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Performance of crossbred (Landrace x *Desi*) barrows reared with different floor space allowances in small fixed group size

SANDEEP KASWAN[1], B.H. MANJUNATH PATEL[2], SHYAMAL K. MONDAL[3], SANJAY KUMAR[4], SUBHASHISH SAHU[5] and PANCH KISHOR BHARTI[6]

Livestock Production Management Section,
Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

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ABSTRACT

To review suitability of Indian Specifications (IS: 3916-1966) drafted way back for floor space requirement of pigs, 36 crossbred (Landrace x *Desi)* barrows were reared with 3 different floor space allowances {n = 4(group size) x 3(replications) = 12 each} including Indian Specifications as control group. Group T_{IS} (control) had floor space allowance (0.9, 1.35 and 1.8 m^2/pig during weaner, grower and finisher stage) as per Indian Standards (IS: 3916-1966), while $T_{2/3}$ and $T_{1/2}$ treatment groups had 33% and 50% reduced floor space allocation with fixed small (n=4) group size. Final body weight (28 week) was marginally higher in $T_{2/3}$ group followed by $T_{1/2}$ and T_{IS} groups. Major performance traits *i.e.* body weight, average daily gain (ADG) and feed conversion efficiency (FCE) did not differ significantly among the groups. For different treatment groups, floor space coefficient (*k* value) was estimated based upon specified floor space allocation and average body weight of pigs in respective group. Lowest value of coefficient of floor space allocation (*k* = 0.046) *i.e.* for $T_{1/2}$ group was found higher than suggested critical *k* value (0.034) in most of the countries. It was concluded that performance traits of crossbred barrows are not affected even at *k* value close to 0.05 in Indian climatic conditions.

Key words: Crossbred barrow, Floor space, *k* value, Performance

Efficient utilization of floor space without adversely affecting the productivity is an important aspect for profitable pork production. Efficient use of indoor floor space enhances economic and management benefits[1,28]. [2,12,21]Many researchers have suggested that space allocations should be based on an allometric equation {A (m^2) = *k* x $BW^{0.67}$(kg)}, which relates total space requirements (A) to average pig weight (BW) by some appropriate factor (*k*). Lot of values has been suggested for *k* coefficient, which varies from 0.029 to 0.05 and critical value of *k* has been suggested as 0.034 below which growth rate of pig retards. Some studies indicate that still there is scope of reduction of floor space for pigs through environment enrichment[7,20].

Average meat yield of pigs in India is 35 kg/animal, which is about 55% less than the corresponding value of world average[10]. Considering average body weight of Indian crossbred weaner pig (2 months) as 9 kg and finisher pig (8 months) as 70 kg and covered floor area allocations as per Indian Standards[15] ranges between 0.9 and 1.8 m^2/pig then *k* value would be 0.206 and 0.104 respectively, which is 6.1 and 3.1 times higher than recommended critical *k* value (0.034). Hence, this investigation was carried out to assess the scope of reduction in floor space allowance for pigs considering performance traits.

1 Corresponding Author: Assistant Professor, Department of Livestock Production Management, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, Punjab, India-141004; Email ID: deepu02vet@gmail.com

2 Principal Scientist, Indian Veterinary Research Institute, Bangalore Campus, India-560024

3 Principal Scientist, Agricultural Technology Application Research Institute (ICAR) Salt Lake, Kolkata, India-700097

4 Pricipal Scientist, Livestock Economics, Statistics and Information Technology, Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India-243122

5 Assistant Professor, Department of Livestock Production Management, LUVAS, Hisar, Haryana

6 Scientist, LPM Section, IVRI, Izatnagar, Bareilly, U.P.-243122

MATERIALS AND METHODS

Experimental animals, facilities and management conditions

A total of 36 crossbred {Landrace x *Desi* (local Indian)} male piglets, from 14 litters of unrelated sows farrowed contemporarily, were selected randomly taking body weight and age into consideration at Indian Veterinary Research Institute, India. These piglets were castrated at one month of age, weaned at 6 weeks of age and subsequently distributed randomly in to three equal groups {n=12 each (group size=4, replications=3)} on the basis of 3 different floor space allowances. T_{IS} (control) group provided floor space as per Indian Standards[15] 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 (23-28 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 (Table 1). Group size of pigs (4) remained same throughout the study.

Table 1. Floor space allowance (m^2/pig) for different treatment groups

Stages	Groups		
	T_{IS}	$T_{2/3}$	$T_{1/2}$
Weaner (6-14 weeks)	0.9	0.6	0.45
Grower (15-22 weeks)	1.35	0.9	0.68
Finisher (23-28 weeks)	1.8	1.2	0.9

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 (May-November, 2012). During weaner, grower and finisher stage 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.

Growth observations and '*k*' value estimation

Pigs were fed twice daily with weighed quantity of concentrate feed and residual feed was measured in the afternoon and next morning. Accordingly, quantity of offered feed was gradually increased. Daily feed intake was calculated after making correction for feed residues collected. Body weights were recorded at weekly interval during weaner stage and at fortnightly interval during grower-finisher stages using electronic balance. Average daily gain (ADG) and feed conversion efficiency (FCE) were calculated from body weights and feed intake values.

For different treatment groups, *k* value was estimated based upon specified floor space allocation and average body weight of the animals of respective group using equation $A\ (m^2) = k \times BW^{0.67}$ (kg), where (A) = Total space requirement, (BW) = Average pig weight, and (*k*) = Coefficient.

Statistical analysis

The data, thus collected during the experimental period, was subjected to the statistical analysis as per the procedures[25] using the Statistical Analysis System (SAS institute Inc., Cary, NC; USA). The mean and standard error values have been presented and data collected for three treatment groups was compared using ANOVA. P value of ≤ 0.05 was considered significant in the analyses.

RESULTS AND DISCUSSION

Body growth and FCE

Body weight of barrows during 6 to 28 weeks of age (6-14 weeks at weekly interval and later fortnightly) didn't differ significantly (Table 2). Body weight gain was meagre during first week probably due to weaning and mixing stressors. In T_{IS} group, body weight even reduced probably due to large unutilized floor area inflicting more loneliness. ADG gradually increased in all the groups and hovered in the range of 500 to 800 g/d during grower-finisher stages (Fig.1). Final body weight was marginally higher in $T_{2/3}$ group followed by $T_{1/2}$ and T_{IS} groups. Body weight of barrows reared with 3 different floor space allowances did not differ between groups.

Table 2. Mean body weight (kg) of weaner (6-14 weeks) and grower-finisher (15-28 weeks) barrows

Groups	Age of weaner (weighed weekly)									
	6	7	8	9	10	11	12	13	14	SEM
T_{IS}	8.67	8.55	8.67	9.38	10.63	11.92	13.36	16.28	19.57	0.754
$T_{2/3}$	9.01	9.03	9.36	10.19	11.33	12.8	14.49	17.48	21.02	0.754
$T_{1/2}$	9.13	9.21	9.68	10.44	11.45	12.88	14.50	17.78	21.55	0.754
Groups	**Age of grower-finisher (weighed fortnightly)**									
	16	**18**	**20**	**22**	**24**	**26**	**28**	**SEM**		
TIS	27.16	36.97	44.68	52.72	60.04	71.33	77.88	2.36		
T2/3	30.23	39.25	45.57	53.74	63.86	73.43	80.19	2.36		
T1/2	29.34	38.95	46.20	54.83	62.69	72.09	78.16	2.36		

SEM = standard error of least square means

Earlier study[24] under Indian climatic conditions reported that weaner pigs with floor space of 0.48 m^2 per pig had lower weight gain than the other groups (0.56, 0.67, 0.84, 1.12 m^2), however, different group sizes could have confounded the effect of floor space allowance in their study. Crowding has negative impacts on feed intake and growth[4,16,17]. Hyun *et al.* (1998)[14] reported slower growth rate in growing pigs with restricted space allowance (0.25 m^2/pig) than pigs with greater space allowance (0.56 m^2/pig) for each week of the four weeks study. Dedecker *et al.* (2005)[8] reported that the growth performance of pigs decreased but total live weight produced/pen increased linearly with increasing groups size (2450, 2839, and 3147 kg of live weight produced/pen for 22, 27, and 32 pigs/pen, respectively).

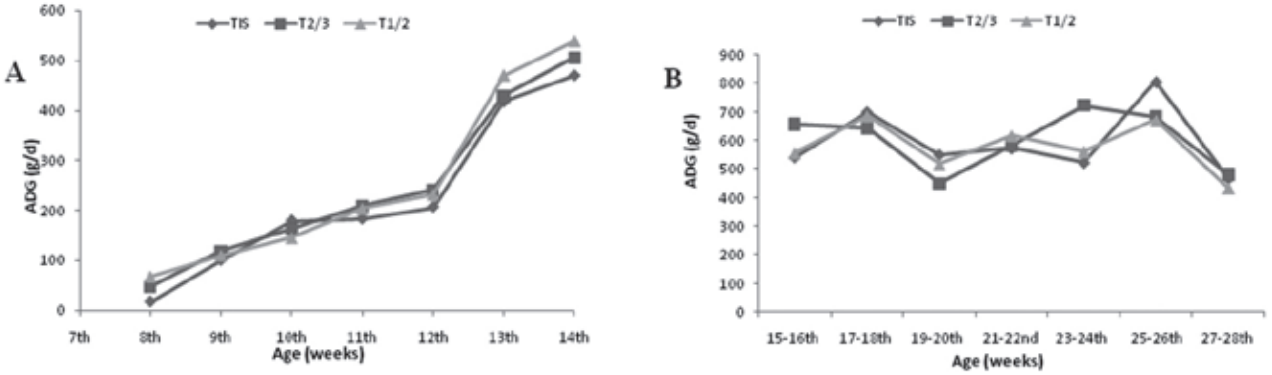

Fig.1. *(A) Mean ADG of pigs during weaner stage (weekly) and (B) grower-finisher stage (fortnightly): pigs reared with Indian standards specification (T_{IS}), pigs reared with 67 % of IS specification ($T_{2/3}$), and pigs reared with 50 % of IS specification ($T_{1/2}$).*

Some authorities recommend 0.4m² floor space per piglet for optimum growth in weaner pigs and space allowances above/below 0.7 m² per 100 kg of pig live weight in the pen will increase/decrease individual pig growth rate by about 2.5% for every 0.1m² change in space allowed[18]. Crowding to a space allowance coefficient of 0.026 resulted in a reduction in ADG[9]. Reducing space allowance from 0.93 to 0.66 m²/pig resulted in 4.0% less body weight and 17.0% less ADG[30]. During six-week nursery period, the crowding reduced ADG of gilts (577: 0.50 m²/pig, 536: 0.25 m²/pig, and 558 g/d: 0.25 m²/pig) and barrows (578, 539 and 527 g/d)[6]. Similarly, Vermeer *et al.* (2014)[29] found that ADG of pigs (110 kg) was higher at 2.4 and 1.6m² than 1.2m² space allowance (827 and 817 vs. 786 g/d, P=0.002). In finishing pigs (initial wt. 80.1 lb) too increased ADG was in pens stocked at 9.7 ft² (P<0.05) against 6.9 ft²/pig[11]. Contrarily in present study, floor space reduction had no significant effect on body weight and ADG values which could be due to the fact that despite 50% reduction of IS specifications i.e. 0.9 m² per finisher pig, *k* values hovered around 0.05 which would not have been sufficient to hamper the dry matter intake and body growth.

FCE values did not differ among the groups during different intervals except during one fortnight of grower (P<0.05) and finisher (P<0.05) stage each (Table 3) where FCE remained highest for T_{IS} group. FCE values remained marginally higher during weaner and grower stages than finisher stage in all the groups. In present study FCE too did not differ among the groups for most of the observations while Sharma *et al.* (2004)[23] reported maximum ADG and FCE for 0.9 m²/pig space for Hampshire grower pigs (12-35 kg BW) among 4 different space allocations i.e. 0.4, 0.6, 0.9 and 1.2 m² and group sizes of 12, 9, 6 and 9, respectively. There is tendency for high stocking density to adversely affect the FCR of finishing pigs[19]. FCE tended to be higher for space (1.4 m²/pig) than (1 m²/pig) in finisher pigs up to 160 kg body weight[22]. Similarly[27], pigs that were crowded (0.52 m²/pig) had poorer feed efficiency than pigs that were not crowded (0.78 m²/pig) (2.7 versus 2.5 lb feed/lb gain, respectively). Whereas, Brumm *et al.* (2004)[5] found no difference in feed conversion as a result of space allocations and the impact of space on FCE is less predictable[3]. As it has been suggested that FCE is adversely affected at higher stocking density and at little higher or other stocking densities it is difficult to predict FCE as supported by present study too.

Table 3. FCE of weaner and grower-finisher barrows

Groups	Weaner stage (weekly)								
	7th	8th	9th	10th	11th	12th	13th	14th	SEM
T_{IS}	-*	0.157	0.512	0.656	0.374	0.425	0.558	0.541	0.071
$T_{2/3}$	0.029	0.320	0.467	0.556	0.399	0.419	0.447	0.506	0.071
$T_{1/2}$	0.091	0.392	0.420	0.489	0.381	0.431	0.493	0.528	0.071
Groups	**Grower-Finisher stage (Fortnightly)**								
	15-16th	17-18th	19-20th	21-22nd	23-24th	25-26th	27-28th	SEM	
T_{IS}	0.411	0.445^{a}	0.339	0.279	0.259	0.330^{ab}	0.175	0.021	
$T_{2/3}$	0.421	0.356^{ab}	0.284	0.273	0.290	0.257^{b}	0.171	0.021	
$T_{1/2}$	0.372	0.398^{a}	0.287	0.274	0.240	0.249^{b}	0.149	0.021	

Means bearing different superscripts column wise are significantly (P<0.05) different; *FCE was not estimated as body weight slightly decreased

Estimates of *k* value

Range of coefficient for floor space allowance (*k*) values for each stage has been presented in Table 4 derived using initial and final mean body weight into consideration. Least *k* values were obtained for $T_{1/2}$ group during grower and finisher stages i.e. 0.046 and 0.049, respectively. Lot of values has been suggested for *k* coefficient, which varies from 0.029

to 0.05. However, most widely accepted critical value of *k* has been suggested as 0.034[12,13], below which growth rate of pig retards.

Table 4. Range of k values during different growth stages

Groups	Weaner	Grower	Finisher	Overall Range
T_{IS}	0.212 - 0.123	0.184 - 0.095	0.126 - 0.097	0.212 - 0.095
$T_{2/3}$	0.138 - 0.078	0.117 - 0.062	0.083 - 0.064	0.138 - 0.062
$T_{1/2}$	0.102 - 0.058	0.087 - 0.046	0.062 - 0.049	0.102 - 0.046

Range of k values estimated using initial and final weight of each stage with respect to allotted floor space in the equation $A\ (m^2) = k \times BW^{0.67}$ (kg)

A change in *k* value of 0.005 below optimum may be taken to be associated with a 4% change in feed intake (when $k \approx 0.025$ there is just sufficient space for the pig to lie down). In present study, *k* value for lowest floor allowance i.e. $T_{1/2}$ group (ranged between 0.046 to 0.102) was relatively higher than earlier studies. Extrapolation of *k* values in the comfort zone to T=31◦C suggests a range of *k*-values from *k* = 0.0331 to *k* = 0.0385 for static space indicating increased floor space requirement for pigs at high temperatures[26]. Variations in floor space recommendations in different studies are due to variable group sizes and management factors such as feeding[31] as well as environmental factors.

CONCLUSIONS

Present investigation highlights that major performance traits *i.e.* ADG and FCE did not differ significantly despite 50% reduction to IS specifications indicating that floor space can be provided using floor space coefficient (*k*) close to 0.05 without compromising performance.

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