateral recumbency towards the later stages of the grower-finisher period (Anil *et al.* 2007). Again such difference was not clearly found in this study probably due to wider difference in climatic conditions. Pearce and Paterson (1993) observed that finishing pigs housed at low rather than high space allowances spent longer standing and sitting motionless. During prandial-cum-postprandial period, least space allowance group spent relatively more time walking or standing (queuing) probably due to more

Table 3. Time spent (sec) in different resting activities during different stages of barrows

Activity	Stage	Preprandial behaviour				Prandial and postprandial behaviour			
		T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM	T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM
CL	W	628.67	374.22	466.67	179.57	18.89	60.00	1.67	31.48
	G	549.78	442.11	312.89	171.15	195.89	466.11	199.67	112.14
	F	600.22	1311.00	818.11	371.95	24.78	454.89	244.67	171.18
CS	W	799.22	904.11	1269.78	144.98	198.44	26.78	40.00	56.83
	G	1024.44	525.56	782.44	215.28	484.44	393.44	371.11	147.45
	F	762.67	469.78	905.67	198.64	200.56	538.22	278.33	117.07
IL	W*	285.00	236.67	13.89	182.04	98.33^{a}	18.33^{ab}	2.22^{b}	24.51
	G	70.56	177.78	81.67	64.94	147.22	406.11	54.44	109.33
	F	32.22	92.78	22.00	36.52	138.33	44.44	43.33	43.36
IS	W**	437.00	219.44	352.00	114.06	317.11^{a}	122.78^{b}	92.78^{b}	37.39
	G	371.67	293.33	395.00	116.69	651.67	498.33	140.56	166.05
	F	421.67	404.22	314.22	100.12	531.11	530.56	363.56	173.54
SI	W	14.33	23.89	40.00	13.65	8.33	6.11	5.56	3.90
	G	51.56	93.67	51.89	26.43	34.67	45.44	39.44	9.10
	F	93.89	191.56	134.11	86.00	19.67	45.67	74.89	23.02
ST	W	210.44	202.11	324.00	52.23	55.89	200.22	221.56	33.43
	G	304.33	187.89	218.22	63.50	382.22	201.11	442.67	78.38
	F**	410.67^{a}	96.44^{b}	224.78^{ab}	58.28	346.78	248.67	430.44	64.27
Total	W**	2004.11	1958.00	2018.78	234.18	632.78^{a}	227.89^{b}	136.67^{b}	89.18
		(55.85)	(54.38)	(56.07)		(17.58)	(6.33)	(3.80)	
	G*	2016.44	1438.78	1572.00	304.78	1479.22^{ab}	1764.00^{a}	765.78^{b}	225.66
		(56.01)	(39.97)	(43.67)		(41.09)	(49.00)	(21.27)	
	F	1816.78	2277.78	2060.00	346.13	894.78	1568.11	929.89	258.18
		(63.27)	(50.47)	(57.22)		(24.85)	(43.56)	(25.83)	

CL, lateral recumbency in cluster; CS, sternal recumbency in cluster; IL, lateral recumbency individually; IS, sternal recumbency individually; SI, sitting, ST, standing; Total, total resting time; W, weaner; G, grower; F, finisher; SEM, standard error of means; Means in a row with different superscripts differ significantly at **P<0.01, *P<0.05; values in parenthesis indicates % of total observed time.

competitiveness as feeder had relatively more proximity to resting area than the other groups.

During preprandial period, exploratory as well as social activities (Table 4) did not differ between the groups except exploratory sniffing activity during weaner stage as shown for more (P<0.05) time in T_{IS} group than $T_{2/3}$ and $T_{1/2}$ groups. Prandial-cum-postprandial period witnessed more (P<0.05) exploratory nosing as well as overall (P<0.05) exploratory activities in T_{IS} and $T_{2/3}$ groups than $T_{1/2}$ group in weaners. While, during grower stage, exploratory sniffing was shown for least (P<0.05) duration in $T_{2/3}$ group. Exploratory nosing seemed to be most common type of exploratory activity. Overall social interactions (P<0.05) as well as nose-to-body contact were shown for more (P<0.05) duration in $T_{2/3}$ than $T_{1/2}$ group in finisher barrows. Nose-to-nose contact was shown for more (P<0.01) time in $T_{2/3}$ than other groups in weaners though it was least frequent activity. Comparative day-time activities of pigs in semi-intensive and intensive production systems suggested that eating, rooting, and explorative activities were more in semi intensive system but in intensive system pig spent most time either lying or standing (Kyriazakis and Whittemore 2006). At a weight of 50–85 kg and 85–110 kg, pigs should have 0.80 m^2 and 1 m^2 space per pig, respectively and increase in space allowance especially along with enrichment increases exploration activities in pigs (Van der Staay *et al.* 2017). Similarly, pigs spent more time in exploration in more space allowance groups ($T_{2/3}$ and T_{IS} groups) than $T_{1/2}$ group. Pigs with restricted pen space engaged in a greater number of social tactile interactions away from the feeder at 17 and 23 weeks of age, which may reflect in greater social stress (Morrison *et al.* 2003). Pigs housed at 0.8 m^2/animal spent more time participating in negative social behaviour (0.76 vs. 0.26%, P=0.0063) than those housed at 1.6 m^2/pig and pigs housed at 1.2 m^2/animal showed more positive social behaviours (1.28 vs. 0.14%, P=0.04) than those housed at 1.6 m^2 (Fu *et al.* 2016). In the present study, barrows showed variable pattern of social behaviour and $T_{2/3}$ group showed relatively more social interactions than other groups. Variations in floor space recommendations in different studies are due to variable group sizes, animal types and management (Whittaker *et al.* 2012) as well as environmental factors.

During prandial-cum-postprandial period, feeding time was significantly more (P<0.05) in $T_{1/2}$ group in weaners (Table 5). Growers of $T_{1/2}$ group spent relatively more (P<0.01) time walking during prandial-cum-postprandial

Table 4. Time spent (sec) in exploratory and social activities during different stages of barrows

Activity	Stage	Preprandial behaviour				Prandial and postprandial behaviour			
		T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM	T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM
EC	W	95.56	105.00	57.22	26.13	18.33	23.33	11.11	10.56
	G	58.33	20.00	25.00	18.16	38.33	32.22	47.22	13.53
	F	96.44	93.67	29.56	47.03	60.56	45.89	60.44	10.48
EN	W*	249.56	525.22	211.11	203.58	361.67^{a}	402.56^{a}	57.78^{b}	81.49
	G	257.11	192.78	67.22	88.20	155.33	101.67	200.56	44.93
	F	122.78	135.67	76.67	39.45	137.22	145.00	182.00	38.62
ES	W*	63.67^{a}	33.33^{b}	30.56^{b}	9.15	52.22	45.00	32.78	9.60
	G*	40.56	25.56	32.78	9.86	40.56^{a}	19.44^{b}	35.0^{ab}	5.58
	F	37.44	37.56	22.22	10.26	33.67	39.22	37.56	11.59
Total	W*	408.778	663.556	298.889	194.670	432.222^{a}	470.889^{a}	101.667^{b}	84.274
		(11.36)	(18.43)	(8.30)		(12.00)	(13.08)	(2.82)	
	G	356.00	238.33	125.00	98.42	234.22	153.33	282.78	50.17
		(9.89)	(6.62)	(3.47)		(6.51)	(4.26)	(7.86)	
	F	256.67	266.89	128.44	84.06	231.44	230.11	280.00	46.59
		(7.13)	(7.41)	(3.57)		(6.43)	(7.78)	(6.39)	
SB	W	86.56	57.67	114.78	33.87	4.44	11.33	13.44	5.75
	G	27.22	34.44	19.44	8.41	40.56	36.67	28.89	13.35
	F*	40.56	26.89	15.56	11.46	11.22^{ab}	31.44^{a}	7.33^{b}	6.25
SN	W**	1.67	4.78	7.11	2.37	1.22^{a}	5.00^{b}	0.22^{a}	0.94
	G	3.22	3.56	3.56	1.34	1.11	3.56	3.33	1.84
	F	4.11	2.00	2.44	1.28	0.00	1.67	1.67	0.89
Total	W	88.22 (2.45)	62.44 (1.74)	121.89 (3.39)	33.86	5.67 (0.16)	16.33 (0.45)	13.67 (0.38)	5.84
	G	30.44 (0.85)	38.00 (1.06)	23.00 (0.64)	8.79	41.67 (1.16)	40.22 (1.12)	32.22 (0.89)	14.29
	F*	44.67 (1.24)	28.89 (0.80)	18.00 (0.50)	11.88	11.22^{ab} (0.31)	33.11^{a} (0.92)	9.00^{b} (0.25)	6.18

EC, exploratory chewing; EN, exploratory nosing; ES, exploratory sniffing; Total, total exploratory activities; SB, nose to body interactions; SN, nose to nose interactions; Total, total time in social activities; W, weaner; G, grower; F, finisher; SEM, standard error of means; Means in a row with different superscripts differ significantly at **P<0.01, *p<0.05; values in parenthesis indicates % of total observed time.

Table 5. Time spent (sec) in feeding and other activities during different stages of barrows

Activity	Stage	Preprandial behaviour				Prandial and postprandial behaviour			
		T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM	T_{IS}	$T_{2/3}$	$T_{1/2}$	SEM
F	W*	672.78	431.33	588.00	113.05	2119.89^{a}	2275.22^{a}	2871.00^{b}	163.66
		(18.69)	(11.98)	(16.33)		(58.89)	(63.20)	(79.75)	
	G	725.00	1102.00	953.56	212.12	1030.33	1076.22	1382.78	235.94
		(20.14)	(30.61)	(26.49)		(28.62)	(29.90)	(38.41)	
	F	707.44	617.67	848.22	234.73	1709.33	1216.11	1241.11	233.791
		(19.65)	(17.16)	(23.56)		(47.48)	(33.78)	(34.48)	
W	W	67.22	80.56	72.22	14.89	88.33	89.33	131.11	14.71
	G**	54.56	48.11	55.89	13.13	67^{a}	37.78^{a}	138.44^{b}	15.92
	F**	83.22^{a}	16.44^{b}	39.11^{ab}	12.24	79.00^{a}	18.56^{b}	82.11^{a}	9.47
R	W	15.67	0.22	0.89	6.11	2.11	28.11	13.67	13.55
	G	2.67	3.33	2.22	2.43	8.89	4.44	38.89	14.23
	F	9.89	0.11	0.11	5.71	1.00	2.44	0.78	1.45

F, feeding; W, walking; R, running/frolicking; W, weaner; G, grower; F, finisher; SEM, standard error of least square means; Means in a row with different superscripts differ significantly at **P<0.01, *P<0.05; values in parenthesis indicates % of total observed time.

period. Finishers of T_{IS} and $T_{1/2}$ group showed more walking both during preprandial (P<0.01) as well as post-prandial (P<0.01) period. It was observed that finishers spent more time standing and walking at lower stocking density and performed exploratory activities simultaneously, whereas at higher stocking densities showed more walking around feeder to get access to feed probably due to more competitiveness as resting area remains relatively closer to feeders. Younger pigs spent more time eating than older ones (Gonyou and Lou 2000). Similarly, in present study, weaner pigs spent more than 50% of 1 hour time in feeding after offering of feed in all the groups and feeding time reduced at later stages. A density of about 0.5–0.6 m^2/pig decreased resting time and increased feeding time, although, this was not necessarily connected with increased feed intake (Brumm and Miller 1996). Whereas, pigs (110 kg)

housed at 2.4 m² spent more time eating than those housed at 1.2m² (4.7% and 4.4% of the time respectively, P<0.05; Vermeer *et al.* 2014). In present study, pigs at higher density spent more time feeding and lesser time resting especially during weaner and grower stages. Locomotory behaviour is influenced by pen space availability and reduced with space reduction (Morrison *et al.* 2003) however, such difference was not found during the recorded period and varying walking activity was noted during different stages. In higher space allowance group, more walking activity could be due to greater access of space for exploration.

From behavioural response, it can be concluded that at 33% reduced floor space allowance behavioural activities are broadly similar to IS group while at 50% reduction deviations are more indicating suitable floor space allowance should be in between 33 and 50% reduction in relation to IS specifications.

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